Environmental and Social Impact Assessment (ESIA) for Offshore Drilling Activities in Namibia in PEL 82

Draft ESIA Report

PREPARED FOR

CHEVRON NAMIBIA EXPLORATION LIMITED II

IN COLLABORATION WITH

URBAN DYNAMICS

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Draft ESIA Report

0775081

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NON-TECHNICAL SUMMARY

Draft Environmental and Social Impact Assessment for Proposed Offshore Drilling Activities in Namibia in PEL 82

Proponent: Chevron Namibia Exploration Limited II

PURPOSE OF THIS DOCUMENT: This document provides a non-technical summary of the Draft Environmental and Social Impact Assessment (ESIA) Report. It outlines the potential exploration activities, describes the current environmental and socio-economic conditions in the project area and assesses the potential impacts. It also explains how stakeholders can participate in the ESIA process.

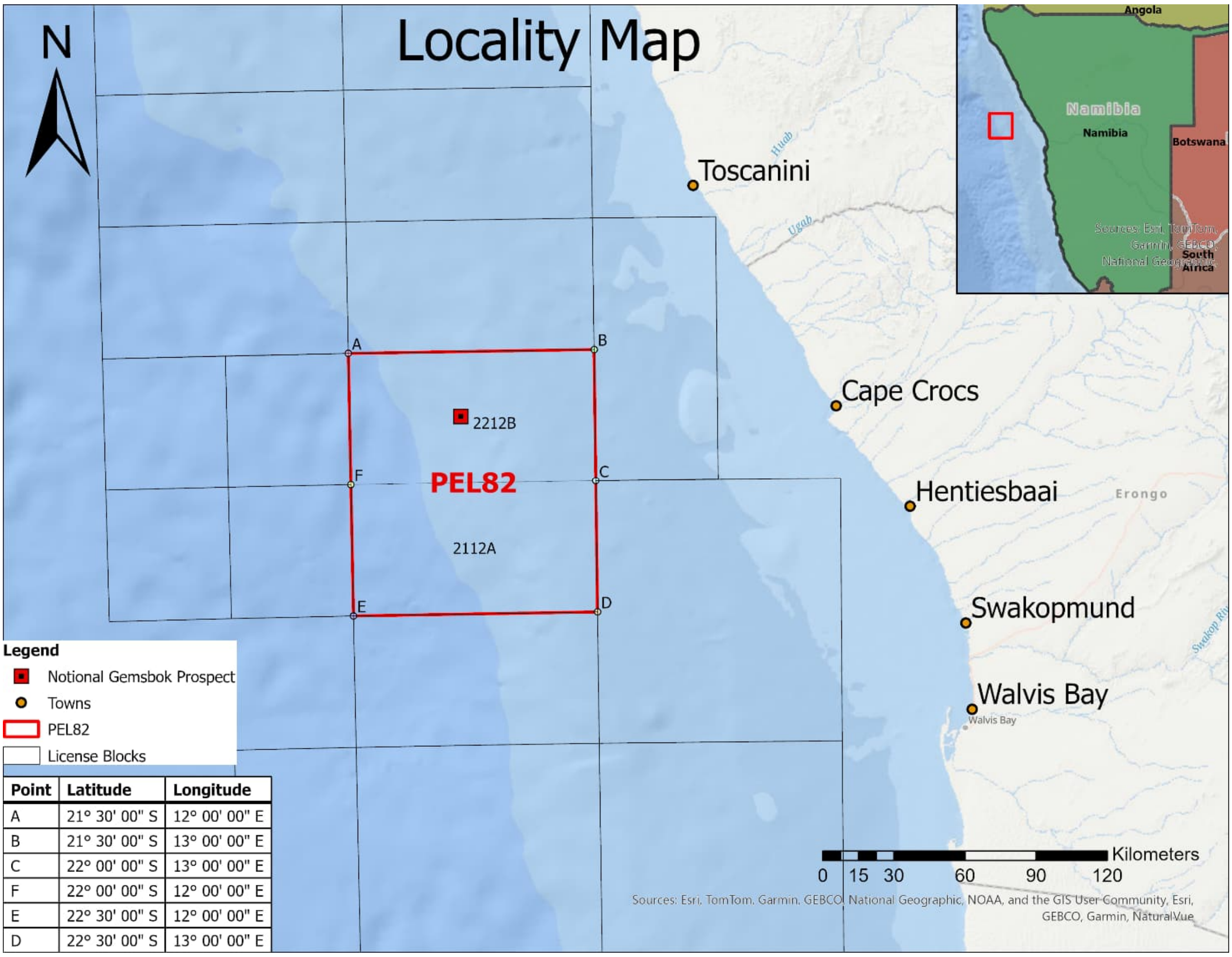
PROJECT OVERVIEW AND DESCRIPTION

Chevron Namibia Exploration Limited II (CNEL) is considering conducting offshore oil and gas exploration activities within the Walvis Basin, located 72-300 km off the coast of Namibia. This area, known as Petroleum Exploration License (PEL) 82, includes two blocks, namely: 2112B and 2212A.

The exploration project is being considered in the 2026/2027 timeframe, in a location called the Gemsbok prospect. Based on the results of this initial well, it may be followed by an appraisal well. Additional drilling campaigns of up to 3 to 4 wells could potentially start from late 2027 to 2028 over a 3 to 5 year period for a total of up to 10 wells (exploration or appraisal). These activities are part of a broader effort to understand whether there are commercially viable oil and gas resources in the area.

To support responsible project development with reduced impact on the environment and local communities, CNEL has commissioned an Environmental and Social Impact Assessment process. This process is being led by Environmental Resources Management Southern Africa (ERM) in collaboration with Urban Dynamics (UD), an independent team of environmental experts.

FIGURE 1 MAP INDICATING THE LOCATION OF THE PROPOSED PROJECT SITUATED WITHIN PEL 82, ENCOMPASSING BLOCKS 2112B AND 2212A IN THE WALVIS BASIN, OFFSHORE NAMIBIA



PROJECT COMPONENTS

Table 1 below provides a summary of the main project components.

TABLE 1: SUMMARY OF MAIN COMPONENTS BEING CONSIDERED

Item	Detail
Purpose	To confirm and test the presence and quality of hydrocarbon resources
Potential number of exploration and appraisal wells	• Up to 5 exploration wells • Up to 5 appraisal wells
Size of Area of Interest for potential exploration drilling	Blocks 2112B and 2212A spanning approximately 11,400 km² located between 72 km and 300 km offshore
Water depths across License area:	Between 200 m and 2,500 m across the license blocks
Well depth (below seafloor)	Variable depth of 1,500 to 4,000 m. A notional well depth of 4,000 m is assumed for the assessment.
Duration	• Mobilisation phase: up to 15 days • Drilling phase: ◦ Well Exploration (including abandonment): up to 60 days

Item	Detail
	◦ Appraisal well: up to 60 days (including abandonment and testing) • Demobilisation phase: up to 15 days. • Total duration 90 days
Commencement of drilling and anticipated timing	The first well on the Gemsbok Prospect may be drilled in the 2026/2027 timeframe.
Potential drilling fluids (muds)	• Riserless stage: Water-Based Muds (WBM). • Risered stage: NADF in a closed-loop system.
Drilling and support vessels	• Drillship or semi-submersible drill rig. • Three to four support vessels. These vessels will be on standby at the drilling site, as well as moving equipment and materials between the drilling unit and the onshore base.
Operational safety zone	Minimum 500 m radius around drilling unit
Flaring	If hydrocarbons are discovered, one or two well tests may be performed per well.
Logistics base	Walvis Bay
Logistics base components	Office facilities, warehouse, laydown area, mud plant.
Support facilities	• Crew accommodation in Walvis Bay area. • Helicopter transport from Walvis Bay. • Fixed-wing transport from Windhoek.
Staff requirements:	• Specialised drilling staff supplied with hire of drilling unit. • Additional specialised international and local staff at logistics base.
Staff changes	Rotation of staff every four weeks with transfer by helicopter to shore.

PROJECT ACTIVITIES

The offshore drilling project will unfold in five main phases, as described below (i.e. Mobilization Phase, Drilling Phase, Well Logging Testing Phase, Well Plugging and Abandonment Phase and Decommissioning Phase).

MOBILIZATION PHASE

Before any drilling begins, a range of preparations must take place:

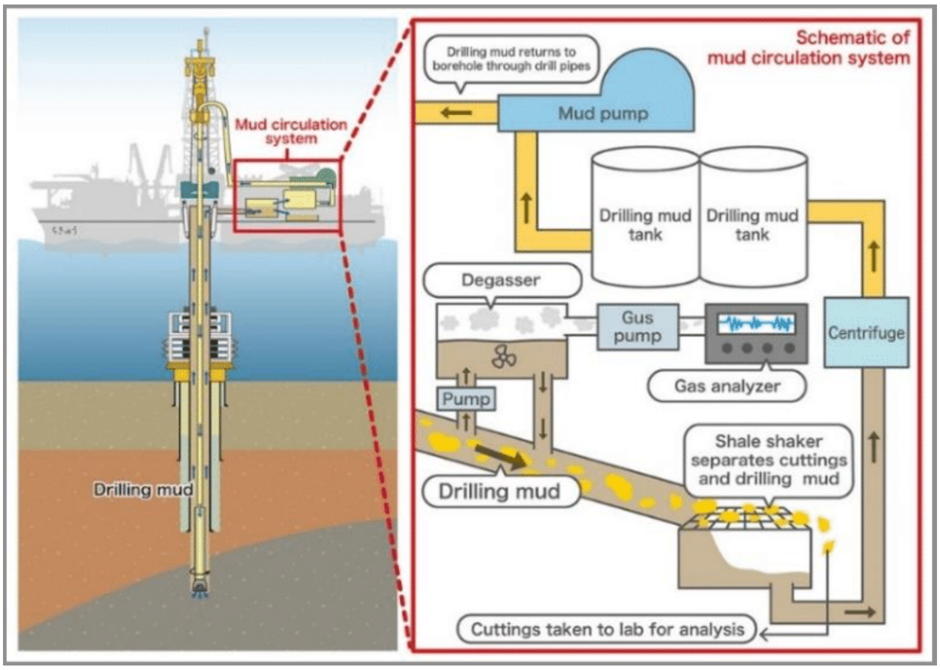
- Transport of equipment and vessels: The drillship and support vessels will be moved to the drilling site, either from a Namibian port or directly from international waters.
- Setup of the shore base: Walvis Bay will serve as the logistics hub, storing materials like pipes, drilling fluids, and fuel.
- Seabed surveys and safety checks: Remote Operated Vehicles (ROVs) will inspect the seabed to ensure it's safe for drilling. Navigation systems and safety drills will also be tested.

DRILLING PHASE

The offshore drilling process for CNEL's exploration project in Namibia's Walvis Basin involves two main stages: riserless drilling and risered (closed-loop) drilling. The operation begins with a drillship or semi-submersible rig positioned at sea using a dynamic positioning system, which allows the vessel to remain stable without anchoring. In the first stage, known as riserless drilling, the upper sections of the well are drilled directly into the seabed without a return pipe (riser). During this phase, the drill cuttings (small fragments of rock created by the drill bit) are released directly onto the seafloor. Water-based drilling muds are used to aid the drilling process and stabilize the well.

Once the initial sections are complete, the operation transitions to the risered drilling stage. A marine riser, which is a large pipe, is installed to connect the wellhead on the seabed to the drilling unit on the surface. This creates a closed-loop system that allows drilling fluids and cuttings to be circulated back to the ship for treatment and recycling. In this phase, non-aqueous drilling fluids (NADF) are typically used due to their superior performance in deeper, more complex geological formations. The well is drilled to depths of up to 4,000 meters below the seabed, with metal casing and cement used to stabilize the borehole and isolate different geological layers. Throughout the process, strict environmental and safety protocols are followed to minimize impacts on the marine environment and ensure operational integrity.

FIGURE 2 DRILLING SCHEMATIC



WELL LOGGING / TESTING PHASE

During drilling, information about the underground rock layers is collected, with more detailed checks (known as wireline logging) planned only if the well shows signs of success. If oil or gas is discovered, a technique called Vertical Seismic Profiling (VSP) may be potentially used to create a clearer image of the underground formations.

Based on the results of the exploration well, a second well, known as an appraisal well, may be drilled and tested to further understand the hydrocarbon potential. Well testing involves the flaring (burning off excess gas).

WELL PLUGGING AND ABANDONMENT

After drilling and testing are complete, the well is permanently sealed to ensure safety and environmental protection. Cement plugs are placed at key points inside the well to block any fluid movement, and a final cap is installed at the top. In deep waters, the wellhead may be left in place for possible future use. A remotely operated vehicle (ROV) performs a final inspection to confirm the site is clean and secure. This process follows strict safety standards and is carried out whether or not oil or gas is found.

FIGURE 3 EXAMPLE OF TYPICAL DRILLING UNIT (LEFT) AND ROV (RIGHT)

DEMOBILIZATION PHASE

Once operations are complete:

- The drillship and support vessels are removed from the site.
- Onshore facilities are cleared and returned to normal use.

Any remaining waste or equipment is transported to licensed disposal or recycling facilities.

PROJECT ALTERNATIVES

The ESIA Report compared different options for how the offshore drilling project could be carried out—like where to drill, when to drill, how many wells to drill, and what equipment or methods to use. Most of these options were either already optimized or had similar environmental impacts, so they weren't explored further. The only option looked at in more detail was the "No-Go" alternative, which means not drilling at all. This would avoid environmental and social impacts but also mean missing out on learning whether there are useful oil or gas resources in the area and potentially losing economic opportunities for Namibia.

EMERGENCY RESPONSE

CNEL, an affiliate of Chevron, is part of the Oil Spill Response Limited (OSRL) industry-funded cooperative for oil spill preparedness and response. This means CNEL has access to special equipment that can be used to control a potential subsea well control incident. This equipment works with most types of wells and can be mobilised, as needed. Instructions on how to access this equipment and the assistance that comes with it are included in CNEL's plans and agreements for dealing with potential, but unlikely, loss of containment events and other emergencies.

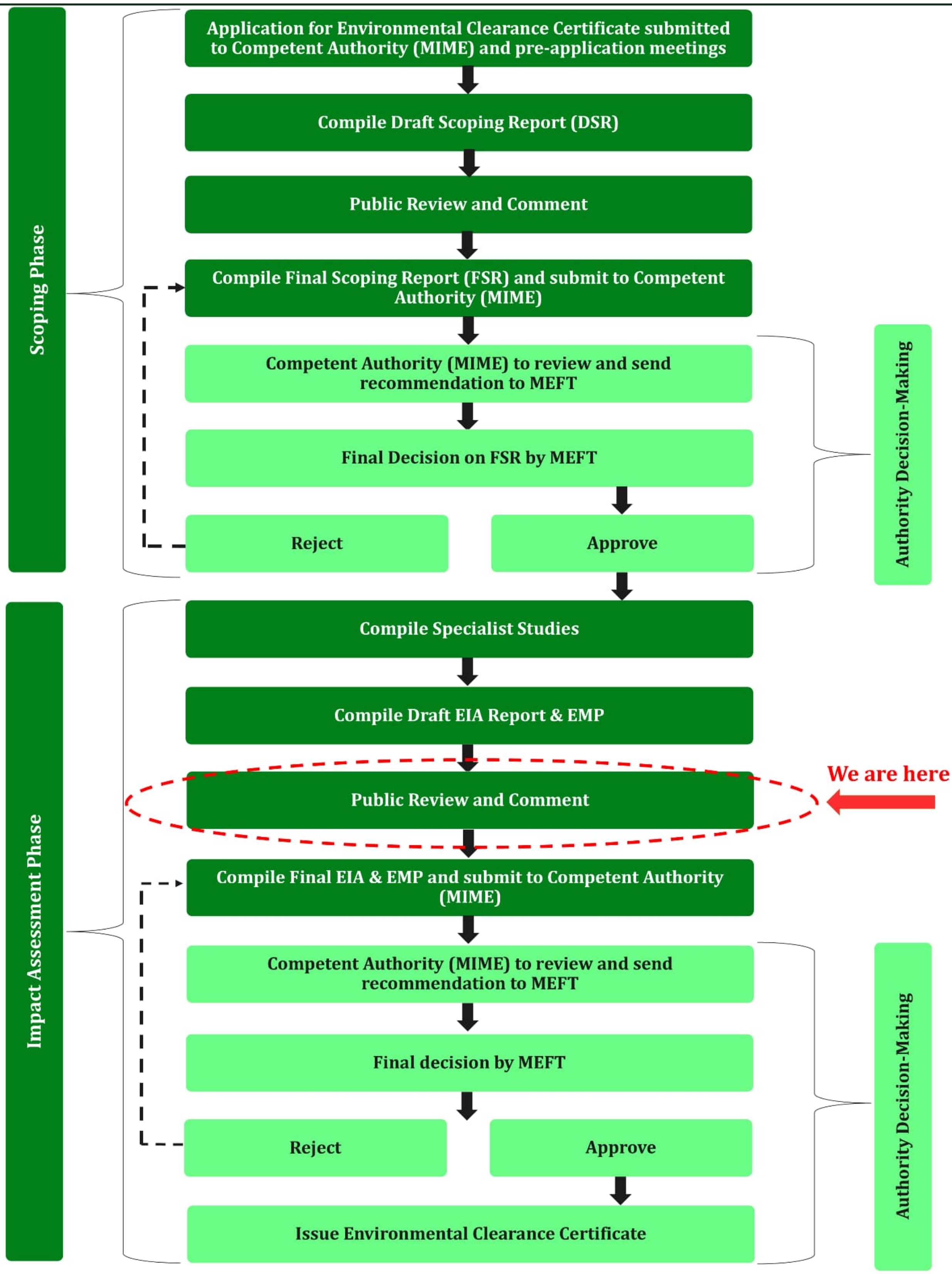
The key environmental and social conditions and sensitivities for the potential project area are summarised in Table 2 below. For a full description of potential environmental and social sensitivities refer to Section 4.6 of the ESIA Report.

Category	Sensitivity	Description
Physical Environment	Upwelling & Low Oxygen Events	Perennial upwelling near Walvis Bay; periodic low oxygen and sulphur eruptions affecting marine life.
	Sediment Transport	Strong winds and swells mobilize sediments; 'berg' winds can transport dust 150 km offshore.
	Ocean Currents & Circulation	Influenced by Benguela and Angola currents; episodic Benguela Niños bring warm water and species shifts.
	Bathymetry & Geology	Complex seabed with Walvis Ridge and phosphate-rich sediments; potential for marine archaeology.
Biological Environment	Pelagic Habitat	North-eastern PEL 82 is 'Endangered'; rest is 'Least Threatened'.
	Fish	Includes endangered and vulnerable species (e.g., kob, sharks, tuna); spawning grounds for hake and monkfish.
	Benthic Communities	Poorly known understood beyond 450 m depth; some areas rated 'Vulnerable' or 'Endangered'.
	Demersal Fish & Invertebrates	Includes commercially important species (e.g., hake, monkfish, red crab); sensitive to oxygen levels.
Social Environment	Artisanal Fishers	Vulnerable livelihoods; dependent on access to marine resources; Topnaar community may be potentially vulnerable.
	Employment & Skills	Limited availability of skilled workforce in oil and gas industry
	Vulnerable Groups	Includes elderly, disabled, and people living on low incomes.
	Cultural Heritage	Potential for unrecorded marine archaeology (e.g., shipwrecks)
	Marine Traffic & Use	PEL 82 lies in trawling lanes and shipping routes; potential for user conflict.
	Conservation Areas	PEL 82 overlaps with Ecological Support Areas (ESAs), Marine IBAs, and is adjacent to EBSAs and Ramsar sites. Six coastal IBAs lie inshore of the license block; of which, two (Walvis Bay Wetland and Sandwich Harbour) are designated RAMSAR sites.

ESIA PROCESS

The ESIA process evaluates potential project impacts, both positive and negative, with input from Interested and Affected Parties. It identifies necessary management measures to mitigate negative effects. The process includes Scoping and Impact Assessment phases and is currently in the Impact Assessment Phase. The purpose is to provide a process so that individuals and groups affected by or interested in the project are informed, consulted and provided with meaningful opportunities to participate.

FIGURE 4 ESIA PROCESS PHASE AND STEPS



STAKEHOLDER ENGAGEMENT

A Stakeholder Engagement Plan (SEP) has been developed to guide this process. It includes a grievance mechanism (GM) and will be updated as the project progresses to reflect changes in the stakeholder context and Project requirements. Key features include:

- Public meetings in affected area.
- Information sharing in local languages (English, Afrikaans, Oshivambo).
- Use of local media (newspapers, radio) to announce meetings and share updates.
- Distribution of Background Information Documents (BIDs) to help people understand the
- project.
- Recording feedback and concerns during meetings.
- Inclusion of vulnerable groups, such as the elderly, disabled, or low-income households, using tailored approaches to ensure that they can participate.
- Receiving and responding to community grievances.

ENGAGEMENT ACTIVITIES

To date, the following stakeholder engagement activities have been undertaken:

- Distribution of the Scoping phase Non-Technical Summary (NTS) with meeting invitations.
- Invitations sent to all stakeholders in the project database, with access to the Scoping Report (DSR) and NTS via a dedicated website.
- Meeting details advertised in The Namibian and New Era newspapers over two consecutive weeks.
- Public comment period for the DSR from 26 May to 19 June 2025.
- Public meeting held on 12 June 2025 at 17:30 at the Walvis Bay Town Hall.
- Focus group meeting held on 03 July 2025 with Ms. La-Toya Shivute from the Ministry of Fisheries and Marine Resources (MFMR).
- Distribution of the ESIA phase Non-Technical Summary (NTS) with meeting invitations.
- Invitations sent to all stakeholders in the project database, with access to the Scoping Report, ESIA and NTS via a dedicated website.
- Meeting details advertised in The Namibian and New Era newspapers over two consecutive weeks.
- Public comment period for the ESIA Report and appendixes from 1st October to 11th November 2025.
- Public meeting will be held on 09th October 2025 at 17:30 at the Protea Hotel.

Key Issues raised by stakeholders during the scoping phase public meetings are summarised within Table 5-5- and Table 5-6 of the ESIA Report.

HOW YOU CAN GET INVOLVED IN THE PROJECT?

If you’re interested in the project or think it might affect you, you can take part by registering as an Interested and/or Affected Party (I&AP). This means you’ll receive updates and have the chance to share your thoughts, ask questions, or raise concerns.

You can also comment on the ESIA Report and appendixes and be part of the public consultation process. Getting involved is easy, just reach out using any of the contact details below (or scan the QR code below):

Contact Person: Heidri Nel

Postal Address: PO Box 20837, Windhoek

Phone /SMS/WhatsApp: +264 81 124 5188 or +264 81 651 7336

Email: cnel.pel82esia@udanam.com

NEXT STEPS IN THE ESIA PROCESS

The current draft ESIA Report has been submitted to the Namibian authorities for review and approval. Copies of the Draft ESIA Report and Non-technical Summary are available on the project website: cnel-esia (https://www.erm.com/public-information-sites/cnel-esia/) and hard copies are available at the Walvis Bay Municipality and Kuisebmond Library.

After this period, the following steps will be undertaken:

- A Final ESIA Report will be prepared, incorporating feedback from the authorities and stakeholders.
- The final documents will be submitted to the competent authorities for consideration.
- After final revisions, the authorities will decide whether to approve the project and issue an ECC.
- Stakeholders and/or interested parties will be informed of the final decision.

DESCRIPTION OF THE RECEIVING ENVIRONMENT

KEY ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

The key environmental and social conditions and sensitivities for the potential project area are summarised in Table 2 below. For a full description of potential environmental and social sensitivities refer to Section 4.6 of the ESIA Report.

TABLE 2: KEY ENVRONMENTAL AND SOCIAL SENSITIVITIES FOR POTENTIAL PROJECT AREA

Category	Sensitivity	Description
Physical Environment	Upwelling & Low Oxygen Events	Perennial upwelling near Walvis Bay; periodic low oxygen and sulphur eruptions affecting marine life.
	Sediment Transport	Strong winds and swells mobilize sediments; 'berg' winds can transport dust 150 km offshore.
	Ocean Currents & Circulation	Influenced by Benguela and Angola currents; episodic Benguela Niños bring warm water and species shifts.
	Bathymetry & Geology	Complex seabed with Walvis Ridge and phosphate-rich sediments; potential for marine archaeology.

Category	Sensitivity	Description
Biological Environment	Pelagic Habitat	North-eastern PEL 82 is 'Endangered'; rest is 'Least Threatened'.
	Marine Mammals	Up to 33 different whale and dolphin species might be found in the potential project. Some of these species are endangered and need protection. Although humpback, sperm and pilot whales may be seen in the PEL 82 area, it's not very likely.
	Turtles	Leatherback and loggerhead turtles might be seen in the offshore waters of the license area, but this is not very likely. Both species are important to protect because they are considered threatened
	Fish	Includes endangered and vulnerable species (e.g., kob, sharks, tuna); spawning grounds for hake and monkfish.
	Seabirds	Most seabirds that nest along Namibia's coast usually feed close to shore, within 10 to 30 km. However, Cape Gannets and African Penguin can travel much farther (sometimes up to 140 km offshore). The nearest colonies of these birds to the PEL 82 area are located on Mercury and Ichaboe Islands, which are over 300 km to the southeast. Since the potential project area is about 72 km offshore and lies north of these islands, it's unlikely that these birds will be affected by exploration drilling activities
	Benthic Communities	Poorly understood beyond 450 m depth; some areas rated 'Vulnerable' or 'Endangered'.
	Demersal Fish & Invertebrates	Includes commercially important species (e.g., hake, monkfish, red crab); sensitive to oxygen levels.
Social Environment	Artisanal Fishers	Vulnerable livelihoods; dependent on access to marine resources; Topnaar community may be potentially vulnerable.
	Commercial Fishing	Different types of fishing happen regularly in the PEL 82 license area: • Bottom trawling for hake and monkfish. • Mid-water trawling. • Longline fishing for surface and deep-sea species. Bottom longline fishing makes up about 15% of Namibia's national catch in this area, while bottom trawling contributes around 4.8%. Other types of fishing (for example mid-water trawl, pelagic longline and crab fishing) are also active but make up smaller portions. Fishing methods such as small pelagic purse seining, rock lobster harvesting, and mariculture are not expected to be affected by drilling, as they take place in shallower waters closer to shore.
	Employment & Skills	Limited local employment and contracting opportunities during exploration.
	Vulnerable Groups	Includes elderly, disabled, and people living on low incomes.
	Cultural Heritage	Potential for unrecorded marine archaeology (e.g., shipwrecks); intangible heritage linked to ocean.

Category	Sensitivity	Description
	Marine Traffic & Use	PEL 82 lies in trawling lanes and shipping routes; potential for user conflict.
	Conservation Areas	The PEL 82 license area does not overlap with nearby protected marine zones, however a small proportion (less than 40 %) of it does fall within areas that help support marine life. Along the coast near the license area, there are six important bird areas, including Walvis Bay Wetland and Sandwich Harbour, which are internationally recognised for their conservation value.

ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

The scoping process identified the key environmental and social impacts that required further assessment. These impacts were studied in detail during the drafting of the ESIA Report to allow appropriate mitigation and management measures to be reported. Table 3 outlines the impact categories, associated issues, causes or activities, why they matter and what was assessed. Details are provided in Chapters 7 to 10 of the ESIA Report.

TABLE 3: SUMMARY OF ENVIRONMENTAL AND SOCIAL CONSIDERATIONS ASSESSED IN THE CURRENT ESIA PHASE

Impact Category	Issue	Cause/Activity	What Was Assessed
Marine Environment	Seabed and water quality degradation	Seabed disturbance, discharge of drill cuttings and fluids during drilling, and release of residual cement	Seabed disturbance and spread and impact of cuttings and fluids on marine ecosystems
	Water quality changes from cement discharge	Disposal of excess cement during well casing	Volume and dispersion of cement and its environmental effects
	Disturbance to marine fauna from noise and lighting	Drilling operations, vessel movement, and potential vertical seismic profiling (VSP)	Noise levels and potential behavioural impacts on marine species
Fisheries & Navigation	Restricted access to fishing and navigation areas	Safety exclusion zones around drilling sites	Extent and duration of access restrictions and their socio-economic implications
	Seabed and water quality changes	Seabed disturbance, discharge of drill cuttings disrupting fish species caught by commercial fishers	Extent and duration of impacts on marine ecosystems and the socio-economic implications
	Disturbance to marine fauna from noise	Drilling operations, vessel movement, and potential vertical seismic profiling (VSP)	Extent and duration of impacts on marine ecosystems from noise and the socio-economic implications
	Disruption of marine traffic	Increase in vessel activity and increased use of the Port of Walvis Bay	Extent and duration of impacts from increase marine traffic

Impact Category	Issue	Cause/Activity	What Was Assessed
Climate Change	Greenhouse gas emissions	Fuel use by ships, helicopters, and equipment	Total emissions and alignment with Namibia's climate goals
Economy and Employment	Job creation	Creation of direct and indirect (supply chain) employment	Extent of employment creation directly with the Project and through the procurement of goods and services
	Local economic growth	Employment creation, increased worker spending and supply chain activities in the local area	Extent of local economic growth opportunities
	Macro-economic growth	Increase in taxes, fees, and worker spending	Extent of macro-economic growth opportunities
Accidental Events	Major oil spill (loss of containment)	Loss of well containment leading to spill	Risk likelihood, emergency response readiness, and potential environmental and socio-economic consequences
	Vessel collisions	Support vessels of drillship involved in collisions with other marine users	Prevention measures and emergency response plans
	Helicopter incidents	Crew transport to and from offshore rigs	Safety procedures and emergency response plans
Cumulative Impacts	Atmospheric emissions	Project emissions contributing cumulatively to air quality changes	Extent of cumulative impacts
	Wate and effluent	Project effluent and wate discharges contributing cumulatively to degradation of marine environment	Extent of cumulative impacts
	Marine ecology	Project changes to marine environment contributing cumulatively to impacts on marine ecology	Extent of cumulative impacts
	Commercial fisheries	Cumulative drilling activities contributing to impacts on commercial fishing	Extent of cumulative impacts
	Economy and employment	Cumulative economic growth and job creation	Extent of cumulative impacts
	Shipping and navigation	Cumulative projects using the marine area increasing risk of vessel collisions	Extent of cumulative impacts

The ESIA assessment has yielded the following results, summarised in the tables below:

- Table 4 presents the potential environmental impacts from planned events, including effects on marine fauna, water quality, and climate change, with ratings before and after mitigation.

- Table 5 outlines the potential social impacts from planned events, such as impacts on fisheries, navigation, employment, and the local economy.
- Table 6 addresses potential impacts from unplanned events, including oil spills, vessel collisions, and helicopter incidents, with a focus on risk severity and mitigation effectiveness.
- Table 7 summarises cumulative impacts, considering the combined effects of multiple projects on marine ecology, fisheries, emissions, and socio-economic factors.

The assessment showed that with the implementation of the proposed mitigation measures, most impacts are reduced to minor or incidental levels, with robust systems in place to manage unplanned events.

The ESIA Report found that if the recommended safety and environmental measures are followed, the expected impacts from planned drilling activities, like effects on marine life, water quality and nearby communities, can be kept small and manageable. The biggest risk comes from an unexpected major oil spill, but this is very unlikely. Strong safety systems are in place to prevent and respond to such incidents, including international equipment and Chevron's emergency standards, which help keep risks as low as reasonably possible.

TABLE 4: POTENTIAL ENVIRONMENTAL IMPACT FROM PLANNED EVENTS

Impact Description	Pre-Mitigation Rating	Post-Mitigation Rating
Climate Change	Minor	Minor
Smothering and disturbance of benthic fauna on unconsolidated sediment	Moderate to Incidental	Minor to Incidental
Smothering and disturbance of benthic fauna on hard substrate	Minor to Incidental	Incidental
Bioaccumulation, toxicity and hypoxic effects on benthic fauna	Moderate to Minor	Incidental
Bioaccumulation, toxicity and hypoxic effects on pelagic fauna	Incidental	Incidental
Potential behavioural disturbance of marine fauna	Minor	Incidental
Potential injury of marine fauna	Minor	Incidental

TABLE 5: POTENTIAL SOCIAL IMPACTS FROM PLANNED EVENTS

Impact Description	Pre-Mitigation Rating	Post-Mitigation Rating
Impacts to fishing and navigation	Minor	Minor
Impacts of drilling on fishing operations	Moderate to Minor	Minor

Impacts of underwater noise on fishing operations	Minor	Incidental
Increase in marine traffic	Minor	Incidental
Increase in direct and indirect employment	Minor Positive	Minor Positive
Impacts to the local economy	Minor Positive	Minor Positive
Impacts to the macro-economy	Minor Positive	Minor Positive

TABLE 6: POTENTIAL IMPACTS FROM UNPLANNED EVENTS (UNLIKELY TO OCCUR)

Impact Description	Pre-Mitigation Rating	Post-Mitigation Rating
Impact of loss of containment on marine fauna	Catastrophic	Severe (ALARP)
Impact of loss of containment on commercial fishing	Moderate	Minor (ALARP)
Impact of loss of containment on communities (socio-economic)	Major	Minor (ALARP)
Impact of vessel collisions	Severe	Moderate (ALARP)
Impact of helicopter incidents	Minor	Minor (ALARP)

TABLE 7: POTENTIAL CUMULATIVE IMPACTS

Impact Description	Pre-Mitigation Rating	Post-Mitigation Rating
Impacts from atmospheric emissions	Incidental	Incidental
Impacts from waste generation and effluent discharge	Incidental	Incidental
Impacts on marine ecology	Incidental	Incidental
Impacts on commercial fisheries	Moderate to Minor	Minor
Impacts on economy and employment	Minor Positive	Minor Positive
Impacts on shipping and navigation of other se users	Incidental	Incidental

MANAGEMENT OF POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS

Following the assessment of potential impacts, mitigation measures have been proposed to ensure the post-mitigation rating is achieved. The Environmental and Social Management Plan provides a comprehensive framework for the management of environmental and social potential impacts throughout the project lifecycle. It details specific mitigation actions, monitoring requirements, roles and responsibilities, stakeholder engagement processes, and mechanisms for continuous improvement and corrective action. The plan is designed as a “living document” to be updated as necessary in response to project changes, monitoring results, audit findings and stakeholder feedback.

KEY MITIGATION MEASURES BY IMPACT CATEGORY

AIR EMISSIONS

- Comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI, covering sulphur oxides, nitrogen oxides, volatile organic compounds, and incineration.
- Use low-sulphur fuel where available.
- Maintain engines and generators to minimise emissions.
- Implement leak detection and repair programmes.

MARINE ECOSYSTEM DISTURBANCE

- Conduct remotely operated vehicle (ROV) surveys before and after drilling to avoid sensitive habitats.
- Use water-based mud or low-toxicity non-aqueous drilling fluids
- Discharge cuttings below 10 metres depth to reduce surface dispersion.
- For non-aqueous drilling fluids, use low toxicity, low bioaccumulation and products that aren’t persistent in the environment
- For non-aqueous drilling fluid cuttings, treat cuttings to reduce average content of oil retained on cuttings (ROC) to <6.9% prior to discharge.
- Maintain a 500-metre buffer from sensitive features.
- Monitor sediment deposition and hydrocarbon levels.
- Register abandoned wellheads and notify mariners and fishers.

NOISE AND VERTICAL SEISMIC PROFILING IMPACTS ON MARINE FAUNA

- Limit vessel speeds near coastlines.
- Implement soft-start procedures for seismic profiling, if conducted.
- Deploy trained marine mammal observers and passive acoustic monitoring during seismic profiling, if conducted.
- Shut down acoustic sources if sensitive species are detected.
- Avoid low-altitude flights over sensitive coastal areas.
- Use high-efficiency burners and monitor flare performance.

WATER QUALITY AND WASTEWATER

- Comply with MARPOL Annexes I (oil), IV (sewage), and V (garbage).
- Implement ballast water, waste, and hazardous substances management plans.

WASTE MANAGEMENT

- Follow MARPOL waste regulations.
- Implement a comprehensive waste management plan.

FISHERIES AND NAVIGATION

- Issue Notices to Mariners and Navtex alerts.
- Manage lighting and Automatic Identification System broadcasts for visibility.
- Notify nearby vessels via radio.
- Implement a grievance mechanism for affected stakeholders.
- Conduct detailed pre-drilling seabed surveys.

GHG EMISSIONS

- Use low-sulphur fuel and maintain engines.
- Prohibit incineration in port.
- Implement leak detection and repair.

MARINE TRAFFIC

- Engage with the Namibian Ports Authority for routing coordination.
- Use a Stakeholder Engagement Plan to coordinate with marine users.
- Monitor vessel traffic using data from the Ports Authority.

EMPLOYMENT AND LOCAL ECONOMY

- Engage local communities and advertise procurement opportunities.
- Reserve certain jobs and services for local suppliers.
- Apply Chevron's local content requirements.

MITIGATION MEASURES FOR UNPLANNED EVENTS

ALIEN INVASIVE SPECIES

- Adhere to IMO ballast water discharge standards.
- Implement Ballast Water Management Plan.

OIL SPILL / LOSS OF CONTAINMENT

- align drilling schedules with favourable weather conditions.
- Develop well-specific Oil Spill Contingency Plans and Source Control Contingency Plans aligned with national frameworks.
- Pre-mobilise dispersants and response equipment.
- Use low-toxicity dispersants approved by the Ministry of Fisheries and Marine Resources.
- Conduct oil spill exercises and wildlife response planning.
- Submit financial assurances to the Ministry of Mines and Energy.

IMPACT ON COMMERCIAL FISHING

- Tailor oil spill contingency plans to local conditions and sensitive areas.
- Maintain a grievance mechanism for fishers.
- Use search and rescue and drifter buoys for spill tracking.

COMMUNITY HEALTH & SAFETY (COLLISIONS, HELICOPTER INCIDENTS)

- Share flight and vessel schedules with communities.
- Conduct offshore emergency drills.
- Ensure helicopter airworthiness and pilot training.
- Restrict helicopter operations during poor conditions.
- Avoid offshore bunkering during high-risk conditions.

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ACRONYMS AND ABBREVIATIONS

Acronym	Description
ADI	Area of Direct Influence
AIDS	Acquired Immune Deficiency Syndrome
AII	Area of Indirect Influence
ALARP	As Low As Reasonably Practicable
AoI	Area of Influence
AUD INJ	Auditory Injury
BAU	Business as Usual
BCC	Benguela Current Commission
BCC-SBA	Benguela Current Commission's Spatial Biodiversity Assessment
BAT	Best Available Techniques
BID	Background Information Document
BOCP	Biological/Oiled Wildlife Contingency Plans
BOP	Blowout Preventor
CBD	Convention of Biological Diversity
CCUS	Carbon Capture, Utilization and Storage
CFSR	Climate Forecast System Reanalysis
CH_4	Methane
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
cm	Centimetre
CMS	Conservation of Migratory Species
CNEL	Chevron Namibia Exploration Limited II
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COLREGs	Convention on the International Regulations for Preventing Collisions at Sea
DEA	Department of Environmental Affairs
DP	Dynamic Positioning
DPS	Dynamic Positioning System
DSC	Decision Support Centre

Acronym	Description
DST	Drill Stem Test
E&S	Environmental and Social
EA	Environmental Assessment
EAP	Environmental Assessment Practitioner
EBSAs	Ecologically or Biologically Significant Areas
ECC	Environmental Clearance Certificate
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMA	Environmental Management Act, 2007 (Act No. 7 of 2007)
EMIS	Education Management Information System
EMP	Environmental Management Plan
EPLs	Exclusive Prospecting Licenses
EPs	Equator Principles
ERC	Erongo Regional Council
ERM	Environmental Resource Management
ERMP	Environment Risk Management Process
ESAs	Ecological Support Areas
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
FAO	Food and Agriculture Organisation
FGDs	Focus Group Discussions
g	Gram
GBV	Gender Based Violence
GDP	Gross Domestics Product
GHG	Greenhouse Gas
GN	Government Notice
GM	Grievance Mechanism
GWP	Global Warming Potential
H_2S	Hydrogen Sulphide
HABs	Harmful Algal Blooms
HDI	Human Development Index

Acronym	Description
HAFA	Hanganeni Artisanal Fishing Association
HIV	Human Immunodeficiency Virus
HSE	Health, Safety, and Environmental
I&AP	Interested and/or Affected Party
IBAs	Important Bird and Biodiversity Areas
ICCAT	International Commission for the Conservation of Atlantic Tunas
IFC	International Finance Corporation
IMO	International Maritime Organization
ISPP	International Sewage Pollution Prevention
IUCN	International Union for the Conservation of Nature
kHz	Kilohertz
km	Kilometre
km^2	Square Kilometre
KZN	Kwazulu Natal
l	Litre
LFPR	Labour Force Participation Rate
LWD	Logging While Drilling
m	Metre
m^3	Cubic Metre
mm	Millimetre
MACCs	Marginal Abatement Cost Curves
MAFWLR	Ministry of Agriculture, Fisheries, Water and Land Reform
MCM	Marine and Coastal Management
MDT	Modular Formation Dynamics Tester
MARPOL	International Convention for the Prevention of Pollution from Ships
MEFT	Ministry of Environment, Forestry and Tourism
MFMR	Ministry of Fisheries and Marine Resources
mg	Milligram
MGO	Marine Gas Oil
MIME	Ministry of Industries, Mines and Energy
MMNET	Marine Mammal Noise Exposure Tool
MMOs	Marine Mammal Observers

Acronym	Description
MODU	Mobile Offshore Drilling Unit
MoHSS	The Namibia Ministry of Health and Social Services
MPI	Multidimensional Poverty Index
MSCF	Million Standard Cubic Feet
MSDSs	Material Safety Data Sheets
MSP	Marine Spatial Planning
$MtCO_2e$	Million Tonnes of CO_2 Equivalent
MWT	Ministry of Works and Transport
N_2O	Nitrous Oxide
NABF	Non-Aqueous Base Fluid
NADF	Non-Aqueous Drilling Fluid
NAMPOA	Namibian Petroleum Operators Association
Namport	Namibian Port Authority
NamPower	Namibia Power Corporation
NatMIRC	National Marine Information and Research Centre
NCDs	Non-Communicable Diseases
NDCs	Nationally Determined Contributions
NDP	Namibian Dolphin Project
NEMBA	National Environmental Management: Biodiversity Act
NGO’s	Non-Governmental Organisations
NIMPA	Namibian Islands’ Marine Protected Area
NMFS	National Marine Fisheries Service
NORM	Naturally Occurring Radioactive Materials
NOx	Nitrogen Oxides
NPA	Namibian Ports Authority
NSA	Namibia Statistics Agency
NTS	Non-Technical Summary
O_2	Oxygen
OE	Operational Excellence
OIC	Oil Industry Contractor
OEMS	Operational Excellence Management System
OMZs	Oxygen Minimum Zones

Acronym	Description
OOC	Oil On Cutting
OSCP	Oil Spill Contingency Plan
OSRL	Oil Spill Response Limited
PAHs	Polycyclic Aromatic Hydrocarbons
PAM	Passive Acoustic Monitoring
PEL	Petroleum Exploration License
PIM	Particulate Inorganic Matter
PLONOR	Pose Little Or No Risk
PM_{10}	Particulate Matter (10 micrometres or less)
$PM_{2.5}$	Particulate Matter (2.5 micrometres or less)
PPE	Personal Protective Equipment
POM	Particulate Organic Matter
PSs	Performance Standards
RED	Regional Electricity Distributors
RMU	Regional Management Units
ROV	Remote Operated Vehicle
s	Second
SACW	South Atlantic Central Water
SANHO	South African Navy Hydrographic Office
SAR	Synthetic Aperture Radar
SCCP	Source Control Contingency Plan
SDSs	Safety Data Sheets
SEP	Stakeholder Engagement Plan
SOLAS	International Convention for the Safety of Life at Sea
SOPEP	Shipboard Oil Pollution Emergency Plan
SOx	Sulphur Oxides
SSDI	Subsea Dispersant Injection
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
STLM	Sound Transmission Loss Modelling
SWIO	Southwestern Indian Ocean
TAC	Total Allowable Catch

Acronym	Description
TB	Tuberculosis
tCO_2e	Tonnes of CO_2 Equivalent
THC	Total Hydrocarbon Concentration
TOPS	South African List of Marine Threatened or Protected Species
TSPM	Total Suspended Particulate Matter
TSS	Total Suspended Solids
TTS	Temporary Threshold Shifts
UD	Urban Dynamics
UNCCD	United Nations Convention to Combat Desertification
UNCLOS	United Nations Convention on the Law of the Sea
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNGASS	United Nations General Assembly Special Session
VMS	Vessel Monitoring System
VOCs	Volatile Organic Compounds
VOS	Voluntary Observing Ship
VSP	Vertical Seismic Profiling
WBM	Water-based Muds
WOAD	Worldwide Offshore Accident Databank
WHO	World Health Organization

1. INTRODUCTION

This section outlines the purpose of the report, provides background and context for the potential offshore exploration project and explains how stakeholders can participate in the Environmental and Social Impact Assessment (ESIA) process.

1.1 BACKGROUND AND CONTEXT TO THE PROJECT

Chevron Namibia Exploration Limited II (CNEL) is considering initiating an offshore hydrocarbon exploration program within Petroleum Exploration License (PEL) 82, encompassing Blocks 2112B and 2212A in the Walvis Basin, Namibia (Figure 1-1) (i.e. potential project). PEL 82 is located approximately 163 km north-west of Walvis Bay, with water depths ranging from 200 m to 2,500 m. CNEL holds the Exploration License for both blocks which spans over an area of approximately 11,400 km².CNEL's contact details are provided in Table 1-1 below.

TABLE 1-1 CONTACT DETAILS OF LICENSE HOLDER

Item	Details
Name	Chevron Namibia Exploration II Limited
Business Registration Number	202201967
Correspondence Address	PO Box 3516, Windhoek, Namibia
Responsible Person	Beatrice Bienvenu
Position	Country Manager

The first exploration well may be drilled in 2026/2027 in the Gemsbok Prospect, located within Block 2112B (coordinates: LAT: 21° 44' 48.15" S, LONG: 12° 27' 13.74" E), in water depths ranging from 900 m to 1,500 m. Based on the results of this well, it may be followed by an appraisal well. Additional drilling campaigns of up to 3 to 4 wells could potentially start from late 2027 to 2028 over a 3 to 5-year period for a total of up to 10 wells (exploration or appraisal).

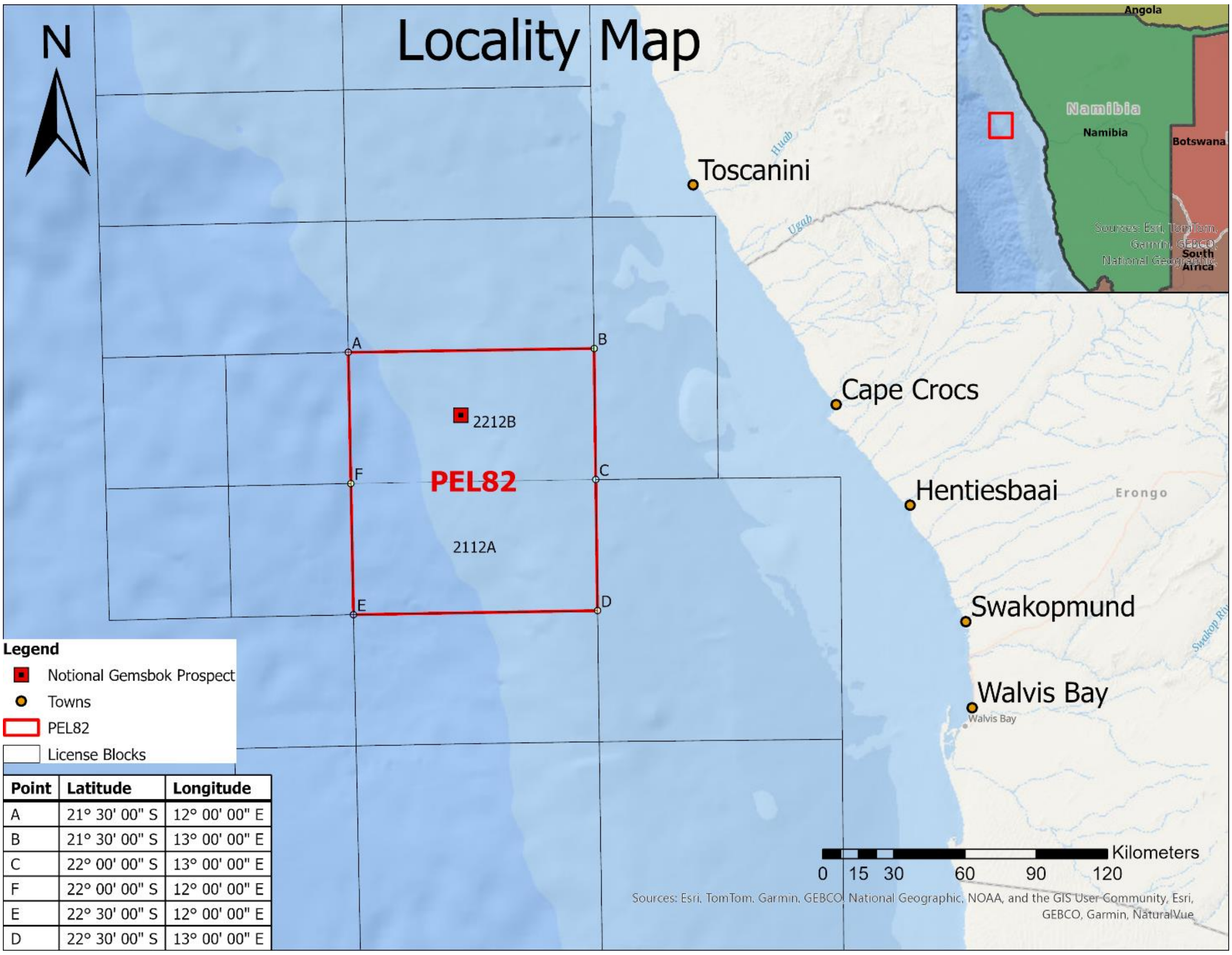
Exploration or appraisal wells, require a maximum of 90 days to complete, including mobilisation, drilling operations, well testing for an appraisal well, and demobilisation.

To date, the following exploration activities have taken place in PEL 82:

- Initial seismic surveys: Over 3,500 km² of 2D seismic data and 9,500 km² of 3D seismic data were acquired in 2013.
- Previous drilling: Two wells, Murombe-1 and Wingat-1, were drilled by Galp Energia in 2013.
- Subsequent 3D seismic survey program of 5,000 km² acquired in 2018.

CNEL has appointed Environmental Resource Management Southern Africa (ERM) as the independent Environmental Assessment Practitioner (EAP) to undertake a Scoping and Environmental Impact Assessment (EIA) process for the potential exploration activities in compliance with the EIA Regulations of 2012 promulgated under the Environmental Management Act, No. 7 of 2007 and international environmental standards and guidelines and (hereafter collectively referred to as "Environmental and Social Impact Assessment" or "ESIA" process).

FIGURE 1-1 LOCALITY MAP



Point	Latitude	Longitude
A	21° 30' 00" S	12° 00' 00" E
B	21° 30' 00" S	13° 00' 00" E
C	22° 00' 00" S	13° 00' 00" E
F	22° 00' 00" S	12° 00' 00" E
E	22° 30' 00" S	12° 00' 00" E
D	22° 30' 00" S	13° 00' 00" E

Source: Chevron, 2025

1.2 SCOPE AND OBJECTIVES OF THE ASSESSMENT

This Draft ESIA Report, which includes the Environmental and Social Management Plan (ESMP) and the Non-Technical Summary (NTS) (hereafter referred to as the Draft ESIA Report) has been prepared in accordance with Section 15(2) of the EIA Regulations, 2012, as part of the ESIA process supporting the application for an Environmental Clearance Certificate (ECC) for the potential offshore exploration activities in PEL 82.

The main objective of this report is to identify, assess and communicate the potential impacts of the potential project on the receiving environment. It provides a detailed analysis of the likely consequences of potential project activities on both the biophysical and socio-economic environments. By applying the Mitigation Hierarchy, the report outlines how potential negative impacts can be avoided, minimised or mitigated and controlled and how positive impacts can be enhanced.

Interested and/or Affected Parties (I&APs) are invited to review and comment on this Draft ESIA Report. Further details on how to participate are provided in Section 1.3.1.

Following the public consultation process, the Final ESIA Report will be submitted to the Ministry of Industries, Mines and Energy (MIME), Energy Directorate, for review and to the Ministry of Environment, Forestry and Tourism (MEFT) for decision-making. In accordance with Section 32 of the Environmental Management Act, 2007 (Act No. 7 of 2007), the MIME will make a recommendation to the MEFT, Department of Environmental Affairs (DEA), which will issue the final decision on the ECC application.

1.3 OVERVIEW OF THE ESIA PROCESS

The ESIA process for the potential project has been undertaken in accordance with the applicable regulations and assessment procedure. The assessment process also took into consideration the corporate governance of CNEL as well as all other relevant Namibian laws (refer to Section 2) and international good practice.

Key steps completed to date include:

- Project screening conducted in February 2025.
- Preparation of a draft Background Information Document and public notice in March 2025.
- Compilation of the Draft Scoping Report in April and May 2025.
- Public consultation for the scoping phase, including publication of notices once a week for two consecutive weeks in *The Namibian* and *New Era* newspapers. The public comment period ran from 26 May to 19 June 2025.
- Public meeting held on 12 June 2025 at 17:30 at the Walvis Bay Town Hall.
- Focus group meeting held on 3 July 2025 with Ms La-Toya Shivute from the Ministry of Fisheries and Marine Resources (MFMR).
- Final Scoping Report hand-delivered to the MEFT on 1 August 2025.

Planned steps for the ESIA phase:

- Preparation of the Draft ESIA Report from July to September 2025.
- Publication of public notices at the end of August 2025.
- Closure of the public comment period for the ESIA phase on 11 November 2025.
- Public meeting on 9 October 2025 at 17:30 at the Walvis Bay Town Hall.
- Finalisation of the ESIA Report in October and November 2025
- Submission of the Final ESIA Report to the Office of the Environmental Commissioner in the MEFT, via the MIME, in November 2025.

1.3.1 HOW TO GET INVOLVED

This Draft ESIA Report is available for public comment from 1st October to 11th November 2025 and I&APs are invited to comment on any aspect of the report, the potential project activities and ESIA process. Copies of the full report will be available at the public locations listed in Table 1-2 and on the project website: cnel-esia (https://www.erm.com/public-information-sites/cnel-esia/).

TABLE 1-2 PUBLIC LOCATIONS WHERE THE DRAFT ESIA REPORT IS AVAILABLE

Location	Draft ESIA Report
Walvis Bay	3rd October to 11th November 2025 (non-technical summary available from the 1st of October)
Town Council Office	3rd October to 11th November 2025 (non-technical summary available from the 1st of October)

Comments should please be submitted using any of the contact details below or by scanning the QR code provided in the public notices. To ensure that comments are considered in the Final ESIA Report, they must be received by no later than 11 November 2025.

Contact Person: Heidri Nel

Postal Address: PO Box 20837, Windhoek

Phone /SMS/WhatsApp: +264 81 124 5188 or +264 81 651 7336

Email: cnel.pel82esia@udanam.com

I&APs are also invited to attend the public meeting scheduled during the Draft ESIA Report comment and review period. The meeting will take place on Thursday, 9 October 2025 at 17:30 at the Protea Hotel Walvis Bay Indongo.

1.4 ASSUMPTIONS AND LIMITATIONS

This Draft ESIA Report is based on information provided by CNEL regarding the potential offshore exploration drilling activities, including the planned well design, operational procedures, support infrastructure, and the designated project area within PEL 82 in the Walvis Basin.

Any planned well sites will be located within the boundaries of PEL 82, although the exact positions have not yet been finalised. The assessment of potential impacts is therefore based on generalised scenarios within the license area, ensuring that the findings are applicable to any location within PEL 82. The assessment assumes that only one well will be drilled at a time, during any season, and that any additional wells will be drilled sequentially.

Preliminary technical details for drilling operations are derived from general industry standards, previous drilling activities, and anticipated future campaigns. While minor variations may occur between individual wells, the specifications used in this Draft ESIA Report are considered broadly representative of those expected to be implemented during the upcoming drilling operations.

Additional assumptions and limitations relevant to specialist studies are contained within the referenced reports and Appendix A to I.

2. LEGAL, POLICY FRAMEWORK AND PROJECT STANDARDS

This section outlines the key legal, policy, and regulatory frameworks applicable to CNEL's potential exploration activities in Petroleum Exploration License (PEL) 82. It covers relevant national and regional legislation, environmental assessment requirements, applicable international standards and guidelines and CNEL's internal project standards.

2.1 ADMINISTRATIVE FRAMEWORK

The overarching legislation of the Republic of Namibia is the Namibian Constitution (1990) that establishes the separation of powers into three main organs of the State: Executive, Legislature and Judiciary. Under this scheme the government defines and executes the general administrative policies of the country while the National Assembly has the power to pass laws with the assent of the President. Within this Government scheme, the responsibilities in terms of oil and gas activities and environmental issues are distributed among different institutions.

The MIME is the competent authority with regards to activities associated with offshore oil and gas exploration. Environmental related issues are the responsibility of the MEFT as the regulatory authority, while the MFMR and the Ministry of Works and Transport (MWT) deal with sensitive issues that could also be impacted by project activities such as fisheries and marine transport.

2.1.1 MINISTRY OF INDUSTRIES, MINES AND ENERGY

The MIME is responsible for promoting and regulating the development and use of Namibia's mining and hydrocarbon resources through suitable legislative and institutional frameworks. The Ministry is organized into seven main directorates:

- Directorate of Mines;
- Directorate of Geological Survey;
- Directorate of Energy;
- Directorate of Energy Funds;
- Directorate of Petroleum;
- Directorate of Diamond; and
- Directorate of Administration and Services

The Directorate of Petroleum Affairs oversees ensuring an adequate supply of petroleum products to the country and minimizing the potential negative impacts of petroleum resource exploitation on the environment. The Petroleum Exploration and Production division is responsible for all exploration-related activities, including regulating and promoting these activities, coordinating Health, Safety, and Environmental (HSE) aspects and issuing licenses for petroleum exploration and production.

2.1.2 MINISTRY OF ENVIRONMENT, FORESTRY AND TOURISM

The MEFT is the custodian of Namibia's natural environment. Its mission is to:

"*Promote biodiversity conservation in the Namibian environment through the sustainable utilisation of natural resources and tourism development for the maximum social and economic benefit of its citizens*."

MEFT is responsible for developing, administering and enforcing environmental legislation and policy. It plays a central role in Namibia's EIA process, particularly for projects requiring ECCs.

The Ministry comprises six directorates, one of which is DEA. The DEA gives effect to Article 95(l) of the Namibian Constitution (1990) by promoting environmental sustainability. The Environmental Commissioner, who serves as the head of the DEA, oversees the EIA process in accordance with the Environmental Management Act, 2007 (Act No. 7 of 2007) and the EIA Regulations of 2012.

In terms of Section 32 of the Environmental Management Act, the MIME, as the competent authority for petroleum activities, is required to make a recommendation on the ECC application to MEFT. The DEA then makes the final decision on the application. If approved, the DEA issues the ECC.

2.1.3 MINISTRY OF FISHERIES AND MARINE RESOURCES

The MFMR is responsible for the management and development of fisheries and aquaculture in Namibia. It is organized into four main directorates:

- Directorate of Resource Management;
- Directorate of Operations;
- Directorate of Policy Planning and Economics; and
- Directorate of Aquaculture and Inland

The Directorate of Resource Management provides advice on the state of commercially important marine fish stocks, recommends catch quotas, establishes fish size limits, dates of closed fishing seasons, types of gear allowed and declares areas closed to fishing. The Directorate of Operations regulates fishing activity within the Namibian Exclusive Economic Zone (EEZ), monitors, controls and surveys fishing-related activities both at sea and onshore, and enforces legislation governing the fisheries sector

2.1.4 MINISTRY OF WORKS AND TRANSPORT

The MWT oversees maritime affairs through its Department of Transport. It ensures the safety of life and property at sea, prevents marine pollution from ships, and promotes Namibia's maritime interests by drafting, reviewing, and implementing national maritime legislation. The Namibian Port Authority (Namport), a public entity associated with the Ministry, manages the ports of Walvis Bay and Lüderitz and is responsible for protecting the environment within harbour areas under the National Ports Authority Act.

2.2 REGULATORY FRAMEWORK

The legal and regulatory framework for CNEL's exploration operations in Namibia is governed by several national and regional laws aimed at ensuring the protection of the environment, public health and safety, while promoting sustainable development.

2.2.1 REGULATORY FRAMEWORK GOVERNING ESIA PROCESS

2.2.1.1 ENVIRONMENTAL ASSESSMENT POLICY FOR SUSTAINABLE DEVELOPMENT AND ENVIRONMENTAL CONSERVATION, 1995

Namibia's Environmental Assessment Policy, published in 1995, provides a foundation for promoting sustainable development while ensuring long-term environmental protection. The policy emphasises the importance of incorporating environmental considerations into economic planning and decision-making.

It identifies Environmental Assessment (EA), commonly referred to as EIA, as a key instrument for implementing sound environmental management. Through the EIA process, the potential environmental effects of development activities are evaluated and addressed during project planning to support informed and responsible decisions.

Marine petroleum exploration and production are specifically listed as activities that require an EA, reflecting the government's commitment to protecting sensitive marine environments.

Implications for this project:

This ESIA process is being undertaken in accordance with the 1995 Policy.

2.2.1.2 ENVIRONMENTAL MANAGEMENT ACT (NO. 7 OF 2007)

This Act provides the overarching legal framework for environmental protection in Namibia. It requires that an ECC be obtained for any listed activity that may significantly affect the environment. The Act outlines the EIA process and ensures that the principles of sustainable development, precaution and integrated environmental management are applied in project planning and decision-making.

The Act also promotes early and meaningful participation by interested and affected parties and mandates that environmental considerations be taken into account before any decisions are made.

Implications for this project:

The potential project requires an ECC. An application has been submitted to the MIME and uploaded to the MEFT online portal. This ESIA process has been initiated to support MIME and MEFT in their review and decision-making regarding the ECC application.

Regulatory Requirements for Environmental Assessment

EIAs in Namibia are governed by a robust legal framework comprising the Environmental Management Act, 2007 (Act No. 7 of 2007), the EIA Regulations published under Government Notice No. 30 of 2012, and the listed activities outlined in Government Notice (GN) No. 29 of 2012.

These instruments collectively establish the procedures and requirements for assessing and managing the environmental and social impacts of development activities. GN 29 of 2012 specifies the types of activities that require an EIA, including:

- Mining and mineral exploration
- Infrastructure development
- Energy generation

- Waste management
- Land use change
- Offshore and coastal activities

Any individual or organization intending to undertake a listed activity must apply for an ECC from the MEFT. The application process must comply with the procedural steps set out in the EIA Regulations, which include:

- Submission of a Scoping Report.
- A Plan of Study for the EIA.
- Where applicable, a full EIA Report and an Environmental Management Plan (EMP).

These documents are reviewed by the DEA within MEFT, which makes the final decision on the ECC application, often with input from the relevant competent authority such as the MIME. The EIA process follows a staged approach:

- Screening Phase: Determines whether a listed activity is triggered.
- Scoping Phase (Regulation 8): Identifies key issues of concern and informs the scope of the impact assessment.
- EIA Phase: Involves a detailed assessment of potential biophysical and socio-economic impacts, including identification, evaluation, and mitigation of significant impacts as required under Regulation 15.

The final outputs of the EIA phase include:

- An EIA Report detailing the proposed activity and its alternatives (Regulation 15(b)), the affected environment (Regulation 15(c)), anticipated impacts (Regulation 15(d)), and mitigation and monitoring measures (Regulation 15(e–f)).
- An EMP outlining practical actions for impact avoidance, mitigation, rehabilitation, and compliance monitoring throughout the project life cycle (Regulation 8(j) and Regulation 15(g)).

Public Participation is a critical component of the EIA process, guided by Section 3(2) of the EMA and Regulations 21–24. Stakeholders and affected communities must be given opportunities to:

- Review project information.
- Raise concerns.
- Influence the assessment process.

This includes publishing notices in at least two newspapers for two consecutive weeks (Regulation 21(2)(a)), installing on-site notices (Regulation 21(2)(b)), and hosting public meetings or consultations with Interested and Affected Parties (I&APs). All engagement activities and outcomes must be documented and included in the Final EIA Report submission.

Upon receipt of the Final EIA Report and EMP, and following a review of the process and documentation, the Environmental Commissioner may issue the ECC with or without conditions, request further information, or reject the application. An ECC, once issued, is valid for three years unless otherwise specified and may be renewed or amended in accordance with Section 39 of the EMA and Regulations 25 and 26.

Implications for this project:

The potential project triggers numerous listed activities (refer to Table 2-1) and therefore requires an ECC. This ESIA process has been initiated to comply with the Environmental Management Act and EIA Regulations, and to support the review and decision-making process by MIME and MEFT.

TABLE 2-1 LIST OF APPLICABLE ACTIVITIES THAT REQUIRE AN ECC IN TERMS OF THE EIA REGULATIONS 2012

Activity	Comment
2. Waste management, treatment, handling and disposal activities	
2.2 Scheduled process under Atmospheric Pollution Prevention Ordinance, 1976	No scheduled activities currently listed but included in case flaring during well testing falls under this ordinance in future.
2.3 Import, processing, use, recycling, temporary storage, transit or export of waste	Waste such as spent Non-aqueous drilling fluid (NADF), chemicals, and garbage will be stored onboard and transported to shore for treatment/disposal by authorised contractors. Refer to the Project Description (Section 3) for operational discharges and wastes.
3. Mining and quarrying activities	
3.2 Other forms of mining or extraction of natural resources	The objective of the potential exploration well drilling is to investigate the hydrocarbon potential of the stratigraphic and structural prospects within the subsurface. of the geological structure of the seabed. This may result in the extraction of oil or gas. Refer to the Project Description (Section 3) for a description of well drilling operations.
3.3 Resource extraction, manipulation, conservation and related activities	
3.4 Extraction or processing of gas from natural and non-natural resources	
9. Hazardous substance treatment, handling and storage	
9.1 The manufacturing, storage, handling or processing of a hazardous substance defined in the Hazardous Substances Ordinance, 1974	NADF and hydrocarbons are not specifically defined in the Ordinance. However, this activity is included as components of the drilling fluid contain hydrocarbons, which are generally considered hazardous. Project Description (Section 3) for a description of drilling fluids.
9.3 The bulk transportation of dangerous goods using pipeline, funiculars or conveyors with a throughput capacity of 50 tons or 50 m^3 or more per day	The potential drilling operation involves infrastructure (e.g., pipe casings inside the wellbore) that could convey oil or gas from the geological structure to the surface. This activity is included to account for scenarios where throughput may exceed 50 tons or 50 m^3/day. Refer to the Project Description (Section 3) for a description of the well drilling procedure and casing installation.
9.4 The storage and handling of dangerous goods, including petrol, diesel, LPG or paraffin, in containers with a combined capacity of more than 30 m^3 at any one location	The drilling unit and support vessels will store and handle oil, gas, and/or fuel (diesel) in quantities exceeding 30 m^3. This activity is included to reflect the potential environmental risks associated with bulk storage. Refer to the Project Description (Section 3) for a detailed description of the potential well drilling programme, including drilling equipment and onshore support infrastructure.
10. Infrastructure	

Activity	Comment
10.1 Construction of oil/gas pipelines or structures below high water mark	The potential drilling operations would result in the placement of drilling equipment (i.e. a wellhead) on the seabed. During decommissioning the wellhead(s) would be abandoned on the seafloor. Refer to the Project Description (Section 3) for a description of the well plugging procedure and abandonment.

2.2.2 REGULATORY FRAMEWORK GOVERNING OIL AND GAS PROJECTS

As discussed in Section 2.1, the regulation of Namibia's oil and gas sector falls under the mandate of the MIME. The legal framework comprises several key statutes that govern licensing, taxation and operational responsibilities for petroleum exploration and production.

2.2.2.1 PETROLEUM (EXPLORATION AND PRODUCTION) ACT (NO. 2 OF 1991) AMENDED BY THE PETROLEUM LAWS AMENDMENT ACT, 1998

This Act regulates the exploration and production of petroleum resources in Namibia. It outlines the requirements for obtaining PEL and provides guidelines for the conduct of exploration activities, including compliance with environmental protection standards.

2.2.2.2 PETROLEUM (EXPLORATION AND PRODUCTION) ACT REGULATIONS, 1999

These regulations detail health, safety and environmental standards for offshore petroleum operations. They cover installation registration, emergency preparedness, exclusion zones, environmental monitoring and reporting obligations.

2.2.2.3 PETROLEUM TAXATION ACT (NO. 3 OF 1991)

The Petroleum Taxation Act regulates the levying and collection of a petroleum income tax on income derived from petroleum exploration, development and production operations. It ensures that the government can collect taxes from these activities to benefit the country's economy.

2.2.2.4 PETROLEUM (EXPLORATION AND PRODUCTION) ACT REGULATIONS, 1991

The Petroleum (Exploration and Production) Act Regulations, 1991, promulgated under Section 76A of the Petroleum (Exploration and Production) Act, 1991, sets out the obligations of the operator, some of which are listed below:

- Implement necessary precautions to safeguard the environment and natural resources;
- Allocate funds and take measures to ensure the health, safety, and welfare of employees, as well as the protection of other individuals, property, the environment, and natural resources from petroleum-related hazards;
- Conduct ESIA studies as stipulated in the Model Petroleum Agreement between the Minister and the operator;
- Register the installation and obtain a certificate of fitness;
- Report the installation's location to the Petroleum Commissioner and ensure its publication in a "Notice to Mariners";

- Ensure the installation is marked in accordance with the International Regulations for Preventing Collisions at Sea, as incorporated into the Merchant Shipping Act, 1951;
- Equip the installation with necessary equipment to record environmental data for controlling petroleum activities;
- Properly transport, handle, and store hazardous substances;
- Develop and regularly update an Emergency Preparedness Plan;
- Establish a safety/exclusion zone, communicate it to the Petroleum Commissioner, and ensure its publication in the "Notice to Mariners"; and
- Immediately notify the Petroleum Commissioner of any emergencies.

2.2.2.5 MINERALS POLICY OF NAMIBIA, 2004

This policy promotes sustainable and inclusive development of Namibia’s mineral resources. It encourages private sector investment, environmental responsibility, and equitable benefit-sharing. One of the purposes of the ESIA Report is to assess the environmental acceptability of the potential project in line with this policy.

Implications for this project:

The potential project must comply with all relevant licensing, fiscal and environmental requirements. This includes securing the necessary exploration or production licenses, preparing decommissioning plans, conducting a compliant ESIA process and fulfilling all reporting and safety obligations under MIME’s oversight.

2.2.3 OTHER REGULATORY FRAMEWORK RELEVANT TO THE POTENTIAL PROJECT

In addition to the core oil and gas legislation, several other statutes are relevant to the potential offshore exploration activities in PEL 82. These laws address environmental protection, biodiversity conservation, cultural heritage, pollution control and labour standards.

2.2.3.1 MARINE RESOURCES ACT (NO. 27 OF 2000)

This Act is relevant for ensuring the sustainable management and protection of marine resources. It covers the regulation of fishing, marine pollution, and the protection of the coastal and offshore ecosystems.

Implications for this project:

The project must avoid adverse potential impacts on marine resources and comply with restrictions and/or monitoring requirements in declared marine areas.

2.2.3.2 NATURE CONSERVATION ORDINANCE (NO. 4 OF 1975) NATURE CONSERVATION AMENDMENT ACT (ACT 5 OF 1996)

This legislation governs the conservation of Namibia's natural resources, including the protection of biodiversity and wildlife. It is particularly relevant for ensuring that exploration and drilling activities do not adversely affect protected species or areas of conservation importance.

Implications for this project:

The ESIA Report must assess potential impacts on protected species and conservation areas and comply with biodiversity protection measures.

2.2.3.3 NAMIBIAN WATER ACT (NO. 54 OF 1956)

This Act is relevant for managing water resources, and this includes coastal or marine environments. The Act aims to safeguard water supplies from pollution and ensure their beneficial use.

Implications for this project:

Any discharge of effluents or use of water resources must comply with pollution control provisions and permit requirements.

2.2.3.4 THE NATIONAL HERITAGE ACT (NO. 27 OF 2004)

This Act provides for the protection of cultural heritage and monuments, which may be relevant for the assessment of impacts on cultural or historical sites within the project area.

Implications for this project:

The ESIA Report must include a heritage impact assessment to identify and mitigate risks to cultural or historical sites.

2.2.3.5 MARITIME ZONES ACT, 1990 (ACT NO. 3 OF 1990)

This Act establishes Namibia's jurisdiction over its territorial sea, EEZ and continental shelf and is critical for regulating offshore projects.

Implications for this project:

The project must comply with jurisdictional boundaries and regulatory requirements applicable to offshore activities within Namibia's maritime zones.

2.2.3.6 WATER RESOURCES MANAGEMENT ACT, 2013

Although not yet fully operational, this Act provides for the control, conservation, and sustainable use of water resources for domestic, agricultural, urban, and industrial purposes. It also governs activities conducted on or in water bodies, including coastal and marine environments.

Implications for this project:

Any use of water resources or discharge of effluents must align with the pollution control provisions and permit requirements under this Act, particularly if the project affects marine or coastal water systems.

2.2.3.7 ATMOSPHERIC POLLUTION PREVENTION ORDINANCE (ORDINANCE 11 OF 1976)

The ordinance aims to prevent and control atmospheric pollution. It empowers appointed officers to enforce regulations, controls the emission of noxious gases, smoke, and dust, and sets standards for vehicle emissions.

Implications for this project:

The project must implement measures to minimise air pollution from drilling operations and associated activities.

2.2.3.8 LABOUR ACT (ACT 11 OF 2007) AND ASSOCIATED REGULATIONS

The law establishes measures to ensure the safety, hygiene and health of workers in their workplace, defining their rights and the basic conditions for their work.

Implications for this project:

All project activities must comply with labour standards, including occupational health and safety requirements for offshore personnel.

2.2.3.9 INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION FROM SHIPS ACT (ACT 2 OF 1986)

This Act enforces the requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) within Namibian legislation. It incorporates the standards set out in Resolution MEPC.159(55), which provides revised guidelines for effluent discharge and performance testing of sewage treatment plants under Annex IV of MARPOL. Additionally, the Act aligns with international best practices outlined in the International Finance Corporation (IFC) Environmental, Health, and Safety Guidelines (2007) Environmental, Health, and Safety Guidelines for Shipping, which support pollution prevention and control measures consistent with MARPOL 73/78 Annexes I to VI.

Implications for this project:

All vessels involved in the project must comply with MARPOL 73/78 standards, including waste management and emissions control.

2.2.3.10 POLLUTION CONTROL AND WASTE MANAGEMENT BILL (DRAFT)

This draft legislation, once enacted, will strengthen Namibia's regulatory framework for pollution control and hazardous waste management, particularly in offshore and coastal environments.

Implications for this project:

The project will anticipate and prepare for compliance with future requirements under this bill, especially regarding offshore waste handling and pollution prevention.

2.3 INTERNATIONAL ENVIRONMENTAL STANDARDS AND GUIDELINES

In addition to complying with Namibian laws and regulations, CNEL will comply with international environmental standards and guidelines.

TABLE 2-2 SUMMARY OF INTERNATIONAL CONVENTIONS RELEVANT TO THE PROJECT

Convention/Standard	Description	Status in Namibia
United Nations Framework Convention on Climate Change (UNFCCC, 1992)	Aims to stabilize greenhouse gas concentrations to prevent harmful human-induced interference with the climate system.	Ratified on May 16, 1995, entered into force on August 14, 1995
Kyoto Protocol (1997)	Sets legally binding emission reduction targets for developed countries.	Acceded on September 4, 2003, entered into force on February 16, 2005
Paris Agreement (2015)	Seeks to limit global warming to well below 2°C, aiming for 1.5°C, through nationally determined contributions.	Signed on April 22, 2016, ratified on September 21, 2016, entered into force on November 4, 2016
Vienna Convention (1985)	Aims to protect human health and the environment against adverse effects resulting from modifications of the ozone layer.	Acceded on September 20, 1993
Montreal Protocol (1987)	Designed to phase out the production and consumption of ozone-depleting substances.	Acceded on September 20, 1993
Basel Convention (1989)	Aims to reduce the movement of hazardous waste between nations and prevent transfer of hazardous waste from developed to less developed countries.	Ratified on December 8, 1994, entered into force on March 8, 1995
Stockholm Convention (2001)	Protects human health and the environment from chemicals that remain intact in the environment for long periods.	Ratified on June 24, 2005
African Convention (1968, revised 2003)	Enhances environmental protection, fosters conservation and sustainable use of natural resources, and harmonizes policies.	Signed on 9th December 2003, ratified the revised convention on October 15, 2020
Ramsar Convention (1971)	Provides the framework for the conservation and sustainable use of wetlands and their resources.	Acceded on December 23, 1995

Convention / Standard	Description	Status in Namibia
MoU on Conservation Measures of Marine Turtles of the Atlantic Coast of Africa (1999)	Focuses on conservation measures for marine turtles.	Signed on 21st February 2006
Convention on Biological Diversity (1992)	Provides for the conservation of biological diversity, sustainable use of its components and fair sharing of benefits.	Signed on 12th June 1992, ratified on 16th May 1995
International Commission for the Conservation of Atlantic Tunas (ICCAT, 1996)	Provides for the conservation of tuna and tuna-like species in the Atlantic Ocean and adjacent seas.	Ratified since 10th November 1999
MARPOL (1973/1978)	Minimises pollution of the oceans and seas caused by ships. It is divided into the following Annexes: • Annex I: Prevention of pollution by oil and oily water; • Annex II: Control of pollution by noxious liquid substances in bulk; • Annex III: Prevention of pollution by harmful substances carried by sea in packaged form; • Annex IV: Pollution by sewage from ships; • Annex V: Pollution by garbage from ships; and • Annex VI: Prevention of air pollution from ships.	Acceded on August 17, 2001
Resolution MEPC.159(55)	Revised guidelines for effluent discharge and performance testing of sewage treatment plants under MARPOL Annex IV.	Incorporated into Namibian law via MARPOL Act.
IFC EHS Guidelines (2007)	Environmental, Health, and Safety Guidelines for Shipping, aligned with MARPOL and international best practices.	Adopted as reference standards in ESIA practice.
International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC, 1990)	Establishes measures for dealing with marine oil pollution incidents nationally and in cooperation with other countries.	Acceded on August 17, 2001
International Convention on Civil Liability for Oil Pollution Damage (CLC, 1969) and its protocol	Liability for oil pollution damage.	Enacted in the International Convention Relating to Intervention on the High Seas in Cases of Oil

Convention/Standard	Description	Status in Namibia
		Pollution Casualties Act 64 of 1987
International Convention for the Safety of Life at Sea (SOLAS, 1974)	Sets minimum safety standards in the construction, equipment, and operation of merchant ships.	Acceded on August 17, 2001
Convention on the International Regulations for Preventing Collisions at Sea (COLREGs, 1972)	Provides rules to prevent collisions at sea.	Acceded on August 17, 2001
International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW, 1978)	Standards of training, certification, and watchkeeping for seafarers.	Enacted in the Merchant Shipping Act 57 of 1951: Schedule 5
Load Lines Convention (1966, protocol 1988)	Establishes load line standards for ships.	Enacted in the Merchant Shipping Act 57 of 1951: Schedule 4
United Nations Convention on the Law of the Sea (UNCLOS, 1982)	Establishes a legal framework for all marine and maritime activities.	Ratified on April 18, 1994
International Maritime Organization (IMO) Convention (1948)	Establishes the International Maritime Organization which is a specialist United Nations agency dealing with maritime issues, including development of all the marine pollution control conventions.	Accepted on 27th October 1994
Abidjan Convention (1984)	Protection and development of the marine and coastal environment of the West, Central, and Southern African region.	Member state, in process of ratification
World Heritage Convention (1972)	Protection of world cultural and natural heritage.	Accepted on 6th April 2000
United Nations Educational, Scientific and Cultural Organization (UNESCO) Convention on the Protection of the Underwater Cultural Heritage (2001).	This convention aims to safeguard all remnants of human activity that possess cultural, historical, or archaeological significance and have been submerged for over a century. It encompasses the protection of shipwrecks, submerged cities, prehistoric artifacts, looted treasures, sacrificial and burial sites, as well as ancient ports scattered across the ocean floors.	Ratified on 9th March 2011

Convention/Standard	Description	Status in Namibia
Compliance Agreement (1993)	Promotes compliance with international conservation and management measures by fishing vessels on the high seas.	Accessed on 7th August 1998

2.4 CHEVRON'S PROJECT STANDARDS

2.4.1 OPERATIONAL EXCELLENCE MANAGEMENT SYSTEM

Chevron's Operational Excellence (OE) puts into action their Chevron Way value to protect people and the environment across their global operations. They work to instil a culture of operational excellence that places the highest priority on the safety and health of the workforce and on the protection of communities and their assets. Chevron's OE objectives set the priorities:

- Eliminate fatalities, serious injuries and illnesses.
- Eliminate high consequence process safety incidents and operate with industry-leading reliability.
- Assess and manage significant environmental risks.
- Use energy and resources efficiently.
- Prevent high consequence security and cyber-security incidents.
- Address OE business risks through stakeholder engagement and issues management.

Chevron uses the Operational Excellence Management System (OEMS) to identify and manage risks encountered in their business and integrate processes, standards, procedures and behaviours into daily operations. OEMS is Chevron's method to identify and adopt operational excellence (OE) in objectives, plans, processes, standards and behaviours into daily operations, aimed at protecting people and the environment today and into the future. OEMS also enables Chevron to close performance gaps, to continually improve their OE results where possible. OE is how they aspire to run their business to achieve a vision of success.

Chevron strives to protect the environment through responsible design, development, operations and retirement of assets. By considering potential environmental risks, the aim is to enhance their environmental performance around the world. They identify and manage safeguards designed to prevent or mitigate potential environmental impacts. The OEMS environment focus area promotes systematic consideration of business risks and environmental performance alongside stakeholder expectations.

Their environmental strategy helps them take steps to steward water, biodiversity, waste, air emissions and asset retirement.

FIGURE 2-1 STEWARDING ENVIRONMENTAL PERFORMANCE

Source: Chevron, 2025

Their environmental strategy prioritizes assessment and management of significant environmental risks. They protect the environment through innovative and responsible operations (responsible design, development, operations, and asset retirement).

Chevron's environmental principles guide decisions and their actions. The entire workforce plays an important role in meeting their commitment to do business in environmentally responsible ways.

Their Environment Risk Management Process encompasses the lifecycle of each asset. It is the framework for assessing and managing potential risks associated with new projects, ongoing operations, and asset retirement.

Our EFA Strategy provides an integrated vision for achieving our goal of protecting the environment while providing affordable and reliable energy. The strategy helps us clarify our environmental expectations, including:

- Preventing and mitigating the consequences of accidental releases
- Reducing air emissions, including GHGs
- Conserving and protecting water and biodiversity
- Managing waste and wastewater
- Conserving energy
- Retiring idle assets and reclaiming sites with residual environmental impacts

2.4.2 WATER MANAGEMENT

Chevron continues to strengthen its water management practices, emphasizing the importance of responsible water use as part of The Chevron Way values and environmental policies and practices. The company aims to protect this vital resource through Risk-Based management systems, processes, and standards. They aim to:

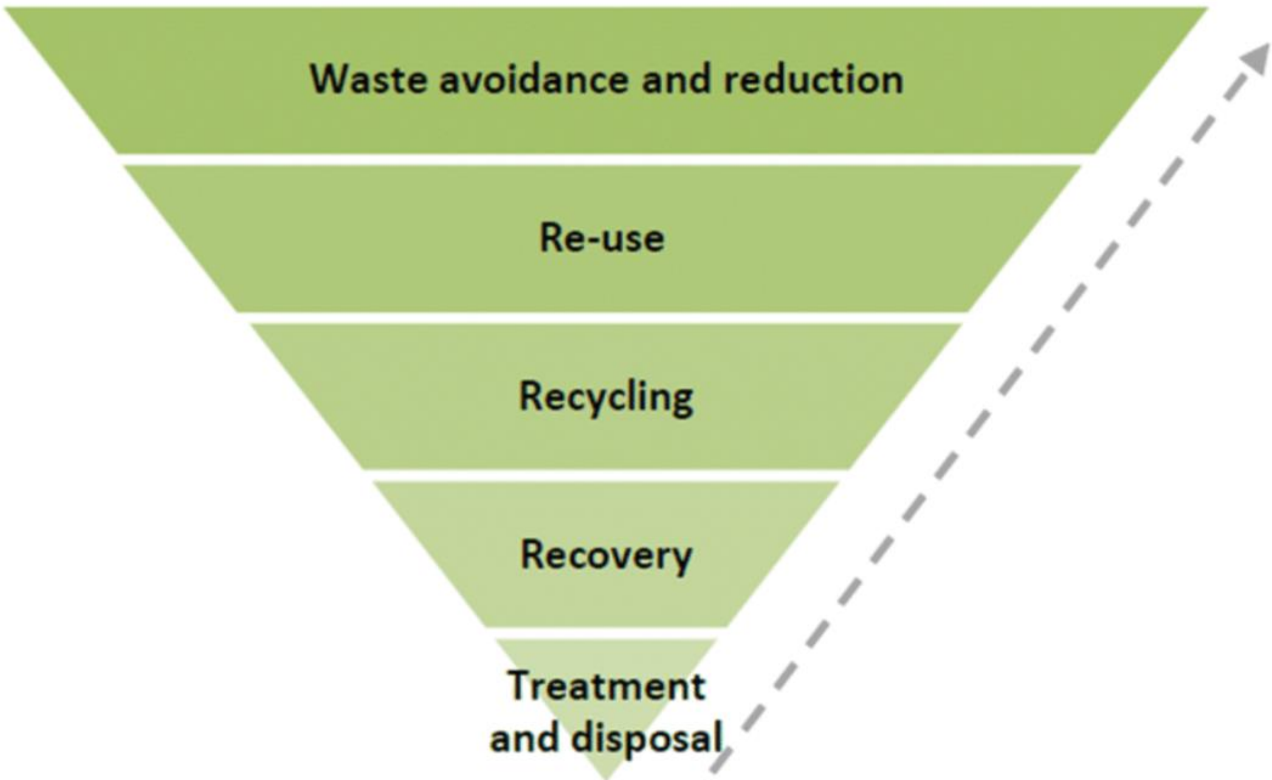
- Evaluate, implement and maintain safeguards designed to prevent or mitigate potential impacts to the environment and surrounding communities, including potential impacts to water resources, throughout the lifecycle of their assets.

- Identify solutions to reduce water withdrawals for our operations, especially in high water stress areas.
- Assess water treatment technology solutions to mitigate potential wastewater-related impacts to the environment.
- Measure the effectiveness of our management practices, drive accountability within our operations and communicate performance to stakeholders.
- Build partnerships with stakeholders and participate in industry water resources initiatives to share best practices in water management and support the development of industry standards and related policy.

2.4.3 WASTE MANAGEMENT

Chevron manages all types of solid waste, irrespective of hazardous classification. At operated facilities, the company employs the waste management hierarchy to prioritize reducing, reusing, recycling, or recovering materials that might otherwise be disposed of. Chevron is committed to implementing business practices that enhance waste management activities and minimise potential environmental, health, and safety impacts.

FIGURE 2-2 WASTE MANAGEMENT HIERARCHY OVERVIEW



Source: Adapted from USEPA, 2025

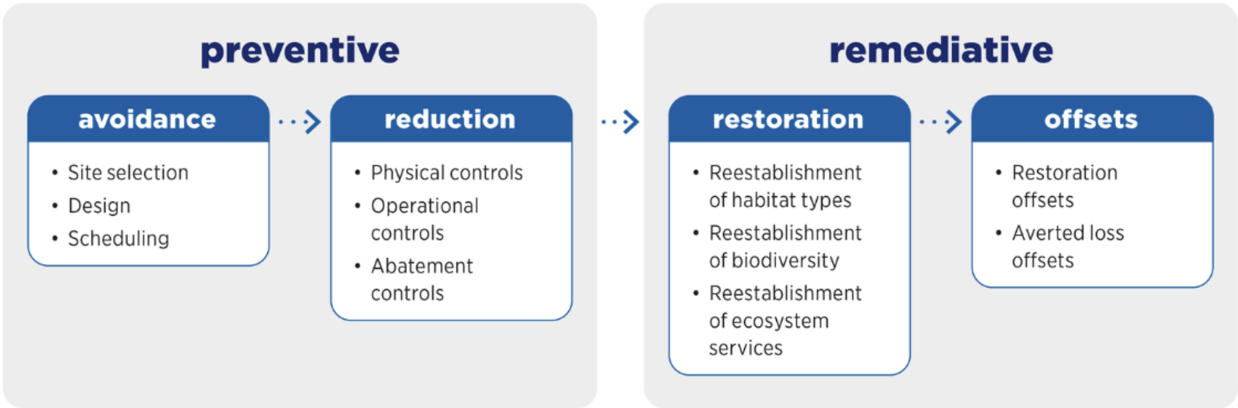
2.4.4 BIODIVERSITY

Chevron acknowledges the importance of protecting and conserving regional biodiversity and has a long-standing history of collaborating with communities, industry groups, regulators, and conservation organizations to identify and safeguard biodiversity in areas where it operates.

Due to the variation in biodiversity and the complexities of operations, Chevron's Environment Risk Management Process (ERMP), under the OEMS, is designed to implement a risk-based approach to identify, assess, and manage potential environmental risks throughout the lifecycle of assets, including those related to biodiversity.

When considering operations in protected or ecologically sensitive areas, Chevron evaluates the area's characteristics, the type and proximity of the potential operation, the ability to meet or exceed regulatory requirements, and the capability to avoid or manage potential impacts through protective operating practices. Chevron has a successful track record of working in sensitive environments and employs a mitigation hierarchy to manage potential impacts. This hierarchy includes avoidance, reduction, restoration, and offsets to minimise development impacts and control any potential negative effects on the environment and surrounding communities.

FIGURE 2-3 MITIGATION HIERARCHY IMPLEMENTATION



Source: Chevron, 2025

2.4.5 CLIMATE CHANGE

Chevron has a long-standing history of producing oil, natural gas, and other products that contribute to human progress. The company continues this legacy while also evolving the energy future. Chevron believes a balanced approach to policy focused on affordability, reliability and environmental protection is needed to meet growing energy demand. The company strives to provide a positive, pragmatic voice on climate policy through involvement with trade associations and engagements with policymakers across the globe.

2.4.5.1 ACHIEVING NET ZERO AT LEAST COST TO SOCIETY

Chevron believes climate policy should be designed in a manner that enables the realization of a lower carbon future at the least cost to society. Chevron supports the Paris Agreement’s global approach to governments addressing climate change. They continue to take actions to help lower the carbon intensity of operations while continuing to meet the demand for energy. Chevron believes policy should drive the most efficient and cost-effective abatement economywide, along with natural and technological emissions removals. Policies should enable lower carbon solutions and products by allowing all solutions to compete without penalizing one sector to build another.

Chevron aspires to achieve net zero Upstream production greenhouse gas (GHG) emissions (Scope 1 and 2) on an equity basis by 2050. Accomplishing this aspiration depends on, among other things, sufficient and substantial advances in technology, including the continuing progress on commercially viable technologies and low-or non-carbon based energy sources; enabling policies and other actions by governing authorities (including those regarding subsidies, tax and other incentives as well as the granting of necessary permits); successful negotiations for carbon capture, utilization and storage (CCUS) and nature-based solutions; market conditions and the availability of cost-effective, verifiable carbon credits.

2.4.5.2 REDUCING CARBON INTENSITY

Chevron is taking actions to reduce carbon intensity by improving operations and using their Marginal Abatement Cost Curve (MACC) process to drive emissions intensity reductions on existing facilities. The MACC process is a value-driven approach to optimize carbon reduction. Through the process Chevron seeks to identify cost-effective carbon reduction opportunities and GHG mitigation technologies to integrate across the company. Lifecycle Approach to Carbon Accounting

Chevron is working to help develop global standards and guidance to advance carbon accounting. A lifecycle approach to carbon accounting is also known as “product carbon footprinting.” They believe a lifecycle approach facilitates informed decision making throughout the value chain of any particular product or service. Carbon data across sectors, products and firms of all sizes can be used to understand the carbon performance associated with a product or service. Four principles that guide their lifecycle approach to carbon accounting are to provide relevant, consistent, accurate and complete data.

2.4.5.3 WELL CONTROL SYSTEMS TEAM

Chevron leads the industry in offshore and onshore well control equipment reliability and standards. Since 2018, Chevron's well control equipment reliability has surpassed all major oil operators in the Gulf of Mexico. The team focuses on improving onshore equipment reliability and operations through external and internal efforts.

2.4.5.4 WELLS DECISION SUPPORT CENTER (DSC)

The Wells DSC integrates technology, processes, and people to eliminate serious well control incidents and improve operational efficiency. The DSC supports real-time operations with a cross-functional team of experts, providing analytical support and ensuring sound engineering practices. The DSC operates 24/7, supporting drilling operations across various regions.

2.4.5.5 CHEVRON WELLSAFE

Developed in 2012, the WellSafe Process is a proprietary well control assurance program for well control on wells capable of sustained natural flow of potentially harmful fluids. The program provides independent verification and validation of compliance with technical standards governing well design and construction, overseen by a WellSafe Technical Authority.

3. PROJECT DESCRIPTION

This section provides a technical description of the potential exploration and appraisal activities and describes the potential project scope and activities to be undertaken by CNEL.

3.1 PROJECT NEED AND DESIRABILITY

3.1.1 STRATEGIC IMPORTANCE AND GEOLOGICAL ADVANCEMENT

The potential offshore exploration drilling campaign in Namibia will advance the country's understanding of its offshore petroleum systems. Despite seismic survey operations dating back to 1968, significant gaps remain in the geological knowledge of Namibia's deep-water offshore regions. This project will assist in addressing these gaps by collecting vital data on subsurface geological conditions, including offshore bathymetry, depositional history, and potential petroleum-bearing structures.

3.1.2 EXPANSION OF GEOLOGICAL DATA COVERAGE

One of the primary outcomes for this project is the enhancement of Namibia's geological data coverage. The drilling campaign will provide high-resolution data that will contribute to a more detailed and accurate understanding of the subsurface environment. Furthermore, the data obtained from drilling will significantly improve the interpretation contrast and confidence in identifying subsurface opportunities. This will support more informed and strategic decision-making in future exploration activities, reducing uncertainty and increasing the efficiency of resource development.

3.1.3 ECONOMIC COMPETITIVENESS AND INVESTMENT ATTRACTION

The project is expected to increase Namibia's attractiveness to multinational oil and gas companies. By providing new geological insights, the campaign could stimulate interest in local exploration blocks offered by NAMCOR (Pty) Ltd and other entities. This increased competitiveness may lead to further investments, job creation, and economic benefits at both local and national levels.

3.1.4 ECONOMIC GROWTH AND DIVERSIFICATION

The desirability of the potential activity is reinforced by its potential to stimulate economic growth. If successful, the exploration drilling could lead to further exploration or production activities, contributing to Namibia's Gross Domestics Product (GDP) and enhancing its energy security. The project also aligns with Namibia's broader strategic goals of leveraging its natural resources to support the development of other sectors, such as offshore wind energy, sustainable hydrogen production, and mineral resource development.

3.1.5 ALIGNMENT WITH NATIONAL POLICY AND SUSTAINABILITY GOALS

The project supports Namibia's long-term vision of sustainable development by integrating resource exploration with environmental stewardship. The ESIA process supports the project being conducted responsibly, with due consideration for environmental and social impacts, in accordance with Namibian regulations and international best practices.

3.2 PROJECT LOCATION

CNEL is considering drilling an exploration and appraisal well in the 2026/27 timeframe within PEL 82 encompassing blocks 2112B and 2212A, situated in the Walvis Basin, Namibia (refer to Table 3-1). The license area spans approximately 11,400 km², located between 72 km and 300 km offshore, with water depths ranging from 200 m to 2,500 m. The plan being considered, is to initially drill up to two-wells in the first campaign at the Gemsbok prospect, located within Block 2112B (coordinates: LAT: 21° 44’ 48.15” S, LONG: 12° 27’ 13.74” E), in water depths ranging from 900 m to 1,500 m. Subject to the results of this initial campaign, additional drilling campaigns of up to 3 to 4 wells per year could potentially start from late 2027 to 2028 over a 3 to 5 year period for a total of up to 10 wells (exploration or appraisal) across blocks 2112B and 2212A .

TABLE 3-1 LICENSE AREA DETAILS

Exploration Right No.:	PEL 82		
License Block No.:	Blocks 2112B and 2212A		
Distance offshore (at closest boundary):	72 and 300 km		
Coordinates of License Block (WGS84):	Point	Latitude (S)	Longitude (E)
	A	21° 30′ 00″ S	12° 00′ 00″ E
	B	21° 30′ 00″ S	13° 00′ 00″ E
	C	22° 30′ 00″ S	13° 00′ 00″ E
	D	22° 30′ 00″ S	12° 30′ 00″ E
	E	22° 00′ 00″ S	12° 00′ 00″ E

3.3 MAIN PROJECT COMPONENTS

This section describes the main project components, these include the following:

- Drilling unit;
- Shore base;
- Personnel; and
- Infrastructure and services.

A summary of the project activities is provided in Table 3-2.

TABLE 3-2 SUMMARY OF MAIN PROJECT COMPONENTS BEING CONSIDERED

Item	Detail
Purpose	To confirm and test the presence and quality of hydrocarbon resources
Potential number of exploration and appraisal wells	• Up to 5 exploration wells • Up to 5 appraisal wells

Item	Detail
Size of Area of Interest for potential exploration drilling	Blocks 2112B and 2212A spanning approximately 11,400 km² located between 72 km and 300 km offshore
Water depths across License area:	Between 200 m and 2,500 m across the license blocks
Well depth (below seafloor)	Variable depth of 1,500 to 4,000 m. A notional well depth of 4,000 m is assumed for the ESIA.
Duration	• Mobilisation phase: up to 15 days • Drilling phase: Exploration well (including abandonment): up to 60 days Appraisal well: up to 60 days (including abandonment) • Demobilisation phase: up to 15 days. • Total duration 90 days
Commencement of drilling and anticipated timing	The first well on the Gemsbok Prospect may be drilled in the 2026/2027 timeframe..
Potential drilling fluids (muds)	• Riserless stage: Water-Based Muds (WBM). • Risered stage: NADF in a closed-loop system.
Drilling and support vessels	• Drillship or semi-submersible drill rig. • Three to four support vessels. These vessels will be on standby at the drilling site, as well as moving equipment and materials between the drilling unit and the onshore base.
Operational safety zone	Minimum 500 m radius around drilling unit
Flaring	If hydrocarbons are discovered, an appraisal well may be considered that would include 1-2 well tests per well. .
Logistics base	Walvis Bay
Logistics base components	Office facilities, warehouse, laydown area, mud plant.
Support facilities	• Crew accommodation in Walvis Bay area. • Helicopter transport from Walvis Bay. • Fixed-wing transport from Windhoek.
Staff requirements:	• Specialised drilling staff supplied with hire of drilling unit. • Additional specialised international and local staff at logistics base.
Staff changes	Rotation of staff every four weeks with transfer by helicopter to shore

3.3.1 DRILLING UNIT

Various types of drilling vessels are used worldwide in offshore drilling operations, with the type of unit typically dependent on water depths in which it needs to operate and marine operating conditions experienced at the well site. The potential drilling unit is a drillship or semi-submersible drill rig using Dynamic Positioning System (DPS). The DPS allows for minimal subsea disturbance due to its ability to operate without moorings. A significant benefit to using a drillship is the ease of mobility as it is a self-propelled vessel with the flexibility to move from location to location without the need of transport vessels. An example of drillship is presented in Figure 3-1.

FIGURE 3-1 EXAMPLE OF A DRILLSHIP

Source: Shutterstock, 2022

The use of a semi-submersible drilling unit may also be considered based on the availability of vessels. This type of drilling unit consists of a rig mounted on a floating structure supported by pontoons. When positioned at the well site, the pontoons are partially filled with seawater (ballasted) to submerge them to a specific depth below the sea surface, where wave motion is reduced. This submersion provides stability to the drilling vessel, thereby enhancing the efficiency of drilling operations.

FIGURE 3-2 EXAMPLE OF SEMI-SUBMERSIBLE DRILLING UNIT

Source: Huisman, 2025

3.3.1.1 SUPPORT VESSELS

The drilling unit will be serviced by up to four support vessels (refer to Figure 3-3). These vessels are expected to operate two to three rotations per week. They will be on standby at the drilling site as well as facilitate the transportation of equipment and materials between the drilling unit and the onshore base. The support vessels can also be utilized for medical evacuations or crew transfers if necessary and provide assistance in firefighting, oil containment and recovery, rescue operations in case of emergencies, and supply any additional equipment that may be needed.

FIGURE 3-3 EXAMPLE OF SUPPORT VESSEL

Source: Wärtsilä, 2025

3.3.1.2 HELICOPTERS

Helicopters similar to the one in Figure 3-4 are the preferred method for transporting personnel to and from the drilling unit. It is estimated that there could be up to four trips per week between the drilling unit and the helicopter support base in the Walvis Bay area (primary) or Windhoek (secondary). If required, helicopters can also be used for medical evacuations from the drilling unit to shore, both during the day and at night.

FIGURE 3-4 EXAMPLE OF A HELICOPTER

Source: MHM Publishing Inc, 2025

3.3.1.3 EXCLUSION ZONE

During the drilling operations, there will be a temporary 500 m exclusion/safety zone around the drillship, which will be enforced by a standby vessel. The exclusion zone would be described in a Notice to Mariners as a navigational warning.

The purpose of the exclusion zone is to prevent a vessel collision with the drillship during operations. Under the Marine Traffic Act, 1981 (No. 2 of 1981), as amended by the Namibia Ports Authority Act No. 2 of 1994, an “exploration platform” or “exploration vessel” used in prospecting for or mining of any substance falls under the definition of an “offshore installation” and as such it is protected by a 500 m exclusion zone.

According to the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part B, Section II, Rule 18), a drillship involved in underwater operations is classified as a "vessel restricted in its ability to manoeuvre." This classification mandates that power-driven and sailing vessels must yield to such a vessel. Additionally, fishing vessels are required to avoid interfering with the well drilling operations as much as possible.

3.3.2 SHORE BASE

An onshore logistics base will be located in Walvis Bay. The shore base within the port authority boundaries and control will provide for the storage of various materials and equipment, including pipes, subsea equipment, drilling fluid, cement, chemicals, marine fuels, and water. It will also house a mud plant for mixing drilling fluids, which will be transported to and from the drilling vessel by sea. Additionally, the shore base will serve as office space equipped with communication systems, first response emergency facilities, and will provide accommodation as well as waste management services, vessel refuelling, and customs clearance services.

This base will include a yard area and a warehouse to store drilling materials such as hardware (tubular, wellhead), bulk materials (barite, bentonite, cement), and other minor equipment. A third-party service provider—yet to be selected—will be responsible for supplying additional resources, including a mud plant, essential materials, equipment, and logistical support. Supply vessels providing fuel, food supplies, water, and other necessities to the drillship will also utilize the shore base.

Supply vessels are expected to occupy the quay for approximately 12 hours per trip, depending on the volume of materials to be loaded or unloaded and the time required for customs and sailing clearance. The shore base will feature a mooring area, a temporary office, and bunkering services for vessels.

The existing service infrastructure at the port is sufficient to provide the necessary onshore support for the project, and no additional permanent onshore infrastructure is anticipated to be required.

3.3.3 PERSONNEL

The shore base will be situated in Walvis Bay. In addition to the support services it will provide, it will also be used for offices (with communication and emergency procedures / facilities).

Shore-based staff will be accommodated in Walvis Bay area. This could be hotels, apartments or house rental. In addition, accommodation during crew changes may be required in Windhoek based on incoming or departure flight times. The only CNEL personnel stationed in Walvis Bay would be the logistics base personnel. Other CNEL representatives will be based in the Windhoek office.

The number of personnel on the drilling unit will depend on the specific unit obtained for the potential activities. Most of the staff will be expatriates due to the short-term nature of the work and the specialized technical skills required. Drilling units typically come with a core team of technical specialists on board.

The number of personnel on supply vessels will vary based on the vessel size and the activities they support. All workers will receive health and safety training and be provided with Personal Protective Equipment (PPE) appropriate for their tasks.

3.3.3.1 CREW TRANSFERS

Transportation of personnel to and from the drillship would most likely be provided by helicopter operations from Walvis Bay area. Crews would generally work in 12 hour shifts in 4 week cycles. Crew changes would be staggered, and in combination with ad hoc personnel requirements. Thus helicopter operations to and from the drillship may occur up to 4 days per week between the helicopter support base and the drilling unit to shore.

3.3.4 INFRASTRUCTURE SUPPORT AND SERVICES

3.3.4.1 FRESHWATER

The project will require freshwater and some limited industrial water for making the water based drilling muds required to drill the well. This industrial water will be transported from shore.

The potable water for the personnel on board the drilling unit will be produced by the Mobile Offshore Drilling Unit (MODU) or bottled water will be made available.

3.3.4.2 FUEL

Estimates for the fuel (Marine Gas Oil (MGO)) use per day by the drillship and support vessels during transit, standby and drilling operations are provided in the Table 3-3 below.

TABLE 3-3 PROJECTED FUEL USAGE FOR DRILLING A SINGLE WELL

Discharge Source	Units of measurement	Duration	Consumption of marine fuel (m^3/annum)	Jet-A-1 fuel consumption (m^3/annum)
1 x Drilling unit	m^3/day	60 days	2,400	-
4 x Support vessels	m^3/day	60 days	800	-
Helicopter	m^3/per flight	4 per week	-	51
Total			3,200	51

3.4 PROJECT ACTIVITIES

The following description outlines the typical phases associated with offshore exploration well drilling. While the general approach remains consistent, specific details such as water depth, geological conditions and seafloor characteristics may vary slightly between wells.

Project activities may include:

- Mobilisation of the supply vessels, operation of the shore-based facilities for handling support services needed by the MODU;
- Drilling of exploration well(s);
- Well execution (side track, logging, completion) options;
- Potential drilling of appraisal wells that may include well testing;
- Well abandonment; and
- Demobilisation of the drillship, vessel and local logistics base.

All activities will be carried out in accordance with internationally recognised industry best practice to ensure safety, environmental protection and operational integrity.

3.4.1 MOBILISATION PHASE

The mobilisation phase will involve issuing necessary notifications, setting up the onshore base, hiring local service providers, sourcing and transporting equipment and materials from different ports and airports, arranging accommodation, and moving the drilling unit and support vessels to the drilling site.

3.4.1.1 VESSEL MOBILISATION AND SITE PREPARATION

The drilling unit and supply vessels may either sail directly to the well site from outside Namibian waters or from a Namibian port, depending on the selected drilling unit and its last location. The drillship will be equipped with navigation equipment for accurate station keeping above the well location (dynamic positioning – using thrusters). Both the drilling unit and support and supply vessels will need to undergo customs clearance.

Once in position, the drillship will carry out its pre-drilling activities comprising seabed survey; Remote Operated Vehicle (ROV) dive; positioning; beacon placement and dynamic positioning (DP) trials. These activities will be followed up with safety checks, drills, communication tests and drilling of the pilot hole.

Drilling materials, including casings, mud components, cement, and other equipment, will be transported into the country either on the drilling unit itself or via a container vessel directly to the onshore logistics base. From there, supply vessels will transfer these materials to the drilling unit.

3.4.2 DRILLING PHASE

Drilling is essentially undertaken in two stages, namely the riserless and risered drilling stages.

3.4.2.1 DRILLING PROCESS

Riserless (Initial) Drilling Stage

The first, 36 inch ("), and second 26" sections of the potential well will be drilled riserless. During this section drilling mud returns are not flowed back to the drilling unit. The drilling of a well generally involves drilling a large diameter hole first and running a large diameter conductor casing which serves as structural pipe to support the load of the well control equipment and subsequent casing strings.

Closed-Loop Drilling Stage

Closed-loop drilling occurs for all sections below the 26" hole section. For deepwater well construction, after the riserless drilling stage, a drilling riser (ie a hollow tube known as the 'marine riser') is run between the drilling unit and the seabed so that weighted drilling fluid can be pumped through the drill pipe and out through the drill bit. It circulates all the way around up through the marine riser back to the drilling unit. Drilling fluid helps prevent the well from caving in and clears the rock bits or "cuttings" that are constantly being chipped away as the drill bit drills deeper into the ground to prevent them from building up on the bottom of the well.

3.4.2.2 WELL DRILLING

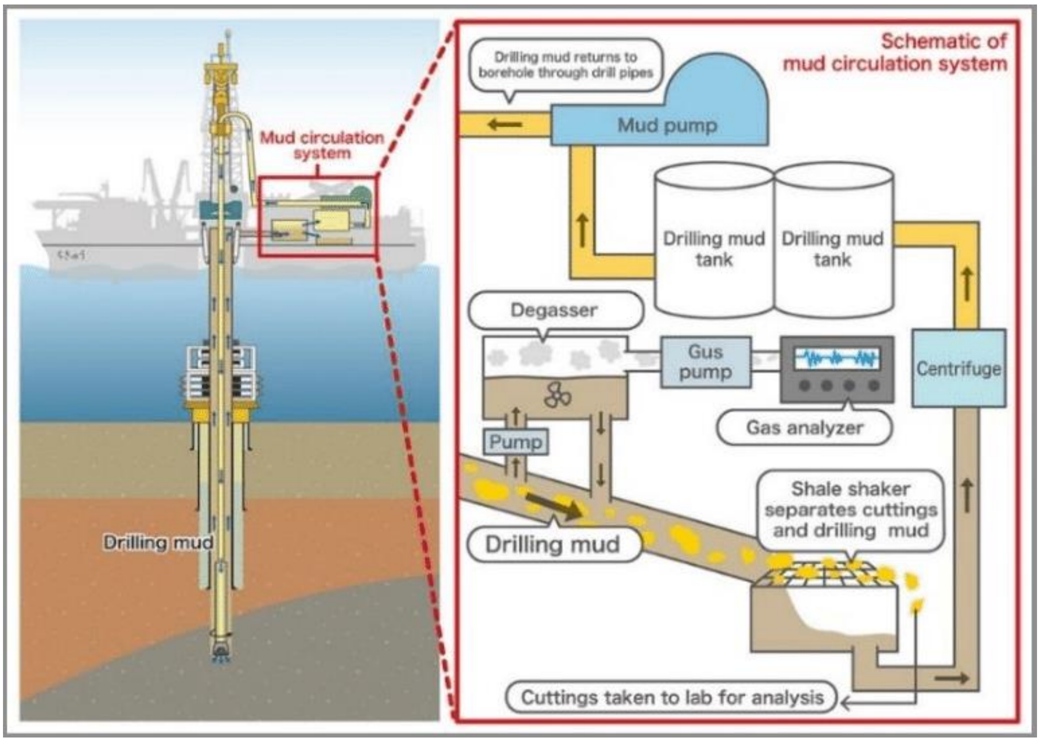
The well is planning to be drilled to a total depth range of 1,500 to 4,000 m below mud line. The schematic of a drilling mud circulation system is illustrated in Figure 3-5.

Once in position at the designated well location, drilling will commence. The well is drilled using a bit that chips off pieces of rock. The drill bit is connected to the surface by segments of hollow pipe, which together are called the drill string. The first and second drilling stages (riserless stage) are made by lowering the drill string from the drill deck to the seafloor and drilling into the seabed. All cuttings are set down directly onto the seafloor. Following these first two stages, a marine riser pipe connects the drilling floor of the drilling unit to the wellhead on the seafloor in order to collect drilling mud. Drilling is undertaken by lowering the drill string through the closed loop riser to the seafloor and rotating the drill string, causing the drill bit to crush the rock. Cuttings are removed from the bottom of the hole thanks to a drilling fluid containing clays, polymers, weighting agents and/or other materials suspended in a fluid medium. Drilling is stopped at regular intervals to allow new sections of pipe to be added to the drill string or to replace the drill bit.

As the well is drilled, metal casing is placed inside the well to line it and stabilize the hole to prevent it from caving in. The casing also isolates aquifers and hydrocarbon-bearing zones through which the well passes, thus preventing liquids or gases from entering the well prematurely. After each casing string is installed, it is cemented in place. The casing string also provides a firm point for the attachment of the blowout preventor (BOP) stack, which is where it will be located. The conductor casing serves as a support during drilling operations, to flowback returns during drilling and cementing of the surface casing, and to prevent collapse of the loose soil near the surface. The lengths and diameters of each casing section of the well are established prior to drilling. The exact details are determined by the geological conditions through which the well is drilled and will be driven by the final desired hole diameter to drill the reservoir section.

The well will be drilled initially with water-based mud for the riserless sections and then NADF for the subsequent sections. Following installation of the wellhead, BOP, and marine riser, forming a closed, circulating system between the well and drilling unit. The spent NADF will be recycled onboard the drilling unit through a dedicated mechanism where the NADF cuttings will be separated from NADF. Spent NADF will be collected in a fully enclosed skip and shipped to shore for disposal in an environmentally responsible manner, at a licensed waste management facility. NADF cuttings will be treated on the drilling unit to reduce oil content to <6.9% Oil On Cutting (OOC) and discharge the treated cuttings overboard.

FIGURE 3-5 DRILLING SCHEMATIC



Source: Apostolidou, Christina, 2019

3.4.2.3 DRILLING FLUIDS AND MATERIAL

Drilling Mud

Seawater with high viscous pills, sweeps, and WBM are used for drilling the tophole sections of the well, which are drilled riserless (that is without the marine riser installed) while NADF are used for the subsequent sections (with riser installed on top of wellhead and BOP).

Mud Management

Unused WBMs will be disposed of at sea after their use. During NADF drilling, drilling muds are circulated in a closed loop system which recycles the drilling muds and removes the drill cuttings. The returns from downhole (muds and cuttings) are routed to the shakers, which will physically separate the drill cuttings from the drilling muds that are then recycled.

Cuttings

During the riserless drilling stage (tophole section drilling) WBM and associated drill cuttings are discharged directly on the seabed in immediate proximity of the well. Cuttings with associated NADF are returned to the drilling unit and processed onboard as stated above (i.e. treated on the drilling unit to reduce oil content to <6.9% OOC and discharged overboard).

Cement

During drilling, the required cement volume will be pumped into the annular space between the casing and the borehole wall. The tophole sections however are cemented to seabed. An excess of cement, necessary to guarantee sufficient presence of cement through the overall annulus, will emerge out of the top of the well. In doing this, the conductor pipe and surface casing are cemented all the way to the seafloor.

After the riser has been installed, for the next phases cement jobs, the excess cement will be returned via the riser to the drilling vessel and treated using the solids control system. Unused cement slurry that has already been mixed is discharged overboard to avoid plugging the lines and tanks.

3.4.3 WELL LOGGING AND TESTING

Wireline logging is currently planned only in the success case. Data from Logging While Drilling (LWD) will be gathered during the drilling sections.

Well logging will be standard electric wireline logging. Logging instruments are attached to the bottom of a ‘wireline’ and lowered to the bottom of the well. The wireline containing a pre-determined array of monitoring instruments is then slowly brought back up, the devices reading different data as they pass each formation and recording it on graphs, which can be interpreted by the geologist, geophysicist, and drilling engineer. The evaluation programme will include sidewall rotary coring; the cores will be recovered to the surface. There are no emissions to the environment associated with standard wireline logging operations. Recovery of fluid samples to surface using a Modular Formation Dynamics Tester (MDT), a type of wireline tester which allows samples of reservoir hydrocarbon to be brought to the surface in small, contained volumes.

Vertical Seismic Profiling (VSP) may be undertaken in any of the wells pending data needs for understanding the subsurface.

Well testing may be conducted to assess the economic viability of a discovery. If conducted, typically, one test is performed per appraisal well if a resource is found, with up to two tests possible. Each test and associated flaring, can last up to seven days, including five days of build-up and two days of flowing and flaring. During testing, any water from the reservoir may be separated from oily components and treated onboard to minimise hydrocarbons. Any treated water is then either discharged overboard or sent to an onshore facility for further treatment and disposal.

3.4.4 WELL PLUGGING AND ABANDONMENT

Once drilling is completed, and after well logging activities have been undertaken, the exploration well will be plugged and abandoned; irrespective of whether any hydrocarbons have been discovered in the reservoir sections.

Abandonment involves inserting cement plugs across all reservoir sections that were identified and an abandonment cap on top of the well following standard procedures. The well will be abandoned in accordance with the Chevron global technical standards and will meet or exceed any local regulations. A minimum of two permanent barriers will be placed in the well between any reservoir sands and the seabed.

3.4.5 DEMOBILISATION

With the exception of the wellhead and potential cuttings depositions, there will be no further physical evidence of drilling on the seafloor. A final clearance survey check will be undertaken using a ROV. On completion of drilling activities, the drilling unit and support vessel will go off hire and will either leave the area or be contracted to other oil and gas exploration operators to continue similar operations.

Wireless monitoring gauges, operating at frequencies between 12.75 and 21.25 kHz, may be installed on wells that CNEL plans to revisit for future appraisal or production activities. These gauges will be positioned on the wellhead and remain there. However, monitoring gauges will not be installed on exploration wells designated for abandonment.

3.5 PROJECT SCHEDULE

The first well on the Gemsbok Prospect, located within Block 2112B, may be drilled in the 2026/2027 timeframe. The plan would be to initially drill an exploration well and subject to the results of this initial well, a second well may be drilled for appraisal (appraisal well). The potential for additional drilling campaigns of up to 3 to 4 wells may be considered in late 2027 to 2028 over a 3 to 5 year period for a total of up to 10 wells (exploration or appraisal) across Blocks 2112B and 2212A.

The drilling of an exploration or appraisal well is expected to require a maximum of 90 days to complete, including mobilisation, drilling operations, well testing if conducted, and demobilisation. This report therefore assesses the potential impact of drilling either an exploration or appraisal well. The preliminary project schedule for the first well is provided in Table 3-4 below.

TABLE 3-4 PRELIMINARY PROJECT SCHEDULE FOR THE DRILLING OF AN EXPLORATION AND APPRAISAL WELL

Project Phase / Activity	Anticipated Timeframe
Mobilisation	Up to 15 days
Drilling (Exploration Well)	Up to 60 days (including abandonment)
Drilling (Appraisal Well)	Up to 60 days (including abandonment and well testing if conducted)
Demobilisation	Up to 15 days
Total Estimated Duration	Conservative estimate of up to 90 days for one exploration or an appraisal well based on the timing of when the wells are drilled. If the appraisal well is drilled sequentially, there will not be a separate mobilization and demobilization activity.

3.6 PLANNED EMISSIONS AND DISCHARGES AND WASTE MANAGEMENT

This section presents the main sources of emissions to air, discharges to sea and waste that would result from the planned drilling activities and associated operations.

All vessels would have equipment, systems and protocols in place for prevention of pollution by oil, sewage and garbage in accordance with MARPOL 73/78.

Waste disposal sites and waste management facilities would be identified, verified for use prior to commencement of project activities.

3.6.1 AIR EMISSIONS

The principal sources of emissions to air from the potential exploration drilling campaign will be vessel propulsion systems and onboard power generation. Minor contributions will arise from fugitive emissions from the drilling unit and support vessels, as well as emissions from onboard waste incinerators.

If well testing is conducted on an appraisal well, emissions will be generated from hydrocarbon flaring for the limited duration of the test.

Dynamically positioned vessels have relatively high fuel consumption, resulting in elevated levels of air emissions. All vessels will use MGO, which primarily emits carbon dioxide (CO_2), sulphur oxides (SO_x), nitrogen oxides (NO_x), and carbon monoxide (CO). Smaller quantities of non-methane volatile organic compounds (VOCs), methane (CH_4), and particulate matter ($PM_{10}/PM_{2.5}$) will also be released. These emissions may cause short-term, localised increases in pollutant concentrations and contribute to regional and global atmospheric emissions.

Helicopter emissions will vary depending on fuel consumption, which is influenced by flight time, payload, weather, and speed.

GHG emissions were calculated using estimated fuel consumption data, fuel-specific emission factors (Table 3-5) and conservative assumptions (Table 3-6). The assessment assumes full utilisation of operational phases (90 days for the drilling of an exploration and an appraisal well) and a drilling rate of up to 3 to 4 wells per year over a 3 to 5 year timeframe.

TABLE 3-5 EMISSIONS FACTORS

Fuel type	CO_2 (t/m^3)	CH_4 (t/m^3)	N_2O (t/m^3)
Jet Fuel[1]	2.5718400	0.0001070	0.0000214
MGO[2]	2.7167400	0.0001100	0.0000220

Source ERM, 2025a

TABLE 3-6 EMISSIONS SOURCES AND ASSUMPTIONS

Emission Source	Activity	Assumption
Helicopters	Personnel transport during mobilisation & demobilisation	2 flights/week during mobilisation and demobilisation
	Personnel transport during drilling	4 flights/week during drilling
	Fuel consumption	1.5 m^3 jet fuel per flight
Support Vessels	Marine transport and support services	Up to 4 vessels operating during all project phases
	Fuel consumption	13 m^3/day per vessel of Distillate Fuel #2
Drillship	Drilling operations	40 m^3/day of Distillate Fuel #2
	Duration (exploration)	5 wells – up to 60 days per well
	Duration (appraisal)	5 wells - up to 60 days per well
	Mobilisation period	15 days per well
	Demobilisation period	15 days per well
Flaring during appraisal	Emergency/contingency flaring	10,000 Sm^3/day for 7 days per well
	Gas composition	95% CH_4 (dry associated gas)
	Combustion efficiency	> 98%
	Methane density	0.717 kg/m^3
General	N/A	The sequence of offshore activities is expected to follow this order: mobilisation, exploration drilling, well abandonment and demobilisation or potential appraisal

[1] Jet Fuel: Emission factors were sourced and derived using constants from the API, COMPENDIUM OF GREENHOUSE GAS EMISSIONS METHODOLOGIES FOR THE NATURAL GAS AND OIL INDUSTRY as follows:

- *Table 3-8: Densities, Higher Heating Values, and Carbon Contents for Various Fuels*
- *Table 4-3: CO_2 Combustion Emission Factors (Fuel Basis) for Common Industry Fuel Types*
- *Table 4-8: CH_4 and N_2O Combustion Emission Factors from EPA Mandatory GHG Reporting Rule*

[2] Distillate #2 fuel: Same as the above.

Emission Source	Activity	Assumption
		well with well testing, well abandonment and demobilisation. For the purposes of the greenhouse gas (GHG) assessment, a conservative worst-case scenario has been applied, assuming 90 days of offshore operations. This includes 15 days for mobilisation, 60 days for exploration and abandonment, 15 days for demobilisation. If an appraisal well is drilled, it will include 15 days for mobilisation, 60 days for drilling and testing, abandonment and 15 days for demobilisation, unless they are drilled back-to-back. There would be no demobilisation and mobilization between the wells. A maximum of four wells is anticipated to be drilled per year, with up to two mobilisation and two demobilisation phases likely to occur during this time.

Source ERM, 2025a

The project is estimated to generate approximately 44,208 tonnes of CO_2 equivalent (tCO_2e) per year, calculated on a worst-case basis, ie. assuming four wells are drilled per year. The key findings are summarised below:

- Mobilisation Phase: The estimated total GHG emissions during the mobilisation phase are approximately 4,394 tCO_2e per annum. The majority of these emissions originated from drillship operations, which are the primary contributors in this phase.
- Drilling Phase (Exploration as the worst case): GHG emissions during the drilling phase are estimated at 35,419 tCO_2e per annum. Drillships account for approximately 74% of these emissions, with the remaining 26% attributed to helicopter and support vessel operations. This is considered a worst-case and most conservative assumption.
- Demobilisation Phase: The estimated GHG emissions for the demobilisation phase are 4,394 tCO_2e per annum, with drillships again being the dominant source of emissions.
- Overall Emissions Profile: Across all project phases, drillships are the primary source of GHG emissions. This is largely due to their use of distillate fuel #2, which has a higher carbon intensity compared to jet fuel. Additionally, drillships consume significantly more fuel per operational day than helicopters, owing to their higher frequency and duration of use throughout the project lifecycle. Table 3-7 presents a breakdown of these emissions by source and project phase.

TABLE 3-7 GHG EMISSIONS BREAKDOWN BY SOURCE AND PROJECT PHASE PER ANNUM

Activity	Mobilisation	Drilling	Demobilisation	Total (tCO_2e) per annum
Support Vessels	1,090	8,722	1,090	10,903
Helicopter	33	531	33	597
Drillship	3,271	26,166	3,271	32,708
TOTAL	4,394	35,419	4,394	

Source ERM, 2025a

3.6.2 DISCHARGES TO SEA

3.6.2.1 DRILL CUTTINGS AND MUD DISPOSAL

For the drilling campaign being considered, the Gemsbok Exploration Well (Block 2112B) and a potential second exploration well location (Block 2112A) would generate drill cuttings as the drill bit penetrates subsurface rock. These cuttings, along with drilling muds, will be discharged according to a defined schedule and composition, as presented in Table 3-8 below.

Although both wells follow the same drilling and discharge procedures, they differ in ocean depth, ranging from 900-1,500 m.

TABLE 3-8 WELL PROFILE, DRILLING SCHEDULE AND DISCHARGE PROPERTIES

Section No. and Bore Diameter (ft)	Section Length (m)	Discharge Duration (hours)	Cuttings Mass (MT)	Discharged Mineral Mass of Mud /Attached NABF Mass (MT)	Cuttings Bulk Density (kg/m^3)	Density of Mineral Mass of Mud / Density of NABF (kg/m^3)
Section 1 36"	85	24	165.49	468.43 / NA	2,588	1,031 (of WBM)
Section 2 26"	938	48	1321.11	9,962.98 / NA	2,588	1,234 (of WBM)
Section 3 17.5"	2,041	120	867.00	101.5 / 101.5	2,108 (Cuttings with adhered NADF Base Oil)	1,984 / 810
Section 4 12.25"	1,417	192	296.75	37.5 / 37.5	2,078 (Cuttings with adhered NADF Base Oil)	2,817 / 810

Source: CNEL, 2025

The drilling process will consist of four sections:

- Sections 1 and 2 will use Water-Based Muds (WBMs), with cuttings discharged near the seabed at approximately 5 m above the seafloor.

- Sections 3 and 4 will use Non-Aqueous Drilling Fluids (NADFs), with treated cuttings containing adhered Non-Aqueous Base Fluid (NABF) discharged at 10 m below the water surface.

Top-hole sections are drilled without a marine riser, using seawater, viscous pills, sweeps and WBM. Fluids and cuttings are discharged directly onto the seabed. Once the riser is installed, excess seawater stored in tanks is discharged. NADF systems operate in a closed-loop configuration, recycling drilling muds and separating cuttings using onboard shakers and dryers. Unused WBMs are discharged to sea, while NADF that cannot be reused is returned to shore. Non-Aqueous Base Fluid (NABF) adhered to cuttings is treated onboard to reduce base fluid retention.

Cuttings containing NADF are treated to minimise NABF retention. NABF, composed of hydrocarbons, may degrade over time once settled on the seabed. Depending on the hydrocarbon properties, they may enter sediment pore water or dissolve into the water column. Although the NABF to be used is considered low toxicity due to the very low percentage of aromatics within the hydrocarbon mixture (Group III as defined by the International Association of Oil and Gas Producers, OGP 2003), degradation may consume dissolved oxygen in sediments, potentially resulting in ecological effects.

The expected fall and spatial extent of the deposition of discharged cuttings is investigated in the Drill Cuttings Deposition Modelling Study conducted by ERM (refer to Appendix D).

3.6.2.2 CEMENT

Generally during drilling cement and its additives are generally not released. However, in the initial cementing process, ie surface casing, surplus cement can flow out of the well's top and onto the seafloor to fully cement the conductor pipe to the seafloor. This process may involve pumping up to 150-200% of the necessary cement volume into the annulus (the space between the casing and the borehole wall). In the worst-case scenario, around 100 m^3 of cement might be discharged onto the seafloor.

3.6.2.3 PRODUCED WATER

The volume of hydrocarbons (to be burned) and possible associated produced water from the reservoir which could be generated during well testing cannot be reliably predicted due to variations in gas composition, flow rates and water content. Burners are manufactured to ensure emissions are kept to a minimum. The estimated volume of hydrocarbons to be burned cannot be with much accuracy because the actual test requirements can only be established after the penetration of a hydrocarbon-bearing reservoir. However, an estimated 20 million standard cubic feet (MSCF) of gas per day and 20,400 barrels of oil could be flared per test.

If produced water is generated during well testing, it will be separated from the hydrocarbons and discharged to the sea.

3.6.2.4 BOP HYDRAULIC FLUID

During routine operations involving the opening and closing of the subsea BOP stack, small volumes of hydraulic fluid are released into the marine environment at the seafloor. It is estimated that approximately 500 to 1,000 litres of oil-based hydraulic emulsion fluid may be discharged over 30 days (up to 60 days per well for drilling) during the drilling of a single well.

These fluids are designed to be environmentally benign and are biodegradable in seawater within 28 days.

3.6.2.5 LIQUID DISCHARGES

Table 3-9 shows types and disposal methods of liquid waste anticipated to be generated during the potential project activities. The disposal methods shall comply with Namibian regulations and MARPOL requirements.

TABLE 3-9 TYPES OF LIQUID WASTE AND THEIR DISPOSAL METHODS

Type	Potential disposal method
Wastewater	Wastewater will include brine (which is produced in the reverse osmosis process to produce freshwater on the drillship). Typically, in well drilling operations, the production of freshwater is approximately 40 m^3 per day, leading to an estimated salt output of about 35 grams for every litre of water generated (equating to roughly 1,400 kg of salt/brine daily). The wastewater will be treated onboard via a dedicated and approved system prior to discharge in accordance with the requirements the International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78.
Bilge water	Bilge water will be collected and piped into a bilge holding tank on board the project vessels in accordance with MARPOL 1973/78 Annex 1. The fluid will be monitored and any oily water would be processed through a suitable separation and treatment system. Detergents used for washing exposed marine deck spaces will be managed as bilge water. The toxicity of detergents varies greatly depending on their composition. Water-based or biodegradable detergents are preferred for use due to their low toxicity. In certain cases of specific area cleaning, e.g., marine deck with no contamination of pollutants, using no toxic detergent, direct overboard discharge may be considered.
Galley waste	The disposal of galley waste into the sea is permitted under MARPOL 73/78 Annex V, only when the vessel is located more than three nautical miles (approximately 5.5 km) from land and the food waste has been ground or comminuted to particle sizes smaller than 25 millimetres (mm).
Ballast water	Ballast water is crucial for maintaining safe operating conditions on a ship. It helps reduce hull stress, provides stability, enhances propulsion and manoeuvrability, and compensates for weight changes due to fuel and water consumption. However, discharging ballast water can introduce foreign marine species, such as bacteria and larvae, into new environments, posing ecological risks. This is particularly relevant when moving a drilling unit to Namibia. To mitigate these risks, the 2004 International Convention for the Control and Management of Ships' Ballast Water and Sediments mandates that all ships must have a Ballast Water Management Plan. Ships using ballast water exchange must do so at least 200 nautical miles (approximately 370 km) from the nearest land in waters at least 200 meters deep when arriving from a different marine region. If this is not feasible, the exchange should occur as far from the nearest land as possible, with a minimum distance of 50 nautical miles (about 93 km) and preferably in waters at least 200 meters deep. Project vessels are required to adhere to these regulations.
Sewage and grey water	Sewage discharge from the project vessels and the drilling unit will meet the requirements of MARPOL 73/78 Annex IV. The drilling unit and all project vessels will have a valid International Sewage Pollution Prevention (ISPP) Certificate. The sewage discharged from vessels will be disinfected, comminuted and any effluent will not produce visible floating solids in, nor cause discoloration of the surrounding water. The treatment system will provide primary settling,

Type	Potential disposal method
	chlorination, and de-chlorination. The treated effluent will then be discharged into the sea.

3.6.3 LAND DISPOSAL

A number of other types of wastes generated during the drilling activities would not be discharged at sea but would be transported to shore for disposal. These wastes would be recycled or re-used if possible or disposed at an appropriate licensed municipal landfill facility (Walvis Bay has general and hazardous landfill sites) or at an alternative approved site. The services of a Licensed waste contractor will be used to collect all operational waste for treatment, disposal or recycling.

Typical waste types generated by a drillship that are disposed of onshore include:

- Garbage (eg paper, plastic, wood and glass) including wastes from accommodation and workshops etc;
- Scrap metal and other material;
- Drums and containers containing residues (eg lubricating oil) that may have environmental effects;
- Used oil, including lubricating and gear oil; solvents; hydro-carbon based detergents, possible drilling fluids and machine oil;
- Chemicals and hazardous wastes (eg radioactive materials, neon tubes and batteries);
- Medical waste from treatment of personal onboard the vessel;
- Filters and filter media from machinery;
- Drilling fluid, spent NADF, brine from drilling and completion activities.

Additionally, Naturally Occurring Radioactive Materials (NORM) can be found in subsurface rocks and fluids in oil and gas fields. While an exploration well can contain low levels of NORM, especially in the produced water, exploration wells are not subject to the long-term, high-volume flow conditions that cause significant build-up and therefore, considered as a low risk during exploration.

3.6.4 NOISE EMISSIONS

Underwater noise generated by the potential drilling operations will arise from several key sources, including vessel propellers and positioning thrusters, drag on the riser, supply vessels, and drilling activities. These sources are expected to produce highly variable sound levels, depending on the operational mode and configuration of each vessel. Additionally, if a VSP survey is undertaken during well logging, it will contribute to short-term noise emissions over a period of approximately 8 to 12 hours.

- The principal sources of noise are categorised as follows:
- Drilling Noise: Drilling units typically emit underwater noise across a frequency range of 10 Hz to 100 kHz, with dominant components below 100 Hz (OSPAR Commission, 2009). Source levels can reach up to 196.2 dB re 1 µPa @ 1 m RMS, particularly when bow thrusters are in use. For this project, the estimated source level for the MODU is

approximately 196.2 dB re 1 µPa @ 1 m RMS, based on the Brown (1977) empirical formula.

- Propeller and Positioning Thrusters: Noise from propellers and thrusters is primarily caused by cavitation around the blades, especially during high-speed transit or when operating under load to maintain vessel position. This noise is typically broadband, with low tonal peaks, and can be audible over several kilometres. Supply vessels also contribute to overall propeller noise. For this project, the estimated source level from a single support vessel is approximately 195.4 dB re 1 µPa @ 1 m RMS, with the combined noise from four support vessels reaching approximately 202 dB re 1 µPa @ 1 m RMS.
- Machinery Noise: When vessels are stationary or moving slowly, low-frequency machinery noise becomes dominant. This originates from large onboard systems such as power generators, compressors and fluid pumps and is transmitted via both structural paths (machine → hull → water) and airborne paths (machine → air → hull → water). Machinery noise is typically tonal. A ROV will be deployed to sweep the drilling site for debris, but it is not expected to be a significant noise source.
- Well Logging Noise (VSP): Although unlikely, a VSP survey may be conducted to acquire high-resolution geological data near the well. This involves a dual airgun array with a total volume of 1,200 cubic inches of compressed nitrogen at 2,000 psi. The airguns discharge approximately five times at 20-second intervals, repeated across different well sections, totalling around 250 shots. VSP operations typically last 8 to 12 hours per well, generating intermittent short-term noise. An alternative scenario considered in the underwater noise modelling assumes 50 VSP pulses over approximately 2 hours, representing a shorter-duration operation. For this project, the estimated source level for the VSP G-Gun array show the Peak level to be 242 dB re 1 µPa at 1 m, the RMS 230 dB re 1 µPa at 1 m, and the SEL 221 dB re $\mu Pa^2 \cdot s$ at 1 m. These values were used in the underwater noise modelling to evaluate transmission loss and potential impacts on marine fauna.
- Well Testing Noise: Flaring during well testing produces airborne noise above sea level, which may affect nearby fauna.
- Subsea Equipment Noise: Equipment such as the drill string generates relatively low levels of underwater noise compared to drilling and dynamic positioning systems.
- Helicopter Noise: Helicopter operations contribute to both airborne and underwater noise, potentially affecting marine fauna.

The extent of project-related noise above ambient levels will vary depending on the types of vessels used, the number of support vessels operating, weather conditions and proximity to other vessel traffic.

An Underwater Noise Modelling Study has been undertaken by ERM to evaluate transmission loss with distance from the well site and to compare results against threshold values for marine fauna, thereby identifying zones of potential impact (refer to Section 7.2).

3.6.5 LIGHT EMISSIONS

For safe operations and navigation during nighttime, the drilling unit and supply vessels will use operational lighting. Efforts will be made to shield these lights to reduce their spill into the surrounding sea where possible.

3.6.6 HEAT EMISSIONS

Heat emissions would only be produced during well testing for an appraisal well due to the combustion of hydrocarbons at the burner head during flaring.

3.7 UNPLANNED EMISSIONS AND DISCHARGES

This section presents the main sources of emissions that would result from unlikely unplanned/ accidental events during the drilling activities and associated operations.

3.7.1 HYDROCARBONS AND CHEMICAL SPILLS (ONSHORE AND OFFSHORE)

Two of the main types of accidental events could result in a discharge of hydrocarbons or chemicals to the marine environment are:

- Loss of well containment; and
- Single-event/batch spills.

A loss of well containment typically involves a continuous release, which could last for a measurable period of time, while a single-event spill is an instantaneous or limited duration occurrence. CNEL is committed to minimising the release of hydrocarbons and hazardous chemical discharge into the marine and onshore environments and avoiding unplanned spills.

In the case of an accidental event, CNEL will aim to minimise any adverse effects to the environment through the following measures:

- Incorporating oil and chemical spill prevention into the well design and drilling plans.
- Confirming that the necessary contingency planning has taken place to respond effectively in the event of an incident.

Prior to the commencement of drilling, CNEL will develop and implement an Oil Spill Contingency Plan (OSCP) to address any accidental release offshore. In addition, precautionary measures will be taken to ensure that all chemicals and petroleum products stored and transferred both onshore and offshore are managed in a manner that minimises the risk of spills and environmental harm in the event of an accidental release.

Additionally, CNEL, is a member of Oil Spill Response Limited (OSRL) which provides advanced capping stacks to shut-in uncontrolled subsea wells in the event of a blow-out. The primary capping stack, a 10K unit, is housed at OSRL's Saldanha Bay Base in South Africa and is available for global mobilisation. Additional stacks are located in Brazil, Norway, and Singapore.

In the event of a sub-sea loss of containment event, a number of critical resources would be mobilized to the location. These include debris removal, stabilization and monitoring equipment and the capping stack. The capping stack allows for the safe capture and/or closure of the oil flow. Before its arrival, a ROV inspects the seabed, removes debris and prepares the wellhead.

An Oil Spill Modelling Study has been undertaken by RPS Ocean Science to evaluate potential spill scenarios (refer to Appendix E). CNEL contracted RPS Ocean Science, a Tetra Tech company, (“ROS”) to assess the trajectory and fate of hypothetical hydrocarbon spill events from three locations, Gemsbok, Potential Second Well, and a Shallow Well, within the PEL 82 exploration license area, Block 2112B and Block 2212A, offshore Namibia

3.8 PROJECT ALTERNATIVES

Project alternatives considered during the design phase are outlined below. According to the relevant environmental regulations, “alternatives” to a potential activity refer to different means of meeting the general purpose and requirements of the activity, which may include:

- The property or location where the activity is proposed;
- The type of activity to be undertaken;
- The design or layout of the activity;
- The technology to be used in the activity; or
- The operational aspects of the activity.

A comparative assessment of project alternatives, where applicable, is provided in Table 3-10 below.

TABLE 3-10 SUMMARY OF PROJECT ALTERNATIVES CONSIDERED IN THIS ESIA REPORT

Aspect	Alternatives	Consideration in this ESIA Report
Site / location alternatives		
Drill Site Locations	None.	Only one potential drill site location has been identified in the Gemsbok prospect. Future well locations within PEL 82 will be identified during the exploration phase based on further analysis of seismic data, geological targets, seafloor obstacles and results from the initial well. While precise locations are not confirmed, this ESIA Report evaluates generic well drilling scenarios across Blocks 2112B and 2212A to ensure the impact assessment remains representative. Hypothetical drill sites were selected to model worst-case scenarios for noise, discharges and oil spills, based on criteria such as metocean data, water depth and proximity to sensitive areas. To minimise environmental impacts (particularly on vulnerable benthic habitats such as hardgrounds) the

Aspect	Alternatives	Consideration in this ESIA Report
		project design includes a precautionary buffer of 500 m from any such habitats identified during pre-drilling ROV surveys. CNEL will also adjust well locations to avoid potential obstructions in an area such as shipwrecks. Therefore, no assessment of alternatives is required in this ESIA Report.
Aviation Base Location	Lüderitz and Walvis Bay	Two alternative aviation base locations were considered during the Scoping Phase: Lüderitz and Walvis Bay. CNEL selected Walvis Bay as the preferred location due to its proximity to the chosen onshore base. Therefore, no assessment of alternatives is required in this ESIA Report.
Timing / Scheduling Alternatives		
Timing of exploration and appraisal drilling	Timing of exploration and appraisal drilling	No specific restrictions or alternative timelines have been proposed. This ESIA Report considers the implications of drilling in different seasons. The timing does not affect the significance of impacts related to drill cuttings deposition or an unlikely oil spill, it does influence the extent of a spill. Summer scenarios (November to April) produced larger surface oil footprints exceeding 10 g/m² compared to winter scenarios.
Design and Technology Alternatives		
Number of Wells	Drill one well vs. up to ten wells	In anticipation of potential exploration activities in the Gemsbok Prospect, one exploration well. Based on the results of this

Aspect	Alternatives	Consideration in this ESIA Report
		well, it may be followed by an appraisal well. Additional drilling campaigns of up to 3 to 4 wells could potentially be conducted for a total of up to 10 wells (5 exploration and 5 appraisal wells) in PEL 82. This ESIA Report assesses the impacts of drilling one well at a time, with a maximum of ten wells. Fewer wells would likely result in less significant impacts.
Drilling Unit	Drillship vs. semi-submersible vessel	Two types of drilling units are under consideration: a drillship and a semi-submersible vessel. Due to the similar environmental consequences of both, they are not treated as alternatives in this ESIA Report and are not comparatively assessed.
Drilling Fluid	WBM vs. NADF	Two types of drilling fluids may be used: WBM and NADF. CNEL plans to use WBMs during the riserless stage and NADFs during the risered stage if WBMs are insufficient. Since each fluid is suited to different conditions, they are not considered alternatives. This ESIA Report assesses the impacts of both, finding no significant difference in impact severity.
Drill Cuttings Disposal Methods	Discharge to sea vs. onshore disposal vs. re-injection	Theoretical options for drill cuttings disposal include discharge to sea, onshore disposal and re-injection. CNEL proposes offshore treatment and disposal, consistent with practices in

Aspect	Alternatives	Consideration in this ESIA Report
		Namibia and South Africa for early exploration phases. This approach is justified by the low density of operations and the high-energy marine environment. Drill cuttings modelling was conducted to determine plume dispersion and assess impacts on marine habitats and species. If significant impacts are identified, alternative disposal methods may be considered. This ESIA Report assesses the impacts discharging the cuttings to sea.
No-Go Alternative		
No-Go Alternative	Proceed with drilling vs. no drilling	The No-Go alternative involves not proceeding with the exploration drilling and maintaining the status quo. While this option avoids potential environmental and social impacts, it also means foregoing the opportunity to enhance geological knowledge and realize potential economic and social benefits. This alternative would limit Namibia's ability to attract investment and develop its offshore petroleum resources. The implications of the No-Go alternative are considered in Section 8 of this report.

4. DESCRIPTION OF THE RECEIVING ENVIRONMENT

This chapter outlines the characteristics of the physical, biological, socio-economic, and cultural environments within the license area and the surrounding region.

The general framework of the baseline data collection was as follows:

- Initial scoping and desktop review – this phase included defining the geographical scope and other relevant boundaries, conducting a preliminary evaluation, and performing a desktop review of available information and data sources.
- Engagement with stakeholders – consultations were held with the public and key stakeholders to gather input and perspectives.
- Specialist studies – expert assessments were conducted to inform the environmental and impact evaluation processes.

4.1 ENVIRONMENTAL PROJECT AREA

The Project Area comprises of the various biophysical and socio-economic conditions receptors that may be affected both directly and indirectly by the project activities. The Project Area is separated into Area of Direct Influence (ADI) and Area of Indirect Influence (AII) (Figure 4-2) depending on the source and causes of the potential impacts and these will vary in extent depending on the type of receptor affected.

4.1.1 AREA OF DIRECT INFLUENCE

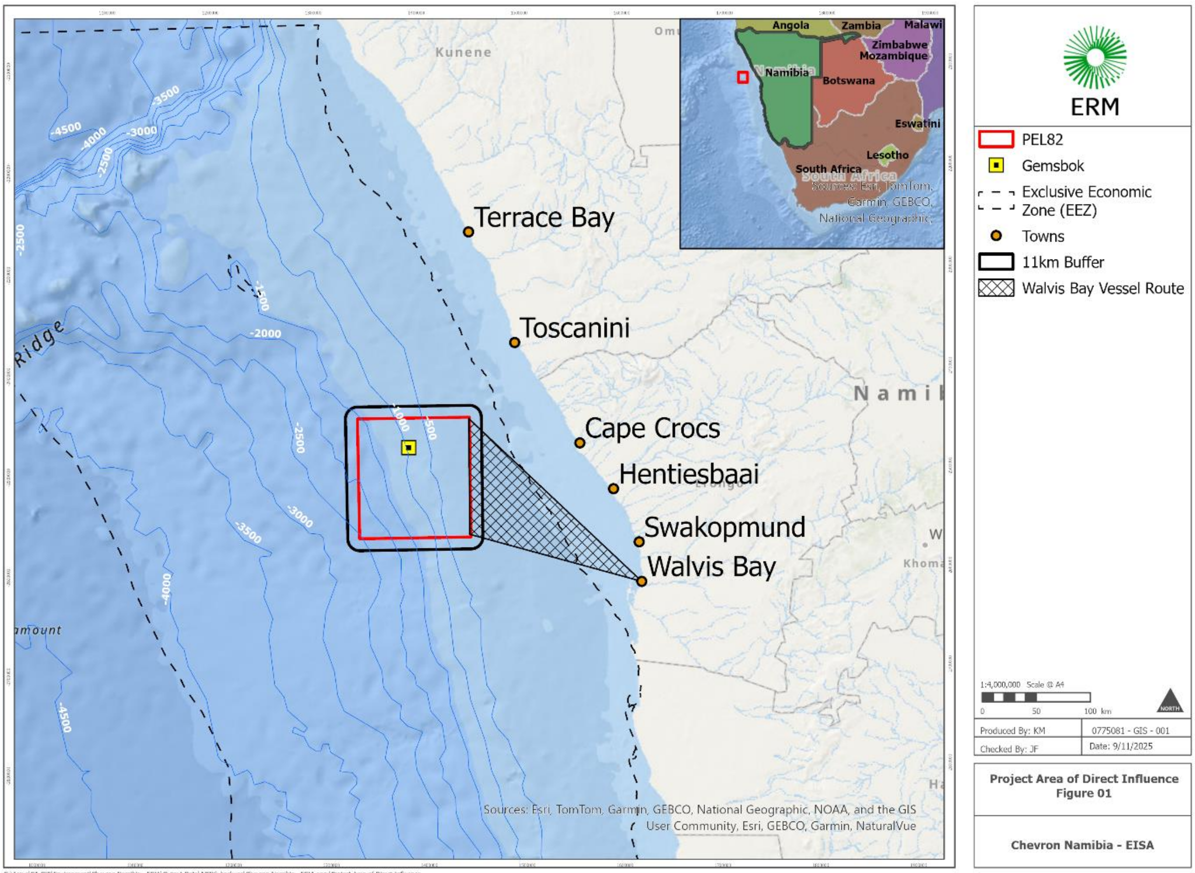
The ADI is offshore of the Namibian west coast, in the Walvis Basin and includes the entire license area (PEL 82) within which the project activities will take place. It also includes:

- Walvis Bay where will be located the logistic base, helicopter transport and crew accommodation;
- The supply vessels and helicopter routes between Walvis Bay and the MODU.

The ADI is also established based on the results of underwater noise and drill cuttings discharge modelling, as well as marine ecology and fisheries assessments. As such, a buffer area of 11 km around the license area is considered, considering different potential well locations within the blocks.

The resulting area of direct influence is shown in Figure 4-1.

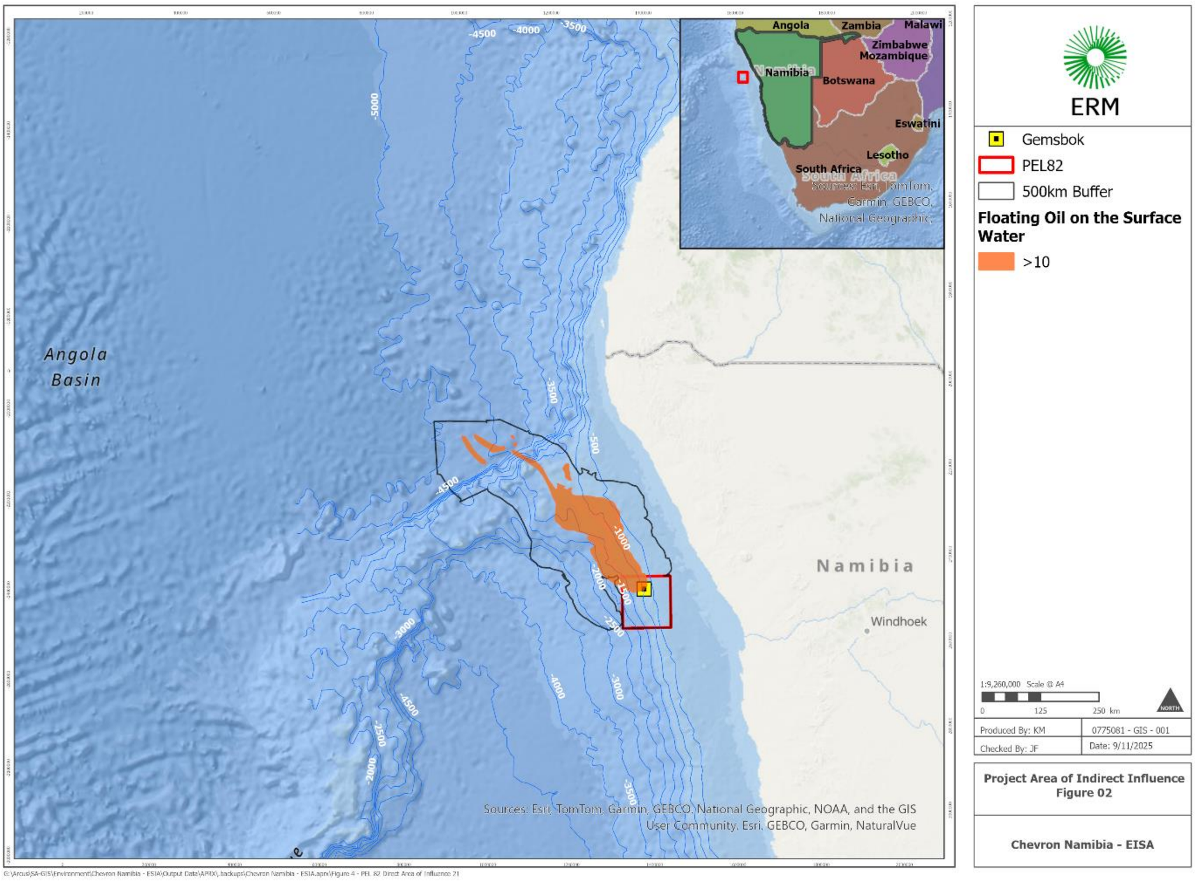
FIGURE 4-1 PROJECT AREA OF DIRECT INFLUENCE



4.1.2 AREA OF INDIRECT INFLUENCE

The AII includes the entire license area and extends where an accidental oil spill, if not contained/recovered, may reach in the worst-case scenario modelled within the oil spill specialist study. Maximum 500 km northwest from the well location was calculated for surface oil trajectory, a buffer zone of this distance will be considered in the northwest direction, to account for the different potential well locations within the blocks (no shoreline oiling was predicted in any scenario).

FIGURE 4-2 PROJECT AREA OF INDIRECT INFLUENCE



4.2 PHYSICAL ENVIRONMENT

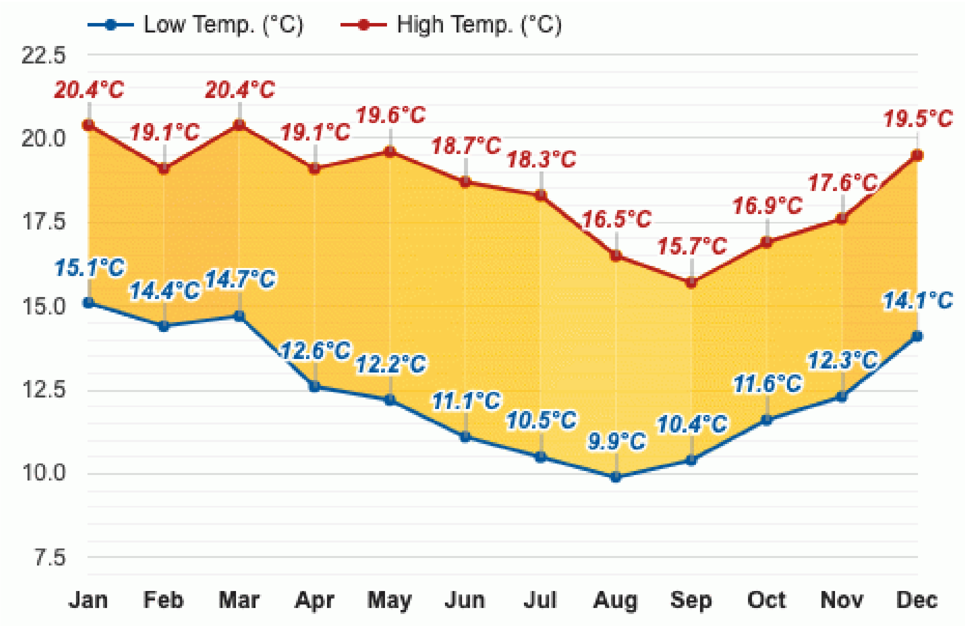
4.2.1 CLIMATE

The climate of the Namibian coastline is classified as hyper-arid with typically low, unpredictable winter rains and strong predominantly southerly or south-westerly winds. Further out to sea, a south-easterly component is more prominent. Winds reach a peak in the late afternoon and subside between midnight and sunrise.

4.2.1.1 TEMPERATURE

The average annual temperature in Walvis Bay is approximately 17.1°C. Monthly average temperatures range from a minimum of 14.7°C in September to a maximum of 19.1°C in March. The temperature variation throughout the year is relatively small, contributing to stable atmospheric conditions.

FIGURE 4-3 MINIMUM AND MAXIMUM TEMPERATURES IN WALVIS BAY



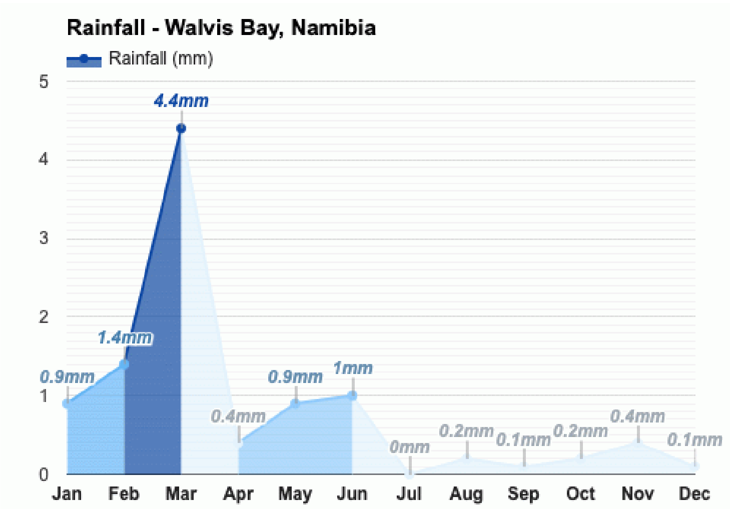
Note: Data was collected from 1991 to 2021

Source: Weather Atlas, 2025

4.2.1.2 RAINFALL

Rainfall in Walvis Bay is extremely low, with an annual precipitation of about 33 mm. The wettest month is January, with an average rainfall of six mm, while May is the driest month with only one mm of rain. The city experiences virtually no rainfall from May to September (Weather Atlas, 2025).

FIGURE 4-4 RAINFALL CLIMATOLOGY IN WALVIS BAY



Note: Data was collected from 1991 to 2021
Source: Weather Atlas, 2025

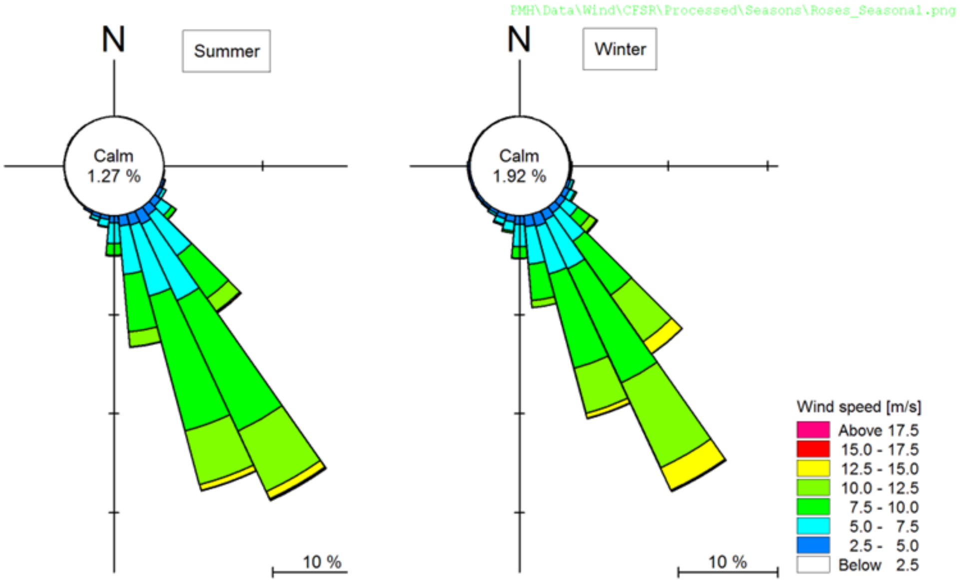
4.2.1.3 WIND PATTERNS

Winds are one of the main physical drivers of the near shore Benguela region, both on an oceanic scale, generating the heavy and consistent south-westerly swells that impact this coast, and locally, contributing to the northward-flowing longshore currents, and being the prime mover of sediments in the terrestrial environment. Consequently, physical processes are characterised by the average seasonal wind patterns, and substantial episodic changes in these wind patterns have strong effects on the entire Benguela region.

The prevailing winds in the Benguela region are controlled by the South Atlantic subtropical anticyclone, the eastward moving mid-latitude cyclones south of southern Africa, and the seasonal atmospheric pressure field over the subcontinent. The south Atlantic anticyclone is a perennial feature that forms part of a discontinuous belt of high-pressure systems that encircle the subtropical southern hemisphere. This undergoes seasonal variations, being strongest in the austral summer, when it also attains its southernmost extension, lying south west and south of the subcontinent. In winter, the south Atlantic anticyclone weakens and migrates north-westwards.

The PEL 82 license area is located in an area of strong south-easterly winds, which blow approximately parallel to the coastline. There is minimal seasonality in the wind pattern, with a slightly more easterly direction in winter. Seasonal wind roses for the Climate Forecast System Reanalysis (CFSR) wind hindcast data at 10°E, 22°S in the vicinity of PEL 82 are illustrated in Figure 4-5 (PRDW, 2019).

FIGURE 4-5 SEASONAL WIND ROSES AT 10°E, 22°S IN THE VICINITY OF PEL 82



Source: PRDW, 2019

During autumn and winter, catabatic, or easterly 'berg' winds can also occur. These powerful offshore winds can exceed 50 km/h, producing sandstorms that considerably reduce visibility at sea and on land. Although they occur intermittently for about a week at a time, they have a strong effect on the coastal temperatures, which often exceed 30°C during 'berg' wind periods (Shannon and O'Toole 1998). The winds also play a significant role in sediment input into the coastal marine environment with transport of the sediments up to 150 km offshore (Figure 4-6).

FIGURE 4-6 AEROSOL PLUMES OF SAND AND DUST BEING BLOWN OUT TO SEA DURING A NORTHEAST 'BERG' WIND EVENT ALONG THE CENTRAL NAMIBIAN COAST

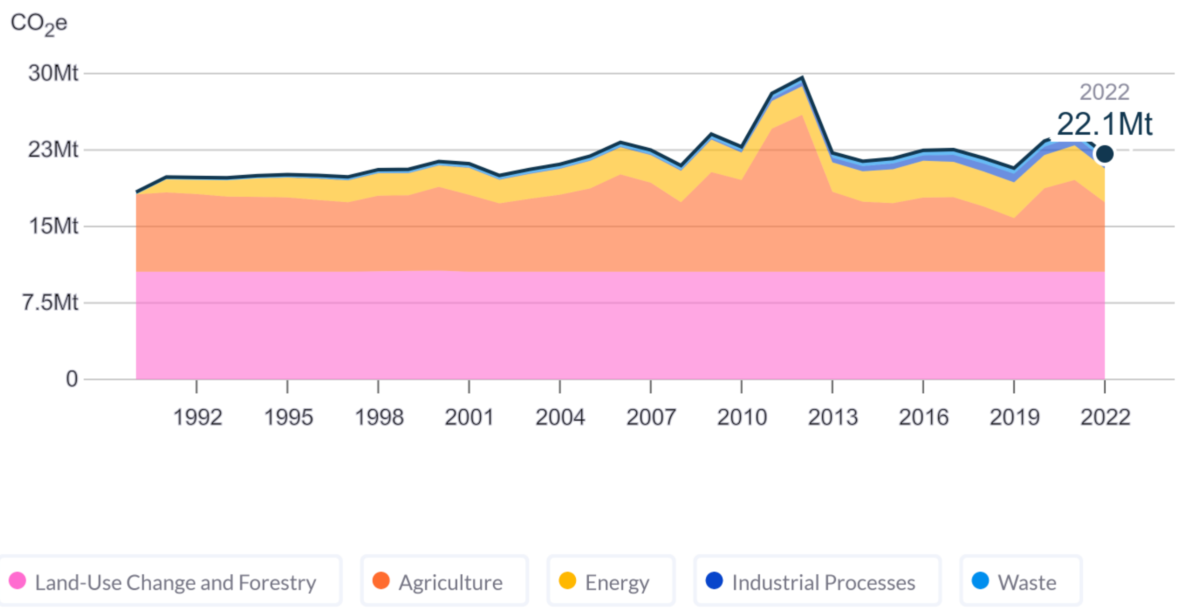
Source: www.intute.ac.uk, 2025

4.2.1.4 NAMIBIA'S GREENHOUSE GAS EMISSIONS

Namibia's national GHG emissions were calculated to be 24.12 $MtCO_2e$ in 2022, including forestry and land use change (ClimateWatch, 2025), representing 0.04% of the world's total emissions.

Figure 4-7 presents Namibian CO_2e emissions per sector from 1990 to 2022. The data shows that, between 1990 and 2022, the land use change and forestry sector is the largest contributor (approximately 50% of the total emissions) and is stable. It is followed by the agriculture, contributing to approximately 30% of the total emissions and energy. Emissions from agriculture increased between 1990 to 2012 and are decreasing since (2022's emissions are comparable to the ones from 1997). Emissions from energy sectors have increased from 1990 to 2015 and are relatively stable since, representing approximately 15% of the total emissions.

FIGURE 4-7 NAMIBIAN CO2 EMISSIONS BY SECTOR FROM 1990 TO 2022



Source: Climate Watch, 2025

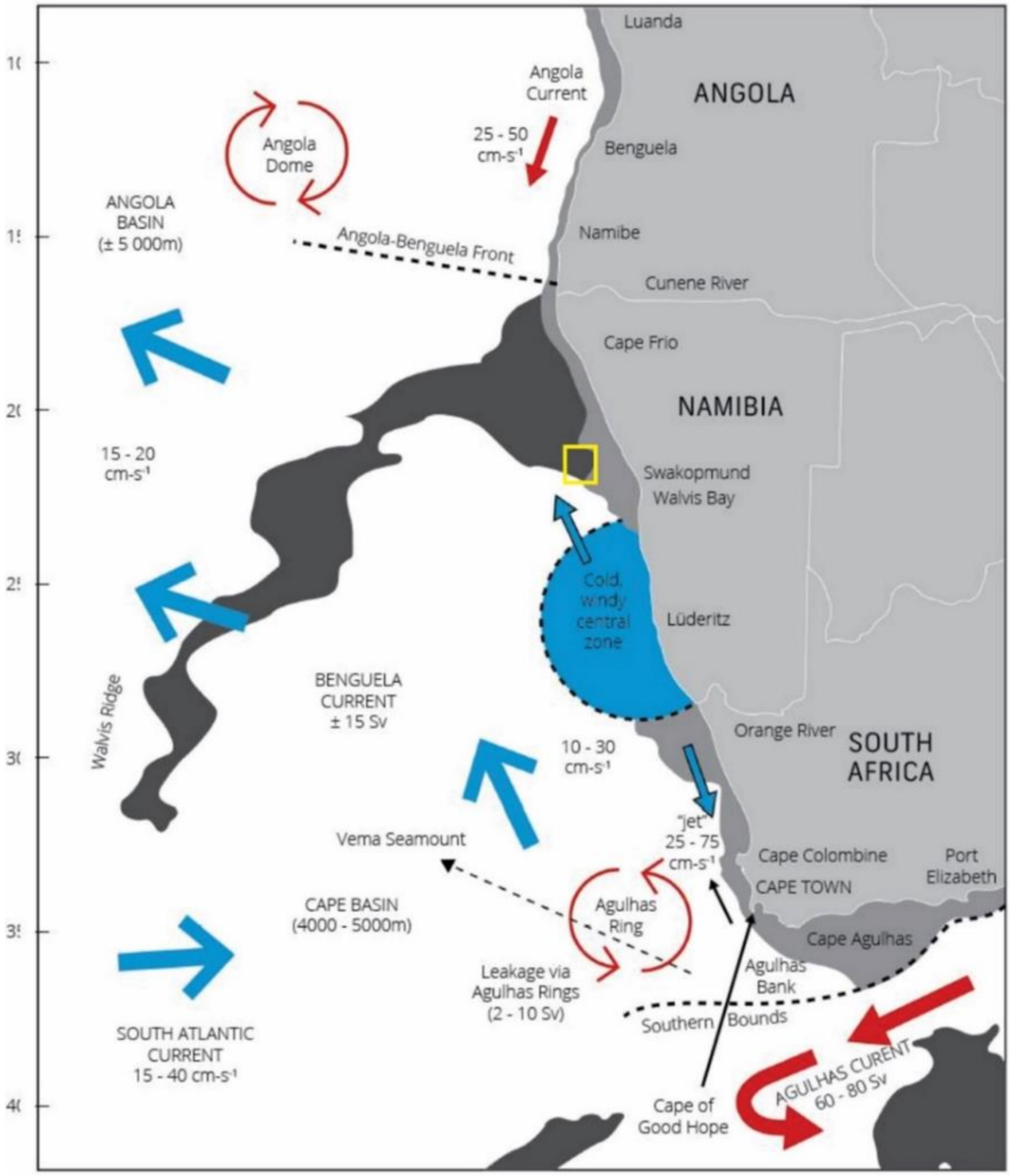
As a party to the Paris Agreement, Namibia is committed to contribute to the global efforts towards reducing its emissions and increasing its removal. This is outlined in the Nationally Determined Contributions (NDCs). Namibia has issued in April 2023 a second update of the First NDC which covers the period 2021 to 2030. Under these NDCs, Namibia, despite being historically a sink and projected to remain so by the target year 2030 in the business as usual (BAU) scenario started to undertake mitigation as from the base year 2010 and is committed to continue on this path to reduce its emissions. Namibia targets a reduction of its projected national emissions by 7.669 Mt CO_2 e while concurrently increasing its removals by 4.233 Mt CO_2 e for a total mitigation potential of 11.902 Mt CO_2 e, representing an increase in the sink capacity by 13.1% compared to the BAU scenario in 2030. The Land Use, forestry and agriculture followed by the energy sector will be the main contributors (respectively 67% and 30%) of the national mitigation potential in 2030. For the energy sector, mitigation measures mentioned in the NDCs aim at substituting fossil fuels with renewables and increasing efficiency.

4.2.2 OCEANOGRAPHIC CONDITIONS

4.2.2.1 LARGE-SCALE CIRCULATION AND COASTAL CURRENTS

The Namibian coastline is strongly influenced by the Benguela Current. Current velocities in continental shelf areas generally range between 10–30 cm/s (Boyd and Oberholster, 1994). In the south the Benguela current has a width of 200 km, widening rapidly northwards to 750 km. The flows are predominantly wind-forced, barotropic and fluctuate between poleward and equatorward flow (Shillington et al., 1990; Nelson and Hutchings 1983). Fluctuation periods of these flows are 3 - 10 days, although the long-term mean current residual is in an approximate northwest (alongshore) direction. Near bottom shelf flow is mainly poleward (Nelson, 1989) with low velocities of typically 5 cm/s.

FIGURE 4-8 PEL 82 (YELLOW POLYGON) IN RELATION TO MAJOR FEATURES OF THE PREDOMINANT CIRCULATION PATTERNS AND VOLUME FLOWS IN THE BENGUELA SYSTEM



Source: Shannon and Nelson 1996

The Angola Dome lies to the north of the license area and is characterised by cyclonic circulation, with periodic intrusion of tropical waters into the northern Benguela from the north and northwest. Off the coast of Angola, the most prominent circulation feature is the southward flowing Angola current, which turns westwards between 16°S and 17°S just north of the Angola-Benguela Front. The Angola-Benguela Front is a permanent feature at the surface and to a depth of at least 200 m between latitudes 14°S and 17°S. The front is maintained by a combination of factors including coastal orientation, wind stress, bathymetry and opposing flows of the Angola and Benguela Currents. To what extent the Angola Current contributes to the Benguela system at the surface and subsurface off northern Namibia is uncertain. At greater depths (400 m), however, the poleward flow of the Angola Current is more continuous. The episodic southward movement of this front during late summer introduces warm tropical water southwards and eastwards along the Namibian coast. Known as Benguela Niños, these events occur on average every ten years (Shannon and O'Toole, 1998).

4.2.2.2 WAVES AND TIDES

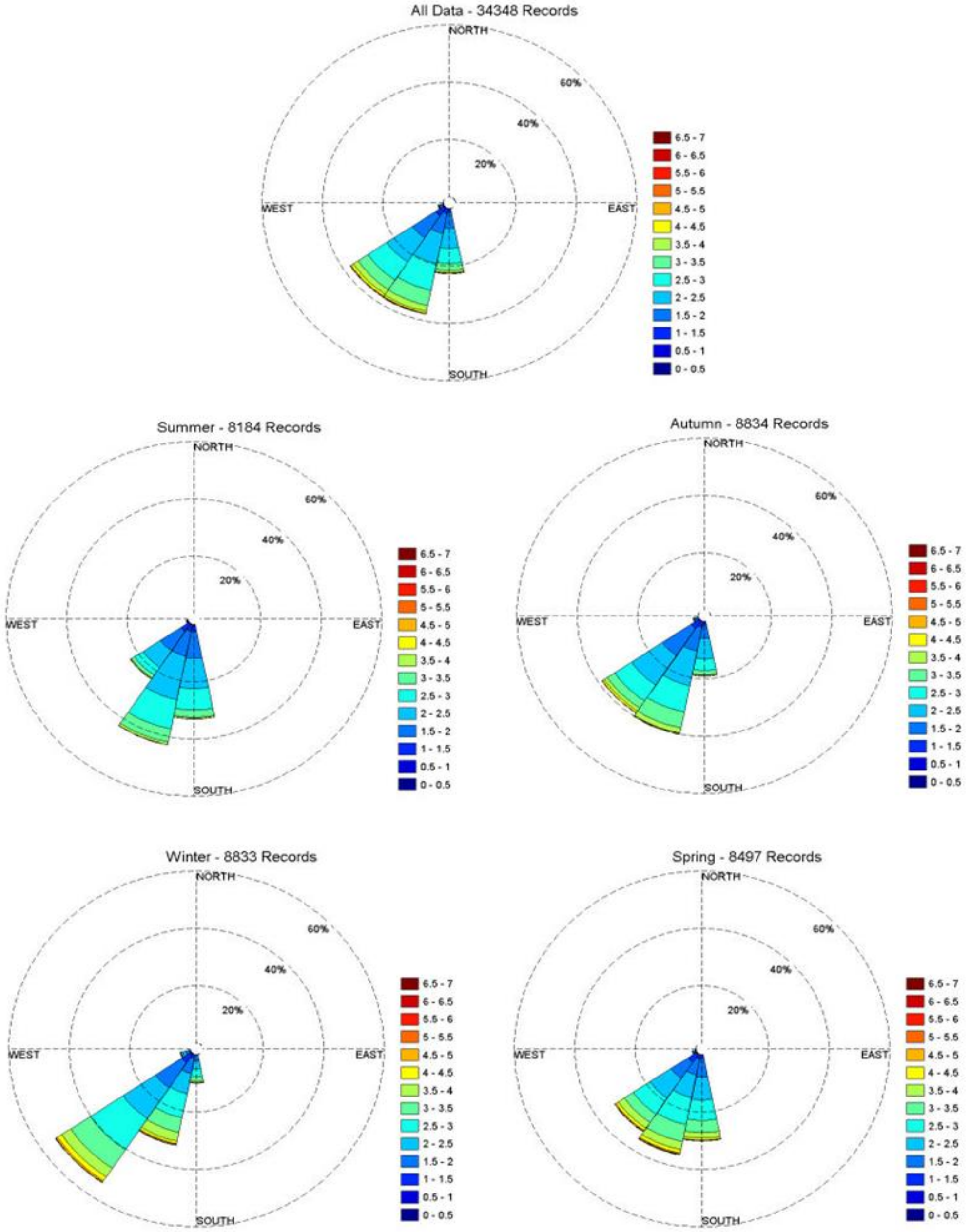
The Namibian Coast is classified as exposed, experiencing strong wave action rating between 13-17 on the 20-point exposure scale (McLachlan, 1980). The coastline is influenced by major swells generated in the roaring forties, as well as significant sea waves generated locally by the persistent southerly winds.

Typical seasonal swell-height rose-plots, compiled from Voluntary Observing Ship (VOS) data off Walvis Bay are shown in Figure 4-9. The wave regime along the southern African west coast shows only moderate seasonal variation in direction, with virtually all swells throughout the year coming from the SW - S direction. In winter there is a slight increase in swell from the SW direction. The median significant wave height is 2.4 m with a dominant peak energy period of ~12 seconds. Longer period swells (11 to 15 seconds), generated by mid-latitude cyclones occur about 25-30 times a year. These originate from the S-SW sectors, with the largest waves recorded along the southern African West Coast attaining 4-7 m. With wind speeds capable of reaching 100 km/h during heavy winter south-westerly storms, winter swell heights can exceed 10 m. Generally, wave heights decrease with water depth and distance longshore.

In comparison, spring and summer swells tend to be smaller on average, typically around 2 m, not reaching the maximum swell heights of winter. There is also a more pronounced southerly swell component in summer. These southerly swells tend to be wind-induced, with shorter wave periods (~8 seconds), and are generally steeper than swell waves (Council for Scientific and Industrial Research (CSIR), 1996). These wind-induced southerly waves are relatively local and, although less powerful, tend to work together with the strong southerly winds of summer to cause the northward-flowing nearshore surface currents, and result in substantial nearshore sediment mobilisation, and northwards transport, by the combined action of currents, wind and waves.

In common with the rest of the southern African coast, tides are semi-diurnal, with a total range of some 1.5 m at spring tide, but only 0.6 m during neap tide periods.

FIGURE 4-9 SEASONAL OFFSHORE WAVE CONDITIONS FOR A DATA POINT LOCATED AT 23° S, 13.75°E



Source: CSIR 2009

4.2.2.3 WATER MASSES

South Atlantic Central Water (SACW) constitutes the majority of the seawater within the study area, found either in its unaltered state in deeper zones or mixed with previously upwelled water of the same origin on the continental shelf (Nelson and Hutchings, 1983). Salinity levels fluctuate between 34.5 ‰ and 35.5 ‰ (Shannon, 1985).

Data collected over a decade at Swakopmund (1988 – 1998) revealed that seawater temperatures range from 10°C to 23°C, with an average of 14.9°C. Well-defined thermal fronts are present, marking the seaward limit of the upwelled water. Upwelling filaments are typical of these offshore thermal fronts, appearing as surface currents of cold water, generally

50 km wide and extending beyond the typical offshore reach of the upwelling cell. These fronts usually last from a few days to several weeks, with the filamentous mixing area reaching up to 625 km offshore.

The continental shelf waters of the Benguela system are noted for their low oxygen levels, particularly near the seabed. SACW itself exhibits reduced oxygen levels (~80% saturation), but even lower oxygen concentrations (<40% saturation) are common (Bailey et al., 1985; Chapman and Shannon, 1985). Nutrient levels in the upwelled waters of the Benguela system reach 20 µm nitrate-nitrogen, 1.5 µM phosphate, and 15-20 µM silicate, indicating nutrient enrichment (Chapman and Shannon, 1985). This enrichment is facilitated by nutrient regeneration from biogenic materials in the sediments (Bailey et al., 1985). The modification of these peak concentrations is influenced by phytoplankton uptake, which varies based on phytoplankton biomass and production rates. Consequently, the range of nutrient concentrations can be extensive, but generally, levels are high. Given that PEL 82 is situated well offshore from the upwelling cells, low nutrient concentrations are anticipated.

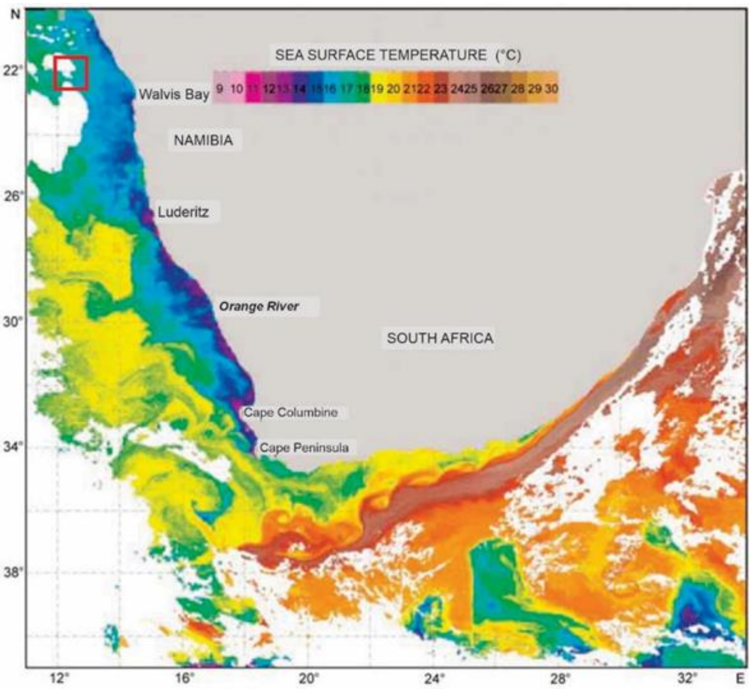
4.2.2.4 UPWELLING AND PLANKTON PRODUCTION

The major feature of the Benguela Current Coastal is upwelling and the consequent high nutrient supply to surface waters leads to high biological production and large fish stocks. The prevailing longshore, equatorward winds move nearshore surface water northwards and offshore. To balance the displaced water, cold, deeper water wells up inshore supporting substantial seasonal primary phytoplankton production. Although the rate and intensity of upwelling fluctuates with seasonal variations in wind patterns, the most intense upwelling tends to occur where the shelf is narrowest and the wind strongest. Consequently, it is a semi-permanent feature at Lüderitz and upwelling can occur there throughout the year and areas to the north due to perennial southerly winds (Figure 4-10; Shannon, 1985). The Lüderitz upwelling cell is the most intense upwelling cell in the system (Figure 4-10)with the seaward extent reaching nearly 300 km, and the upwelling water is derived from 300-400 m depth (Longhurst, 2006). A detailed analysis of water mass characteristics revealed a discontinuity in the central and intermediate water layers along the shelf north and south of Lüderitz (Duncombe Rae, 2005). The Lüderitz / Orange River region thus forms a major environmental barrier between the northern and southern Benguela sub-systems (Ekau and Verheye, 2005). Off northern and central Namibia, several secondary upwelling cells occur. Upwelling in these cells is perennial, with a late winter maximum (Shannon, 1985).

FIGURE 4-10 UPWELLING CENTRES AND LOW OXYGEN AREAS IN RELATION TO PEL 82

Source: Shannon 1985

FIGURE 4-11 SEA SURFACE TEMPERATURE AND COASTAL UPWELLING EVENTS FOR 15 MAY 2003 IN RELATION TO PEL 82 (RED POLYGON)



Source: Weeks et al., 2006

The cold, upwelled water is rich in inorganic nutrients, the major contributors being various forms of nitrates, phosphates and silicates (Chapman and Shannon, 1985). The seasonal primary production, in turn, serves as the basis for a rich food chain up through zooplankton, pelagic baitfish (anchovy, pilchard, round-herring and others), to predatory fish (hake and snoek), mammals (primarily seals and dolphins) and seabirds (jackass penguins, cormorants, pelicans, terns and others). High phytoplankton productivity in the upper layers again depletes the nutrients in these surface waters. This results in a wind-related cycle of plankton production, mortality, sinking of plankton detritus and eventual nutrient re-enrichment occurring below the thermocline as the phytoplankton decays.

4.2.3 BATHYMETRY AND SEDIMENTS

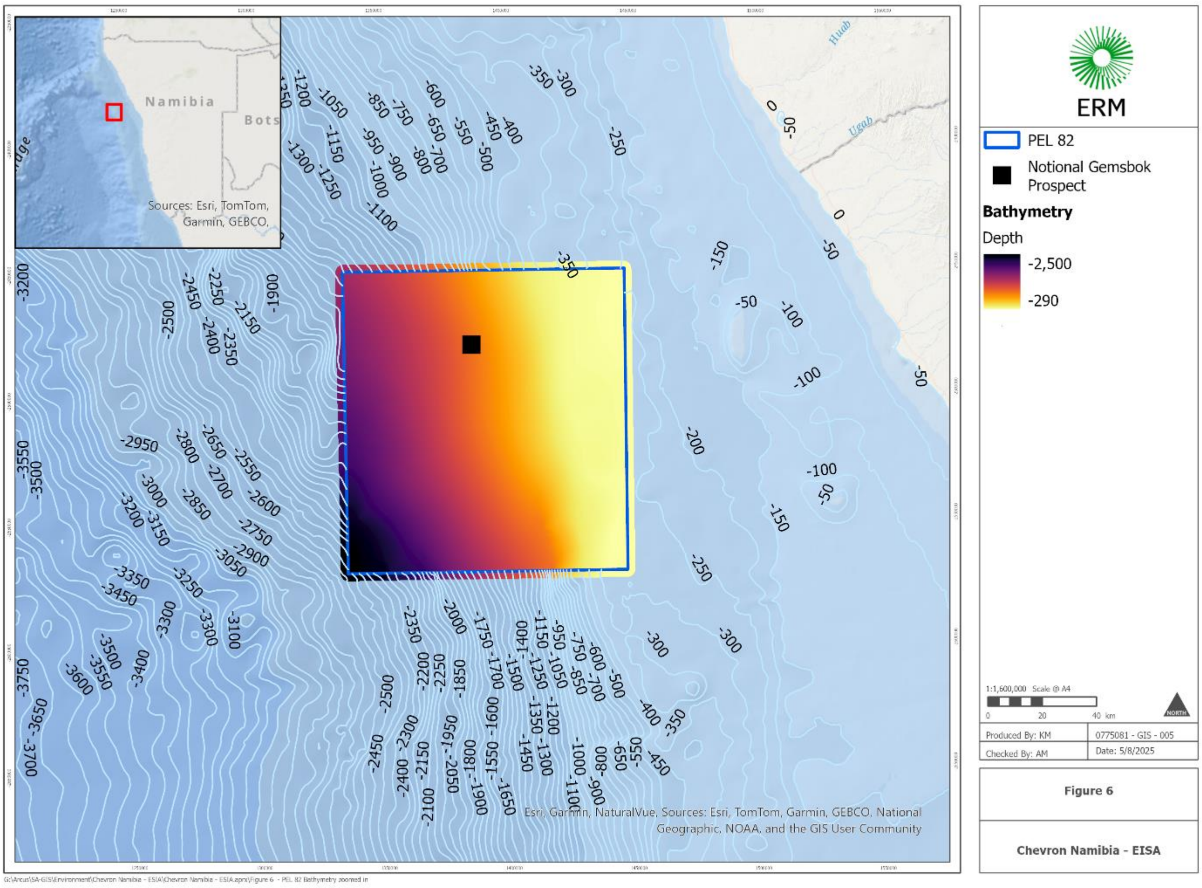
4.2.3.1 BATHYMETRY

The continental shelf off Namibia is variable in width. The shelf off of the Orange River is wide (230 km) and characterised by well-defined shelf breaks, a shallow outer shelf and the aerofoil-shaped submarine Recent River Delta on the inner shelf. It narrows to the north reaching its narrowest point (90 km) off Chameis Bay, before widening again to 130 km off Lüderitz (Rogers, 1977). Off Walvis Bay, a double shelf break occurs at about 140 m and 400 m depths for the inner and outer breaks, respectively (Shannon and O'Toole, 1998).

Off Terrace Bay the shelf gives rise to the Walvis Ridge, an underwater plateau extending obliquely (NE-SW) south-westwards far into the south Atlantic from the northern Namibian shelf (18°S) to the Tristan da Cunha island group at the Mid-Atlantic Ridge (38°S). Beyond the Walvis Ridge, the shelf narrows again towards Cape Frio (refer to Figure 4-12). The Walvis Ridge is a chain of seamounts and guyots that individually and collectively constitute an ecologically and biologically significant deep-sea feature. It also includes steep canyons, embayments formed by massive submarine slides, trough-like structures, a graben, abyssal plains, and a fossilized cold-water coral reef mound community (GEOMAR, 2014).

The salient topographic features of the shelf include the relatively steep descent to about 100 m, the gentle decline to about 180 m, and the undulating depths to about 200 m. The most prominent topographic feature in the study area is the Walvis Ridge, which extends from the African coast at around 18°S more than 3,000 km south-westwards to Tristan da Cunha, the Gough Islands and the Mid-Atlantic Ridge. This plateau effectively splits the abyssal plain of the Southeast Atlantic into the Angola Basin to the north and the Cape Basin to the south. The variable topography of the shelf is of significance for near shore circulation and for fisheries (Shannon and O'Toole, 1998).

FIGURE 4-12 BATHYMETRY OF THE PROJECT AREA

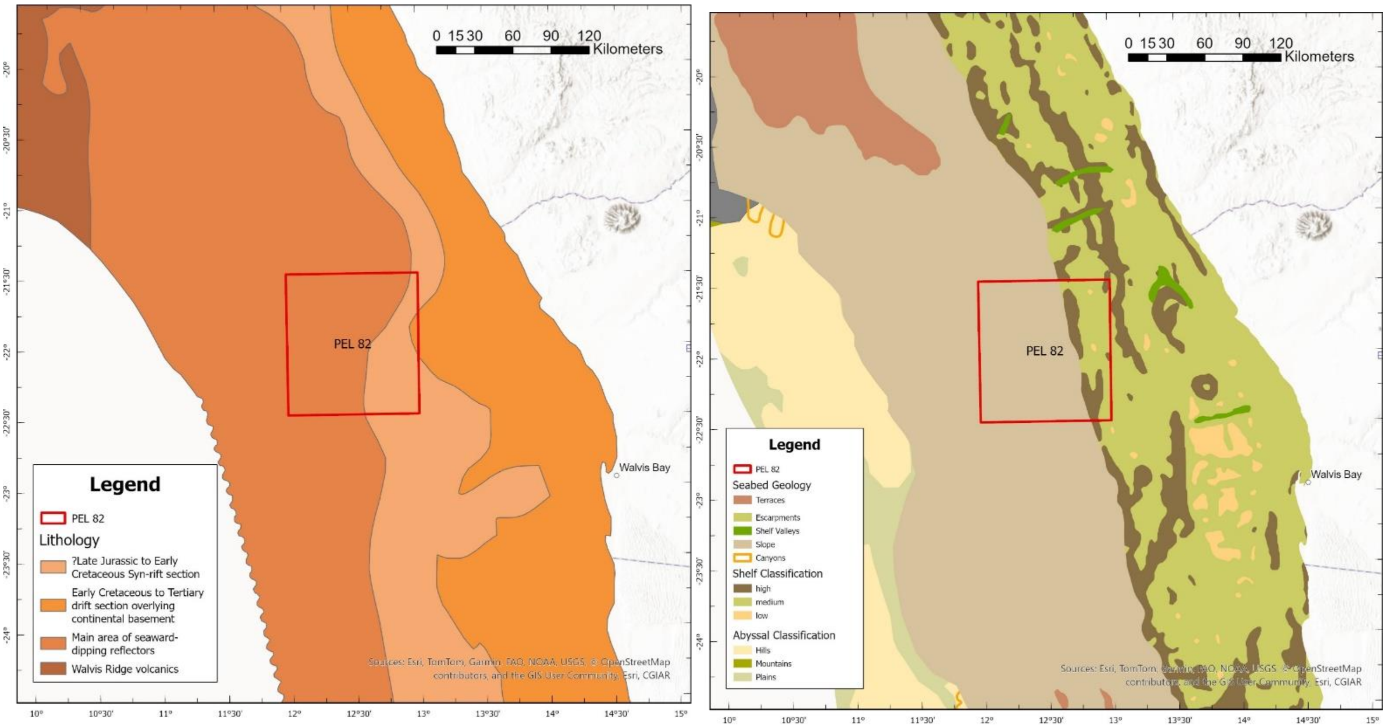


Source: CNEL, 2025

4.2.3.2 COASTAL AND INNER-SHELF GEOLOGY AND SEABED GEOMORPHOLOGY

As part of the recent Marine Spatial Planning (MSP) process in Namibia, the marine geology of the Namibian continental shelf and geomorphic seafloor features within the EEZ were mapped (refer to Figure 4-13).

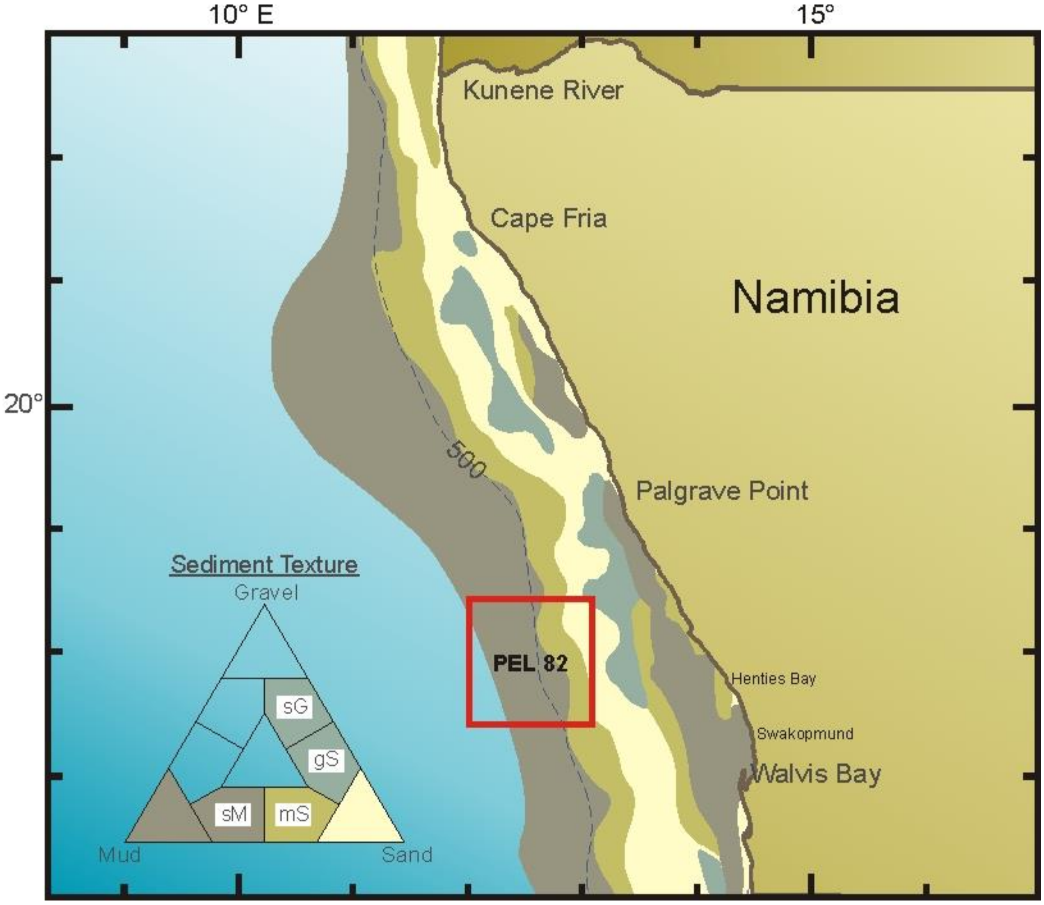
FIGURE 4-13 MARINE GEOLOGY OF THE SOUTHERN NAMIBIAN CONTINENTAL SHELF (LEFT) AND SEABED GEOMORPHIC FEATURES (RIGHT) IN RELATION TO PEL 82



Source: Adapted from MFMR 2021

Figure 4-14 illustrates the distribution of seabed surface sediment types of the central and northern Namibian coast. The inner shelf is underlain by Precambrian bedrock (also referred to as Pre-Mesozoic basement), whilst the middle and outer shelf areas are composed of Cretaceous and Tertiary sediments (Dingle, 1973; Birch et al., 1976; Rogers, 1977; Rogers and Bremner, 1991). As a result of erosion on the continental shelf, the unconsolidated sediment cover is generally thin, often less than 1 m. Sediments are finer seawards, changing from sand on the inner and outer shelves to muddy sand and sandy mud in deeper water. However, this general pattern has been modified considerably by biological deposition (large areas of shelf sediments contain high levels of calcium carbonate) and localised river input. Off central Namibia, the muddy sand in the near shore area off Henties Bay gives way to a tongue of organic-rich sandy mud, which extends from south of Sandwich Harbour to ~ 20°40’S northwards to Pelgrave Point (Figure 4-15). These biogenic muds are the main determinants of the formation of low-oxygen waters and sulphur eruptions off central Namibia. Further offshore this gives way to muddy sands, sands and gravels before changing again into mud-dominated seabed beyond the 500-m contour. The continental slope, seaward of the shelf break, has a smooth seafloor, underlain by calcareous ooze.

FIGURE 4-14 PEL 82 IN RELATION TO THE SEDIMENT DISTRIBUTION ON THE CONTINENTAL SHELF OFF CENTRAL AND NORTHERN NAMIBIA



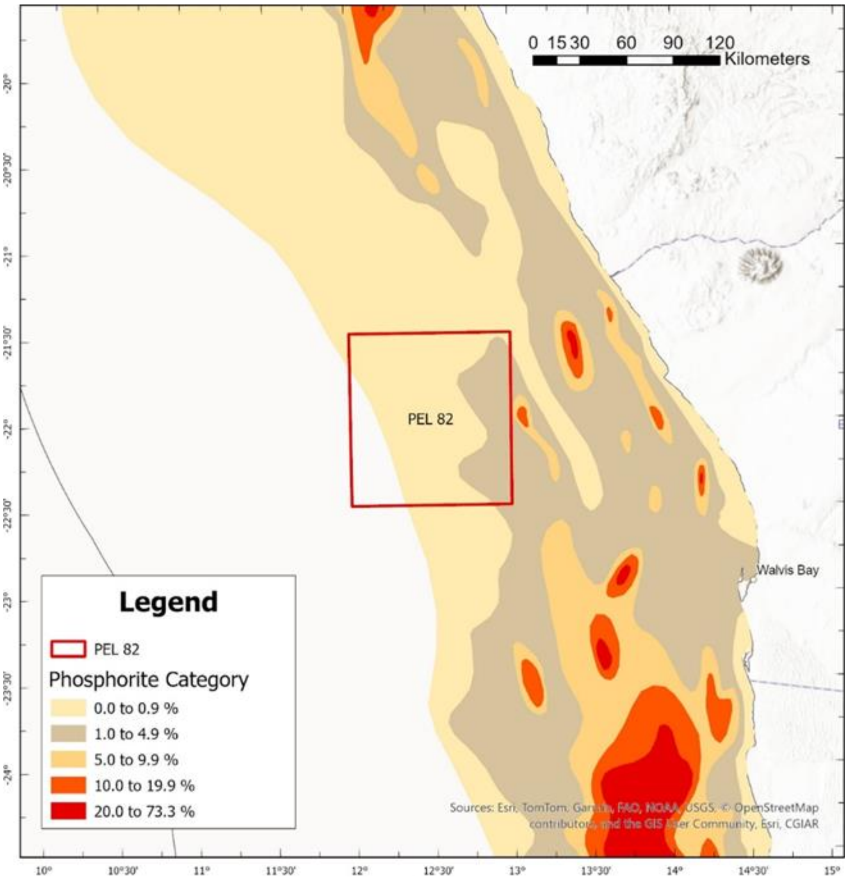
Source: Rogers, 1977

4.2.3.3 SEDIMENTARY PHOSPHATES

Phosphorite, or phosphate-rich rock, is defined as sedimentary rock typically containing between 5%-20% phosphate. In the marine environment, it occurs either as a nodular hard ground capping of a few metres thick or as layers of consolidated or unconsolidated sediments on continental shelves and in the upper part of continental slopes (Morant, 2013). Such deposits provide a record of paleoceanographic changes in upwelling systems linked to climate. Being one of the most productive upwelling systems in the world, the Benguela Upwelling System is associated with major phosphorite deposits (of various type and grade) exposed over an area of 24 700 km² on the Namibian shelf (Compton & Bergh, 2016).

PEL 82 overlaps primarily with low percentage occurrence of the known phosphate deposits (Figure 4-15).

FIGURE 4-15 PEL 82 IN RELATION TO THE KNOWN LOCATION OF PHOSPHATE DEPOSITS ON THE SOUTHERN NAMIBIAN CONTINENTAL SHELF



Source: MFMR, 2021

4.2.3.4 TURBIDITY

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulate matter. Total Suspended Particulate Matter (TSPM) can be divided into Particulate Organic Matter (POM) and Particulate Inorganic Matter (PIM), the ratios between them varying considerably. The POM usually consists of detritus, bacteria, phytoplankton and zooplankton, and serves as a source of food for filter-feeders. Seasonal microphyte production associated with upwelling events will play an important role in determining the concentrations of POM in coastal waters. PIM, on the other hand, is primarily of geological origin consisting of fine sands, silts and clays. Off the southern African West Coast, the PIM loading in nearshore waters is strongly related to natural riverine inputs. ‘Berg’ wind events can potentially contribute the same order of magnitude of sediment input as the annual estimated input of sediment by the Orange River (Shannon and Anderson, 1982; Zoutendyk, 1992, 1995; Shannon and O’Toole, 1998; Lane and Carter, 1999).

Concentrations of suspended particulate matter in shallow coastal waters can vary both spatially and temporally, typically ranging from a few mg/l to several tens of mg/l (Bricelj and Malouf, 1984; Berg and Newel,l 1986; Fegley et al., 1992). Field measurements of TSPM and PIM concentrations in the Benguela current system have indicated that outside of major flood events, background concentrations of coastal and continental shelf suspended sediments are generally <12 mg/l, showing significant long-shore variation (Zoutendyk 1995). Considerably higher concentrations of PIM have, however, been reported from southern African West Coast waters under stronger wave conditions associated with high tides and storms, or under flood conditions.

The major source of turbidity in the swell-influenced nearshore areas off the West Coast is the redistribution of fine inner shelf sediments by long-period Southern Ocean swells. The current velocities typical of the Benguela (10-30 cm/s) are capable of resuspending and transporting considerable quantities of sediment equatorwards. Under relatively calm wind conditions, however, much of the suspended fraction (silt and clay) that remains in suspension for longer periods becomes entrained in the slow poleward undercurrent (Shillington et al., 1990; Rogers and Bremner, 1991).

Superimposed on the suspended fine fraction, is the northward littoral drift of coarser bedload sediments, parallel to the coastline. This northward, nearshore transport is generated by the predominantly south-westerly swell and wind-induced waves. Longshore sediment transport varies considerably in the shore-perpendicular dimension, being substantially higher in the surf-zone than at depth, due to high turbulence and convective flows associated with breaking waves, which suspend and mobilise sediment (Smith and Mocke, 2002).

On the inner and middle continental shelf, the ambient currents are insufficient to transport coarse sediments, and resuspension and shoreward movement of these by wave-induced currents occur primarily under storm conditions (see also Drake et al., 1985; Ward, 1985).

The powerful easterly ‘berg’ winds occurring along the Namibian coastline in autumn and winter also play a significant role in sediment input into the coastal marine environment (refer to Figure 4-6), potentially contributing the same order of magnitude of sediment input as the annual estimated input of sediment by the Orange River (Zoutendyk, 1992; Shannon & O’Toole, 1998; Lane and Carter, 1999). For example, for a single ‘berg’-wind event it was estimated that 50 million tons of dust were blown into the sea by extensive sandstorms along much of the coast from Cape Frio, Namibia in the north to Kleinzee, South Africa in the south (Shannon & Anderson, 1982) with transport of the sediments up to 150 km offshore.

4.2.4 ORGANIC INPUTS

The Benguela upwelling region is an area of particularly high natural productivity, with extremely high seasonal production of phytoplankton and zooplankton. These plankton blooms in turn serve as the basis for a rich food chain up through pelagic baitfish (anchovy, pilchard, round-herring and others), to predatory fish (snoek), mammals (primarily seals and dolphins) and seabirds (jackass penguins, cormorants, pelicans, terns and others). All of these species are subject to natural mortality, and a proportion of the annual production of all these trophic levels, particularly the plankton communities, die naturally and sink to the seabed.

Balanced multispecies ecosystem models have estimated that during the 1990s the Benguela region supported biomasses of 76.9 tons/km² of phytoplankton and 31.5 tons/km² of zooplankton alone (Shannon et al., 2003). Approximately 36% of the phytoplankton and 5% of the zooplankton are estimated to be lost to the seabed annually. This natural annual input of millions of tons of organic material onto the seabed off the southern African West Coast has a substantial effect on the ecosystems of the Benguela region. It provides most of the food requirements of the particulate and filter-feeding benthic communities that inhabit the sandy-muds of this area, and results in the high organic content of the muds in the region. As most of the organic detritus is not directly consumed, it enters the seabed decomposition cycle, resulting in subsequent depletion of oxygen in deeper waters.

An associated phenomenon ubiquitous to the Benguela system are red tides (dinoflagellate and/or ciliate blooms) (see Shannon and Pillar, 1985; Pitcher, 1998). Also referred to as Harmful Algal Blooms (HABs), these red tides can reach very large proportions. Toxic dinoflagellate species can cause extensive mortalities of fish and shellfish through direct poisoning, while degradation of organic-rich material derived from both toxic and non-toxic blooms results in oxygen depletion of subsurface water.

4.2.4.1 LOW OXYGEN EVENTS

The continental shelf waters of the Benguela system are characterised by low oxygen concentrations with <40% saturation occurring frequently (e.g. Visser, 1969; Bailey et al., 1985). The low oxygen concentrations are attributed to nutrient remineralisation in the bottom waters of the system (Chapman and Shannon, 1985). The absolute rate of this is dependent upon the net organic material build-up in the sediments, with the carbon rich mud deposits playing an important role. As the mud on the shelf is distributed in discrete patches (refer Figure 4-14) there are corresponding preferential areas for the formation of oxygen-poor water (refer to Figure 4-15). The two main areas of low-oxygen water formation in the central Benguela region are in the Orange River Bight and off Walvis Bay (Chapman and Shannon, 1985; Bailey, 1991; Shannon and O'Toole, 1998; Bailey, 1999; Fossing et al., 2000). The spatial distribution of oxygen-poor water in each of the areas is subject to short- and medium-term variability in the volume of hypoxic water that develops. De Decker (1970) showed that off Lambert's Bay in South Africa, the occurrence of low oxygen water is seasonal, with highest development in summer/autumn. Bailey and Chapman (1991), on the other hand, demonstrated that in the St Helena Bay area in South Africa, daily variability exists as a result of downward flux of oxygen through thermoclines and short-term variations in upwelling intensity. Subsequent upwelling processes can move this low-oxygen water up onto the inner shelf, and into nearshore waters, often with devastating effects on marine communities.

Oxygen deficient water can affect the marine biota at two levels. It can have sub-lethal effects, such as reduced growth and feeding, and increased intermoult period in the rock-lobster population (Beyers et al., 1994). The oxygen-depleted subsurface waters characteristic of the central and southern Namibian shelf are an important factor determining the distribution of rock lobster in the area. During the summer months of upwelling, lobsters show a seasonal inshore migration (Pollock and Shannon, 1987), and during periods of low oxygen become concentrated in shallower, better-oxygenated nearshore waters.

On a larger scale, periodic low oxygen events in the nearshore region can have catastrophic effects on the marine communities. Low-oxygen events associated with massive algal blooms can lead to large-scale stranding of rock lobsters, and mass mortalities of other marine biota and fish (Newman and Pollock, 1974; Matthews and Pitcher, 1996; Pitcher, 1998; Cockroft et al., 2000). In March 2008, a series of red tide or algal blooms dominated by the (non-toxic) dinoflagellate *Ceratium furca* occurred along the central Namibian coast (MFMR, 2008). These bloom formations ended in disaster for many coastal marine species and resulted in what was possibly the largest rock lobster walkout in recent memory. Other fish mortalities included rock suckers, rock fish, sole, eels, shy sharks, and invertebrates such as octopuses and red bait, which were trapped in the low oxygen area below the surf zone (Louw, 2008). The main cause for these mortalities and walkouts is oxygen starvation that results from the decomposition of huge amounts of organic matter. The blooms develop over a period of unusually calm wind conditions when sea surface temperatures were high. These anoxic conditions were further exacerbated by the release of hydrogen sulphide - which is highly toxic to most marine organisms. Algal blooms usually occur during summer-autumn (February to April) but can also develop in winter during the 'bergwind periods', when similar warm windless conditions occur for extended periods.

4.2.4.2 SULPHUR ERUPTIONS

Closely associated with seafloor hypoxia, particularly off central Namibia, is the generation of toxic hydrogen sulphide and methane within the organically-rich, anoxic muds following decay of expansive algal blooms. Under conditions of severe oxygen depletion, hydrogen sulphide (H_2S) gas is formed by anaerobic bacteria in anoxic seabed muds (Brüchert et al., 2003). This is periodically released from the muds as 'sulphur eruptions', causing upwelling of anoxic water and formation of surface slicks of sulphur discoloured water (Emeis et al., 2004), and even the temporary formation of floating mud islands (Waldron, 1901). Such eruptions are accompanied by a characteristic pungent smell along the coast and the sea takes on a lime green colour (Figure 4-16). These eruptions strip dissolved oxygen from the surrounding water column, resulting in mass mortalities of marine life. Such complex chemical and biological processes are often associated with the occurrence of harmful algal blooms, causing large-scale mortalities to fish and crustaceans.

FIGURE 4-16 SATELLITE IMAGE SHOWING DISCOLOURED WATER OFFSHORE THE CENTRAL NAMIBIAN COAST RESULTING FROM A NEARSHORE SULPHUR ERUPTION.

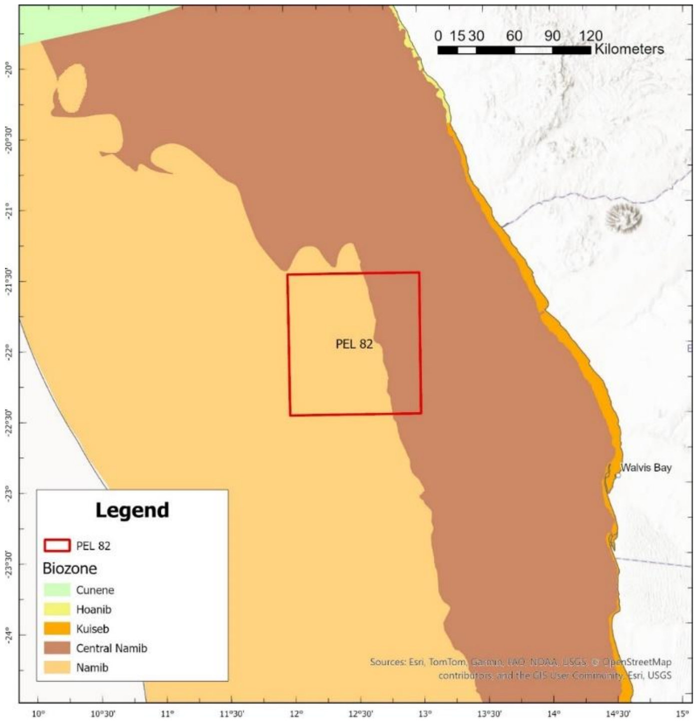
Source: www.intute.ac.uk, 2025

4.3 BIOLOGICAL ENVIRONMENT

Biogeographically, the central Namibian coastline falls into the warm-temperate Namib Province, which extends northwards from Lüderitz into southern Angola (Emanuel et al., 1992). PEL 82 is located in the offshore Central Namib and Namib Biozones (De Cauwer, 2007), which extend beyond the shelf break onto the continental slope and into abyssal depths (Figure 4-17). The coastal, wind-induced upwelling characterising the Namibian coastline, is the principal physical process which shapes the marine ecology of the central Benguela region. The Benguela system is characterised by the presence of cold surface water, high biological productivity, and highly variable physical, chemical and biological conditions (Barnard, 1998). During periods of less intense winds off the northern Nambian coast (*Benguela Niños*), upwelling weakens and the warmer, more saline waters of the Angola Current intrude southwards along the coast introducing organisms normally associated with the subtropical conditions typical off Angola (Barnard, 1998). As these events are typically temporary, the species of tropical west African origin associated with them will not be discussed here.

Communities within marine habitats are largely ubiquitous throughout the southern African West Coast region, being particular only to substrate type or depth zone. These biological communities consist of many hundreds of species, often displaying considerable temporal and spatial variability (even at small scales). PEL 82 is located beyond the 200 m depth contour, the closest points to shore being ~80 km off the coast near the Ugab River mouth. The near- and offshore marine ecosystems comprise a limited range of habitats, namely unconsolidated seabed sediments and the water column. The biological communities 'typical' of these habitats are described briefly below, focusing both on dominant, commercially important and conspicuous species, as well as potentially threatened or sensitive species, which may be affected by the exploration well-drilling.

FIGURE 4-17 PEL 82 IN RELATION TO THE NAMIBIAN BIOZONES



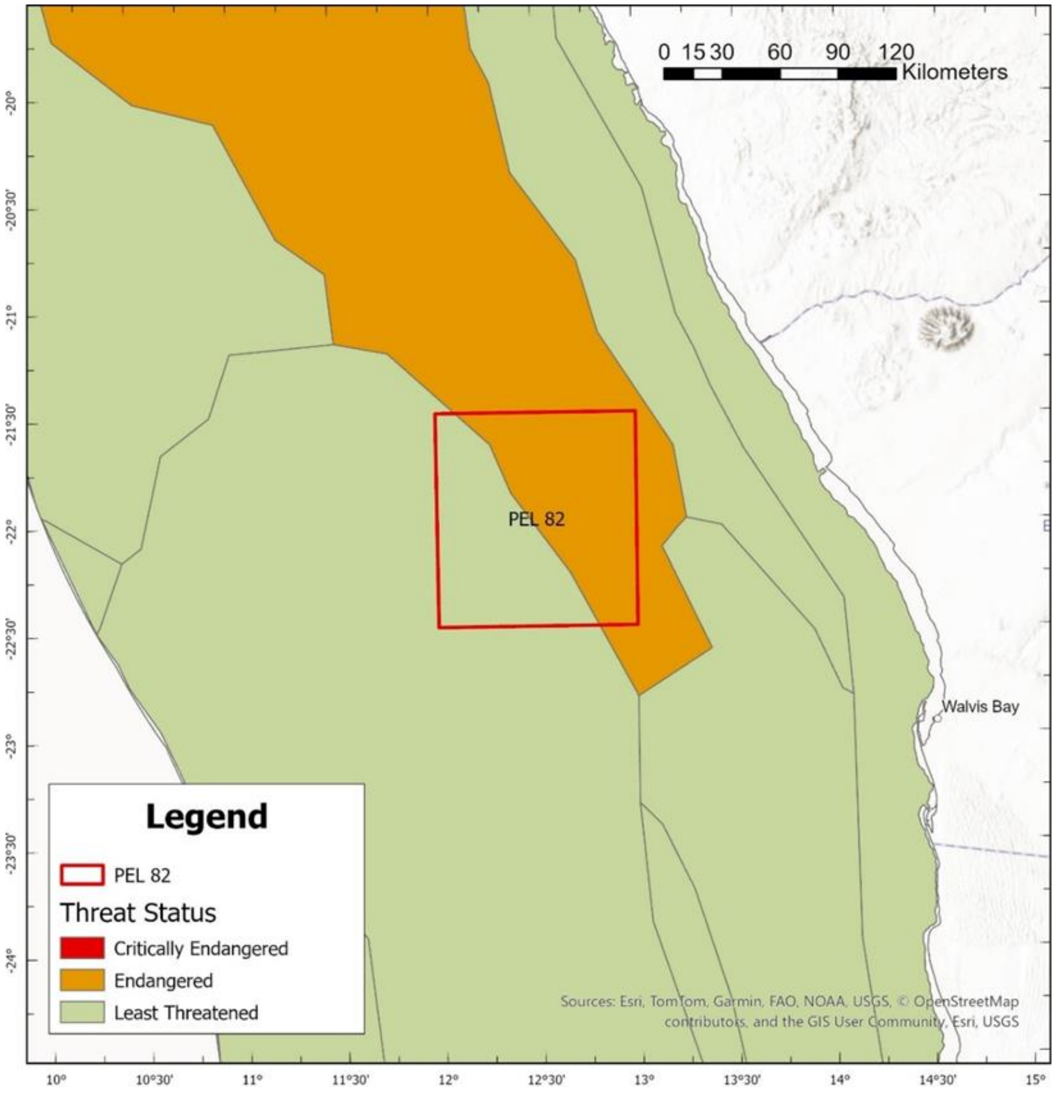
Source: De Cauwer 2007; MFMR 2021

4.3.1 PELAGIC COMMUNITIES

The pelagic communities are typically divided into plankton, pelagic invertebrates and fish, and their main predators, marine mammals (seals, dolphins and whales), seabirds and turtles.

Pelagic habitat types within the broader project area have been defined as 'Least Threatened, 'Endangered' or 'Critically Endangered' depending on their level of protection (Sink et al., 2012; Holness et al., 2014) (Figure 4-18). The north-eastern half of PEL 82 falls within a pelagic habitat considered 'Endangered', with the remainder rated as 'Least Threatened'.[3]

FIGURE 4-18 PEL 82 IN RELATION TO ECOSYSTEM THREAT STATUS FOR OFFSHORE PELAGIC HABITAT TYPES ON THE CENTRAL NAMIBIAN COAST



Source: Holness et al., 2014

[3] Ecosystem Threat Status represents the degree to which ecosystems are still intact, or alternatively losing vital aspects of their structure, function or composition, on which their ability to provide ecosystem services ultimately depends. Unlike IUCN, the threat status here is at the ecosystem scale rather than the species level. Specific info on the species and features threatened are thus not provided but the threat status is based on the output of the MARXAN decision support tool, which utilises data on species, ecosystems and other biodiversity features; combined with data on planning unit costs to identify sets of areas that meet biodiversity targets while minimizing the total cost of the solution and hence ensuring a spatially optimal configuration of sites.

4.3.1.1 PLANKTON

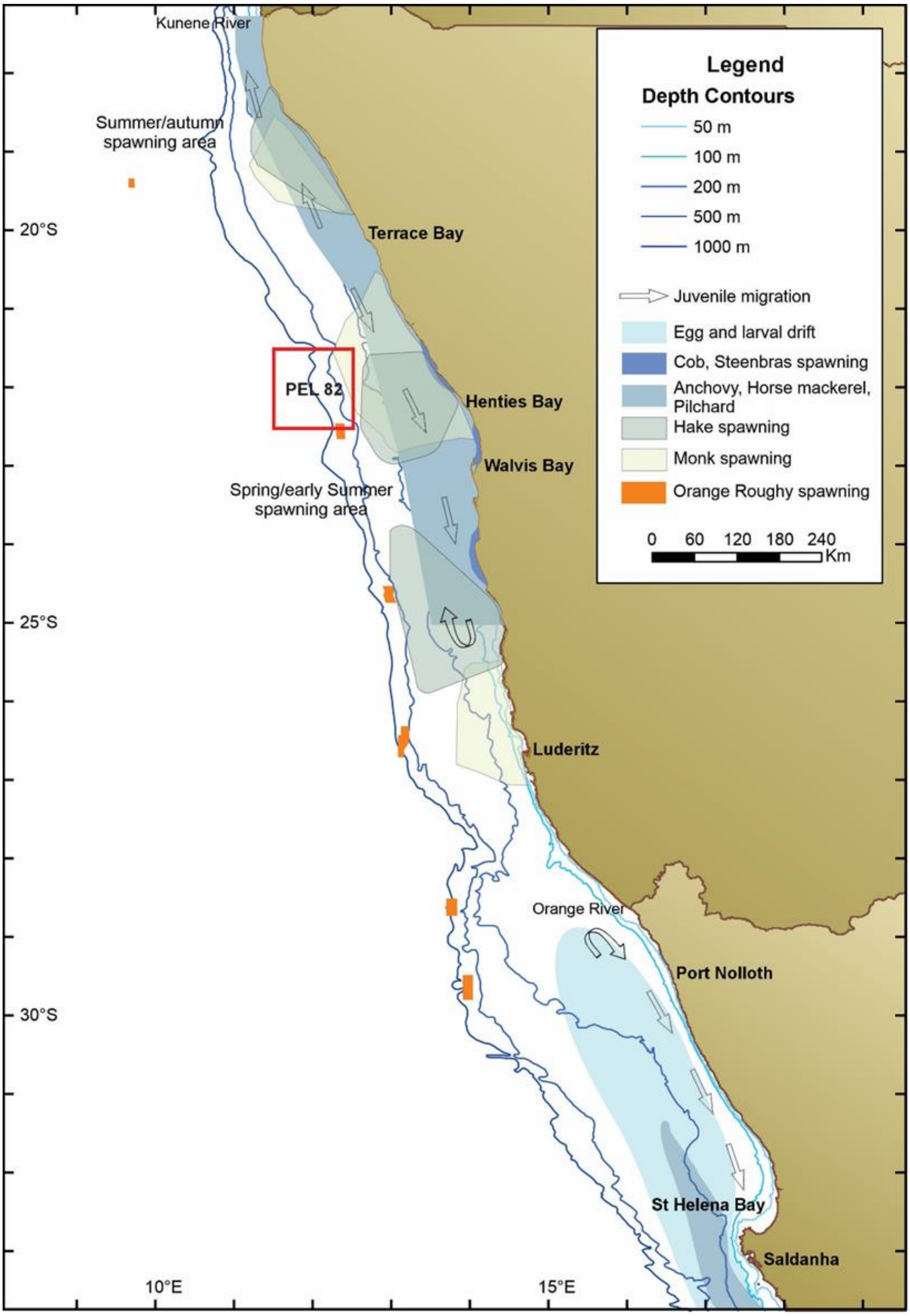
Plankton is particularly abundant in the shelf waters off Namibia, being associated with the upwelling characteristic of the area. Plankton range from single-celled bacteria to jellyfish of 2-m diameter, and include bacterio-plankton, phytoplankton, zooplankton, and ichthyoplankton.

Off the Namibian coastline, phytoplankton are the principal primary producers with mean annual productivity being comparatively high at 2 g C/m^2/day (Barnard, 1998). The phytoplankton is dominated by diatoms, which are adapted to the turbulent sea conditions. Diatom blooms occur after upwelling events, whereas dinoflagellates are more common in blooms that occur during quiescent periods, since they can grow rapidly at low nutrient concentrations. In the surf zone, diatoms and dinoflagellates are nearly equally important members of the phytoplankton, and some silicoflagellates are also present.

Namibian zooplankton reaches maximum abundance in a belt parallel to the coastline and offshore of the maximum phytoplankton abundance. Samples collected over a full seasonal cycle (February to December) along a 10 to 90-nautical-miles transect offshore Walvis Bay showed that the mesozooplankton (<2 mm body width) community included egg, larval, juvenile and adult stages of copepods, cladocerans, euphausiids, decapods, chaetognaths, hydromedusae and salps, as well as protozoans and meroplankton larvae (Maartens, 2003; Hansen et al., 2005). Copepods are the most dominant group making up 70–85% of the zooplankton. Seasonal patterns in copepod abundance, with low numbers during autumn (March–June) and increasing considerably during winter/early summer (July–December), appear to be linked to the period of strongest coastal upwelling in the northern Benguela (May–December), allowing a time lag of about 3–8 weeks, which is required for copepods to respond and build up large populations (Hansen et al., 2005). This suggests close coupling between hydrography, phytoplankton and zooplankton. Timonin et al. (1992) described three phases of the upwelling cycle (quiescent, active and relaxed upwelling) in the northern Benguela, each one characterised by specific patterns of zooplankton abundance, taxonomic composition and inshore-offshore distribution. It seems that zooplankton biomass closely follows the changes in upwelling intensity and phytoplankton standing crop. Consistently higher biomass of zooplankton occurs offshore to the west and northwest of Walvis Bay (Barnard, 1998).

Ichthyoplankton constitutes the eggs and larvae of fish. As the preferred spawning grounds of numerous commercially exploited fish species are located off central and northern Namibia (Figure 4-19), their eggs and larvae form an important contribution to the ichthyoplankton in the region. Phytoplankton, zooplankton and ichthyoplankton abundances in the project area will be seasonally high, with diversity increasing in the in the vicinity of the confluence between the Angola and Benguela currents and west of the oceanic front and shelf-break.

FIGURE 4-19 PEL 82 IN RELATION TO MAJOR SPAWNING AREAS IN THE CENTRAL AND NORTHERN BENGUELA REGION

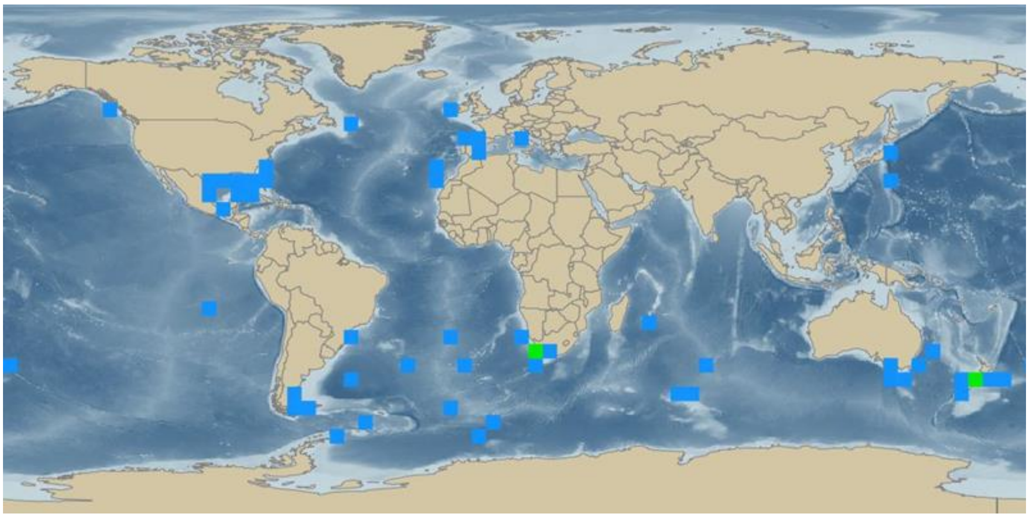


Source: Cruikshank, 1990; Hampton, 1992; Holness et al., 2014

4.3.1.2 PELAGIC INVERTEBRATES

Pelagic invertebrates that may be encountered in the project area are the giant squid (*Architeuthis sp.*) The giant squid is a deep dwelling species usually found near continental and island slopes all around the world's oceans (Figure 4-20) and could thus potentially occur in the pelagic habitats of the project area, although the likelihood of encounter is extremely low. Growing to in excess of 10 m in length, they are the principal prey of the sperm whale, and are also taken by beaked whaled, pilot whales, elephant seals and sleeper sharks. Nothing is known of their vertical distribution, but data from trawled specimens and sperm whale diving behaviour suggest they may span a depth range of 300 – 1,000 m. They lack gas-filled swim bladders and maintain neutral buoyancy through an ammonium chloride solution occurring throughout their bodies.

FIGURE 4-20 DISTRIBUTION OF THE GIANT SQUID



Note: Blue squares <5 records, green squares 5-10 records

Source: Ocean Biodiversity Information System, 2025

4.3.2 FISH

The surf zone and outer turbulent zone habitats of sandy beaches are considered to be important nursery habitats for marine fishes (Modde, 1980; Lasiak, 1981; Clark et al., 1994). However, the composition and abundance of the individual assemblages seems to be heavily dependent on wave exposure (Blaber and Blaber, 1980; Potter et al., 1990; Clark, 1997a, b). Surf zone fish communities off the coast of central Namibia have been studied at Langstrand (McLachlan, 1986; Romer, 1988), between Mile 9 and Wlotzkasbaken (Pulfrich, 2015) and south of Langstrand to the Walvis Bay Naval Base (Laird et al., 2018). Species from the surf zone off Langstrand beach and further south included galjoen (*Dichistius capensis*), West Coast steenbras (*Lithognathus aureti*), flathead mullet (*Mugil cephalus*), southern mullet (*Chelon richardsonii*) and Cape silverside (*Atherina breviceps*) (McLachlan, 1986; Romer, 1988; Laird et al., 2018). The size composition of the catches confirmed that most of these species utilize the surf zone in the area as a nursery. North of Mile 9 the surf zone fish catches were more diverse with silver kob (*Argyrosomus inodorus*), Blacktail (*Diplodus capensis*), elf (*Pomatomus saltatrix*), bluntnose guitarfish (*Rhinobatos blochii*) and maned blennie (*Scartella emarginata*) also being reported (Pulfrich, 2015). Off Cape Cross only two species were recorded, these being sandsharks (*Rhinobatos annulatus*) and West Coast steenbras. Many of these species are important in the catches of recreational and/commercial net fisheries and line fisheries in Namibia (Kirchner et al., 2000; Holtzhausen et al, 2001, Stage and Kirchner, 2005).

The inshore waters of the central and northern Namibian coastline are also home to a number of bony fish and cartilaginous fish, many of which are popular angling species. Other than those mentioned above, these include the dusky kob (*Argyrosomus coronus*), white steenbras (*Lithognathus lithognathus*), west coast steenbras (*Lithognathus aureti*), copper shark (*Carcharhinus brachyurus*), the spotted gulley shark (*Triakis megalopterus*)and the smoothhound (*Mustelus mustelus*) (Kirchner et al., 2000; Zeybrandt and Barnes, 2001). Warm water species that occur further north include garrick (*Lichia amia*), shad (*Pomatomus saltatrix*) and spotted grunter (*Pomadasys jubelini*) (Barnard, 1998).

A number of the nearshore teleost and chondrichthyan species are considered Endangered', 'Near Threatened' or 'Vulnerable' (Table 4-1).

TABLE 4-1 KEY LINEFISH SPECIES LIKELY TO OCCUR OFF CENTRAL NAMIBIA

Common Name	Species	IUCN Conservation Status
Teleosts		
Silver kob	*Argyrosomus inodorus*	Vulnerable
Elf	*Pomatomus saltatrix*	Vulnerable
West Coast steenbras	*Lithognathus aureti*	Near threatened
West coast dusky kob	*Argyrosomus coronus*	Data deficient
Chondrichthyans		
Bronze whaler	*Carcharhinus brachyurus*	Vulnerable
Six gill shark	*Hexanchus griseus*	Near threatened
Spotted gullyshark	*Triakis megalopterus*	Least Concern
Smooth houndshark	*Mustelus mustelus*	Endangered
Broadnose seven-gill cow shark	*Heptranchias perlo*	Near threatened

Source: FishBase, 2025

Small pelagic species include the sardine/pilchard (*Sadinops ocellatus*) (Figure 4-21, left), anchovy (*Engraulis capensis*), chub mackerel (*Scomber japonicus*), horse mackerel (*Trachurus capensis*) (Figure 4-21, right) and round herring (*Etrumeus whiteheadi*). These species typically occur in mixed shoals of various sizes (Crawford et al., 1987), and generally occur within the 200 m contour, although they may often be found very close inshore, just beyond the surf zone. They spawn downstream of major upwelling centres in spring and summer, and their eggs and larvae are subsequently carried up the coast in northward flowing waters. Historically, two seasonal spawning peaks for pilchard occurred; the first from October to December in an inshore area between Walvis Bay and Palgrave Point and the second from February to March near the 200 m isobath between Palgrave Point and Cape Frio. However, since the collapse of the pilchard stock, spawning in the south has decreased (Crawford et al., 1987). Recruitment success relies on the interaction of oceanographic events and is thus subject to spatial and temporal variability. Consequently, the abundance of adults and juveniles of these small pelagic fish is highly variable both within and between species. The Namibian pelagic stock is currently considered to be in a critical condition due to a combination of overfishing and unfavourable environmental conditions as a result of *Benguela Niños* (Boyer et al. 2006).

Since the collapse of the pelagic fisheries, jellyfish biomass has increased and the structure of the Benguelan fish community has shifted, making the bearded goby (*Sufflogobius bibarbatus*) the new predominant prey species. Gobies have a high tolerance for low oxygen and high H_2S levels, which enables them to feed on benthic fauna within hypoxic waters during the day, and then move to oxygen-richer pelagic waters at night, when predation pressure is lower, to feed on live jellyfish (Utne-Palm et al., 2010; van der Bank et al., 2011).

FIGURE 4-21 CAPE FUR SEAL PREYING ON A SHOAL OF PILCHARDS (LEFT). SCHOOL OF HORSE MACKEREL (RIGHT)

Source: Under water video, 2025; Superstock, 2025

Two species that migrate along the southern African West Coast following the shoals of anchovy and pilchards are snoek (*Thyrsites atun*) and chub mackerel (*Scomber japonicas*). Both these species have been rated as ‘Least concern’ on the South African national assessment (Sink et al., 2019). Snoek has not been assessed by the International Union for the Conservation of Nature (IUCN), and chub mackerel is considered of ‘Least concern’. While the appearance of chub mackerel along the West coast is highly seasonal, adult snoek are found throughout their distribution range and longshore movement are random and without a seasonal basis (Griffiths, 2002). Initially postulated to be a single stock that undergoes a seasonal longshore migration from southern Angola through Namibia to the South African West Coast (Crawford and De Villiers 1985; Crawford et al. 1987), Benguela snoek are now recognised as two separate sub-populations separated by the Lüderitz upwelling cell (Griffiths, 2003). Snoek are voracious predators occurring throughout the water column, feeding on both demersal and pelagic invertebrates and fish. The abundance and seasonal migrations of chub mackerel are thought to be related to the availability of their shoaling prey species (Payne and Crawford, 1989).

The fish most likely to be encountered on the shelf, beyond the shelf break and in the offshore waters of PEL 82 are the large migratory pelagic species, including various tunas, billfish and sharks, many of which are considered threatened by the International Union for the Conservation of Nature (IUCN), primarily due to overfishing (Table 4-2). Tuna and swordfish are targeted by high seas fishing fleets and illegal overfishing has severely damaged the stocks of many of these species. Similarly, pelagic sharks, are either caught as bycatch in the pelagic tuna longline fisheries, or are specifically targeted for their fins, where the fins are removed and the remainder of the body discarded.

Species occurring off Namibia include the albacore/longfin tuna (*Thunnus alalunga*) (Figure 4-22, right), yellowfin (*T. albacares*), bigeye (*T. obesus*), and skipjack (*Katsuwonus pelamis*) tunas, as well as the Atlantic blue marlin (*Makaira nigricans*) (Figure 4-22, left), the white marlin (*Tetrapturus albidus*) and the broadbill swordfish (*Xiphias gladius*) (Payne and Crawford, 1989). Large pelagic species migrate throughout the southern oceans, between surface and deep waters (>300 m) and have a highly seasonal abundance in the Benguela. The distributions of these species are dependent on food availability in the mixed boundary layer between the Benguela and warm central Atlantic waters. Concentrations of large pelagic species are also known to occur associated with underwater feature such as canyons and seamounts as well as meteorologically induced oceanic fronts (Penney et al., 1992).

TABLE 4-2 KEY LARGE MIGRATORY PELAGIC FISH LIKELY TO OCCUR IN THE OFFSHORE REGIONS OF THE WEST COAST.

Common Name	Species	IUCN Conservation Status
Tunas		
Southern Bluefin Tuna	*Thunnus maccoyii*	Endangered
Bigeye Tuna	*Thunnus obesus*	Vulnerable
Longfin Tuna/Albacore	*Thunnus alalunga*	Least concern
Yellowfin Tuna	*Thunnus albacares*	Least concern
Frigate Tuna	*Auxis thazard*	Least concern
Eastern Little Tuna	*Euthynnus affinis*	Least concern
Skipjack Tuna	*Katsuwonus pelamis*	Least concern
Billfish		
Black Marlin	*Istiompax indica*	Data deficient
Blue Marlin	*Makaira nigricans*	Vulnerable
Striped Marlin	*Kajikia audax*	Least Concern
Sailfish	*Istiophorus platypterus*	Vulnerable
Swordfish	*Xiphias gladius*	Near Threatened
Pelagic Sharks		
Oceanic Whitetip Shark	*Carcharhinus longimanus*	Critically Endangered
Dusky Shark	*Carcharhinus obscurus*	Endangered
Great White Shark	*Carcharodon carcharias*	Vulnerable
Shortfin Mako	*Isurus oxyrinchus*	Endangered
Longfin Mako	*Isurus paucus*	Endangered
Whale Shark	*Rhincodon typus*	Endangered
Blue Shark	*Prionace glauca*	Near Threatened

*Until recently Southern Bluefin Tuna was globally assessed as ‘Critically Endangered’ by the IUCN. Although globally the stock remains at a low state, it is not considered overfished as there have been improvements since previous stock assessments. As a result of improvements shown by stock assessments, indicative of more sustainable management over recent years, the IUCN Red List has reclassified Southern Bluefin Tuna from ‘Critically Endangered’ to ‘Endangered’.

Source: FishBase, 2025; IUCN, 2025

FIGURE 4-22 LARGE MIGRATORY PELAGIC FISH SUCH AS BLUE MARLIN (LEFT) AND LONGFIN TUNA (RIGHT) OCCUR IN OFFSHORE WATERS

Source: Samathatours and Osfimages, 2025

A number of species of pelagic sharks are also known to occur off the southern African West Coast, including blue shark (*Prionace glauca*), short-fin mako (*Isurus oxyrinchus*) and oceanic whitetip sharks (*Carcharhinus longimanus*). Occurring throughout the world in warm temperate waters, these species are usually found further offshore. Great whites (*Carcharodon carcharias*) and whale sharks (*Rhincodon typus*) may also be encountered in coastal and offshore areas, although the latter occurs more frequently along the South and East coasts of southern Africa. The recapture of a juvenile blue shark off Uruguay, which had been tagged off the Cape of Good Hope, supports the hypothesis of a single blue shark stock in the South Atlantic (Hazin, 2000; Montealegre-Quijano and Vooren, 2010) and Indian Oceans (da Silva et al., 2010). Using the Benguela drift in a north-westerly direction, it is likely that juveniles from the parturition off the south-western Cape would migrate through the project area en route to South America (da Silva et al., 2010).

The shortfin mako inhabits offshore temperate and tropical seas worldwide. It can be found from the surface to depths of 500 m, and as one of the few endothermic sharks is seldom found in waters <16 °C (Compagno, 2001; Loefer et al., 2005). As the fastest species of shark, shortfin makos have been recorded to reach speeds of 40 km/h with burst of up to 74 km/h, and can jump to a height of 9 m. Most makos caught by longliners off South Africa are immature, with reports of juveniles and sub-adults sharks occurring near the edge of the Agulhas Bank and off the South Coast between June and November (Groeneveld et al., 2014), whereas larger and reproductively mature sharks were more common in the inshore environment along the East Coast (Foulis, 2013).

While Southern Bluefin Tuna may transit Namibian waters, there is limited data on its specific status in the region. Regional conservation efforts, such as those led by the Benguela Current

Commission, aim to address broader marine resource sustainability, which may indirectly benefit the species.

Whale sharks are regarded as a broad ranging species typically occurring in offshore epipelagic areas with sea surface temperatures of 18–32°C (Eckert and Stewart, 2001). Adult whale sharks reach an average size of 9.7 m and 9 tonnes, making them the largest non-cetacean animal in the world. They are slow-moving filter-feeders and therefore particularly vulnerable to ship strikes (Rowat, 2007). Although primarily solitary animals, seasonal feeding aggregations occur at several coastal sites all over the world, those closest to the project area being off Sodwana Bay in KwaZulu Natal (KZN) (Cliff et al., 2007). Satellite tagging has revealed that individuals may travel distances of tens of 1000s of kms (Eckert and Stewart, 2001; Rowat and Gore, 2007; Brunnschweiler et al., 2009). On the southern African West Coast their summer and winter distributions are centred around the Orange River mouth and further south between Cape Columbine and Cape Point (Harris et al., 2022). The likelihood of an encounter in the offshore waters of PEL 82 is relatively low.

Of the species listed above, the Oceanic Whitetip is listed as 'Critically Endangered', blue shark is listed as 'Near threatened', and the short-fin and long-fin mako, Dusky and whale shark as 'Endangered' on the IUCN database. The whale shark and shortfin mako are listed in Appendix II (species in which trade must be controlled in order to avoid utilization incompatible with their survival) of CITES (Convention on International Trade in Endangered Species) and Appendix I and/or II of the Bonn Convention for the Conservation of Migratory Species (CMS).

4.3.3 TURTLES

Five of the eight species of sea turtle worldwide occur off Namibia (Bianchi et al., 1999). The Leatherback (*Dermochelys coriacea*) turtle (Figure 4-23, left) is occasionally encountered in the offshore waters off Namibia. Observations of Green (*Chelonia mydas*), Loggerhead (*Caretta caretta*) (Figure 4-23, right), Hawksbill (*Eretmochelys imbricata*) and Olive Ridley (*Lepidochelys olivacea*) turtles in the area are rare. Loggerhead turtles have been reported by marine mammal observers (MMOs) during seismic operations in PEL 82. The leatherback turtle may also be encountered, although abundance in the study area is expected to be low.

FIGURE 4-23 LEATHERBACK (LEFT) AND LOGGERHEAD TURTLES (RIGHT) OCCUR ALONG THE COAST OF CENTRAL NAMIBIA

Source: Ketos Ecology, 2009

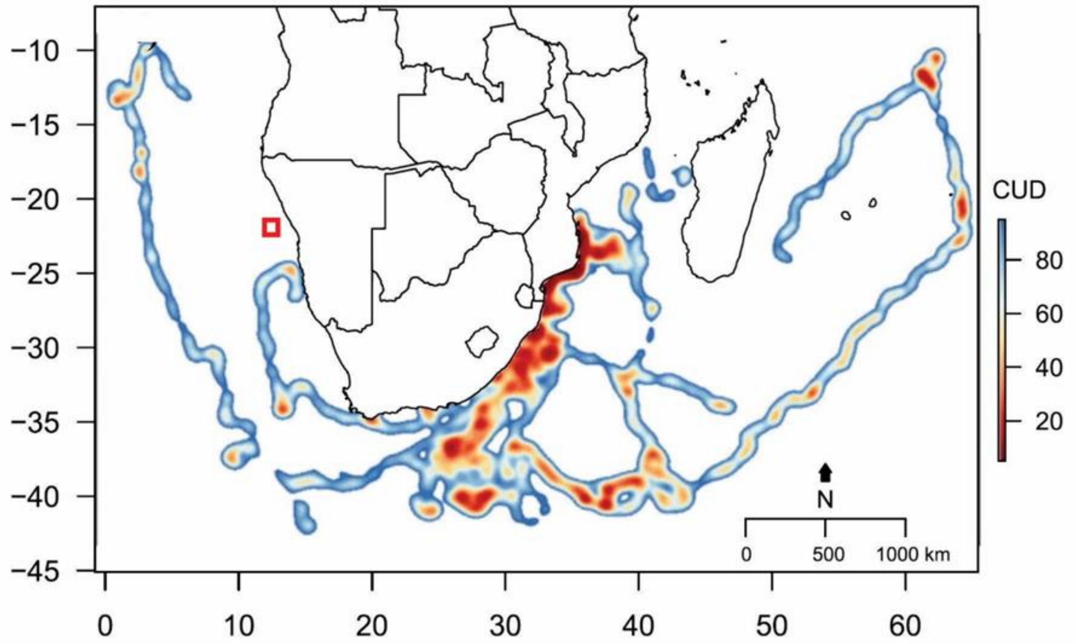
The Benguela ecosystem is increasingly being recognized as a potentially important feeding area for leatherback turtles from several globally significant nesting populations in the south Atlantic (Gabon, Brazil) and south-east Indian Ocean (South Africa) (Lambardi et al., 2008, Elwen and Leeney, 2011). Leatherback turtles from the east South Africa population have been satellite tracked swimming around the west coast of South Africa and remaining in the warmer waters west of the Benguela ecosystem (Lambardi et al., 2008, Elwen and Leeney, 2011; SASTN, 2011[4]).

Leatherback turtles inhabit deeper waters and are considered a pelagic species, travelling the ocean currents in search of their prey. While hunting they may dive to over 600 m and remain submerged for up to 54 minutes (Hays et al., 2004). Their abundance in the study area is unknown but expected to be low. Although they tend to avoid nearshore areas, they may be encountered in Walvis Bay and off Swakopmund between October and April when prevailing north wind conditions result in elevated seawater temperatures (Figure 4-24).

After completion of the nesting season (October to January) both Leatherbacks and Loggerheads undertake long-distance migrations to foraging areas. Loggerhead turtles are coastal specialists keeping inshore, hunting around reefs, bays and rocky estuaries along the African South and East Coast, where they feed on a variety of benthic fauna including crabs, shrimp, sponges, and fish. In the open sea their diet includes jellyfish, flying fish, and squid (www.oceansafrica.com/turtles.htm). Satellite tagging of loggerheads suggests that they seldom occur west of Cape Agulhas (Harris et al., 2018; Robinson et al., 2019). A green turtle and loggerhead turtle recently released on the Cape Peninsula by the Two Oceans Aquarium has, however stayed in the West Coast waters, spending time in St Helena Bay and travelling up the Namaqualand coast before heading northwards into Namibian waters to north of Walvis Bay, suggesting that occurrence in West Coast waters does arise.

4 SASTN Meeting – Second meeting of the South Atlantic Sea Turtle Network, Swakopmund, Namibia, 24-30 July 2011.

FIGURE 4-24 PEL 82 (RED POLYGON) IN RELATION TO THE MIGRATION CORRIDORS OF LEATHERBACK TURTLES IN THE SOUTH-WESTERN INDIAN OCEAN



Relative use (CUD, cumulative utilization distribution) of corridors is shown through intensity of shading: light, low use; dark, high use

Source: Harris et al. 2018.

Loggerheads and leatherbacks nest along the sandy beaches of the northeast coast of KwaZulu Natal, as well as southern Mozambique during summer months. Loggerhead and leatherback females come ashore to nest from October to March, with peak nesting for both species occurring in December – January (Le Gouvello et al., 2020). Hatchlings emerge from their nests from mid-January to mid-March. Those hatchlings that successfully escape predation en route to the sea, enter the surf and are carried ~10 km offshore by coastal rip currents or swim actively offshore for 24-48 hours (frenzy period) to reach the Agulhas Current (Hughes 1974). Although they can actively swim to influence their dispersal trajectories (Scott et al., 2014; Putman and Mansfield, 2015), hatchlings are not powerful swimmers and will primarily drift south-westwards in the current. The Agulhas Current migration corridor will therefore be very active with migrating sea turtles between January and April (Harris et al., 2018), some of which may be distributed along the West Coast through mass transport of Agulhas Current water into the southeast Atlantic by warm core rings. Despite their extensive distributions and feeding ranges, the numbers of adult and neonate turtles encountered in PEL 82 may therefore be seasonally high.

Turtles marked with titanium flipper tags have revealed that South African loggerheads and leatherbacks have a remigration interval of 2 – 3 years, migrating to foraging grounds throughout the Southwestern Indian Ocean (SWIO) as well as in the eastern Atlantic Ocean. They follow different post-nesting migration routes (Hughes et al., 1998; Luschi et al., 2006). Loggerheads use one of 3 migration corridors between their nesting and foraging grounds of which the coast-associated Mozambique Corridor is the most commonly used (>80% of the population). Leatherbacks largely follow the same corridors as the loggerheads, with most riding the Agulhas Current southward to forage in high seas regions of the Agulhas Plateau

(Hughes et al., 1998; Luschi et al., 2003b; Luschi et al., 2006), at which point they either swim east following the Agulhas Retroflection (Agulhas-Retroflection Corridor) as far north as the Mascarene Plateau or enter the Benguela Current to migrate into the southeastern Atlantic, as far north as central Angola (Agulhas-Benguela Corridor) (Figure 4-24) (Lambardi et al., 2008; de Wet, 2013; Harris et al., 2018).

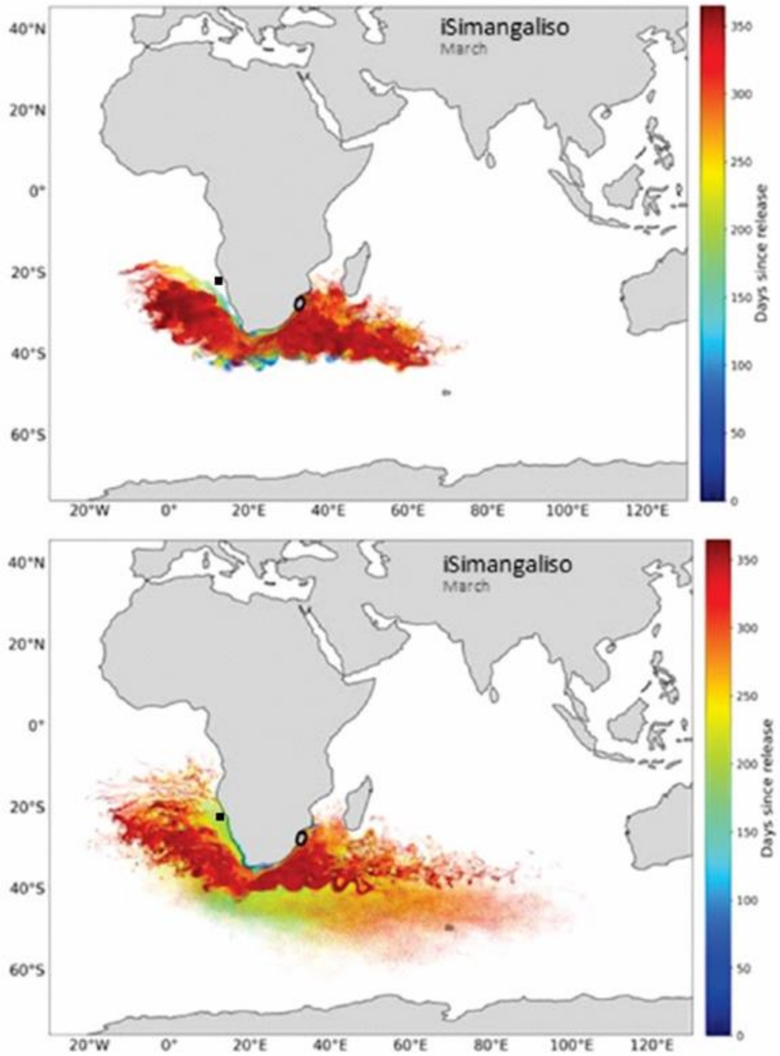
Ocean circulation models and numerical dispersal simulations have recently provided insights into the cryptic 'lost years' of neonate turtles (Hamann et al., 2011; Putman et al., 2012; Putman and Naro-Maciel 2013; Le Gouvello et al., 2020; Putman et al., 2020; DuBois et al., 2021; Le Gouvello et al. 2024). After ~10 years, juvenile loggerheads return to coastal areas to feed on crustaceans, fish and molluscs and subsequently remain in these neritic habitats (Hughes, 1974). In contrast, leatherbacks remain in pelagic waters feeding primarily on jellyfish until they become sexually mature and return to coastal regions to breed. While hunting they may dive to over 600 m and remain submerged for up to 54 minutes (Hays et al., 2004).

Leatherback Turtles are listed as 'Vulnerable' worldwide by the IUCN and are in the highest categories in terms of need for conservation in CITES (Convention on International Trade in Endangered Species), and CMS (Convention on Migratory Species).

Loggerhead and Olive Ridley turtles are globally listed as 'Vulnerable' whereas Hawksbill are globally listed as 'Critically Endangered', and Green turtles as 'Endangered'. The most recent conservation status, which assessed the species on a scale of Regional Management Units (RMU)[5], is provided in Table 4-3. From this it is evident that leatherback and loggerhead turtles, the two species most likely to be encountered in the license area, are rated as 'Critically Endangered' and 'Near Threatened', respectively in the Southwest Indian RMU. Although not a signatory of CMS, Namibia has endorsed and signed a CMS International Memorandum of Understanding specific to the conservation of marine turtles. Namibia is thus committed to conserve these species at an international level.

5 Regional Management Units (RMUs) organise marine turtles that might be on independent evolutionary trajectories within regional entities into units of protection above the level of nesting populations, but below the level of species.

FIGURE 4-25 DISPERSAL MAPS SHOWING TRAJECTORIES OF 5,000 PARTICLES RELEASED FROM THE RESPECTIVE NESTING SITES (WHITE CIRCLES) IN MARCH 2018 FOR LOGGERHEADS (TOP) AND LEATHERBACKS (BOTTOM)



Colours (blue to red) indicate the number of days since release. PEL 82 is depicted as a small black square.

Source: Le Gouvelle et al., 2020

TABLE 4-3 GLOBAL CONSERVATION STATUS OF THE TURTLES OCCURRING OFF THE SOUTHERN AFRICAN COASTLINE SHOWING VARIATION DEPENDING ON THE LISTING USED

Listing	IUCN Red List	Population (RMU)
Leatherback	V (2013)	CR
Loggerhead	CR (2013)	E
Green	CR	V
Hawksbill	E	NT
Olive Ridley	V (2017)	CR

NT – Near Threatened V – Vulnerable E – Endangered CR – Critically Endangered

4.3.4 MARINE MAMMALS

Marine mammals occurring off the central Benguela ecosystem include cetaceans (whales and dolphins) and seals. The cetacean fauna of central Namibia comprises 33 species of whales and dolphins known (historic sightings or strandings) or likely (habitat projections based on known species parameters) to occur here (Table 4-4), and their known seasonality (Table 4-5). Apart from the resident species such as the endemic Heaviside's dolphin, bottlenose and dusky dolphins, Namibia's waters also host species that migrate between Antarctic feeding grounds and warmer low latitude breeding grounds, as well as species with a circum-global distribution. The Namibian shelf and deeper waters have been poorly studied with most available information in deeper waters (>200 m) arising from historic whaling records, although data from marine mammal observers and passive acoustic monitoring is improving knowledge in recent years. Current information on the distribution, population sizes and trends of most cetacean species occurring in Namibian waters is lacking and information on smaller cetaceans in deeper waters (>100 m) is particularly poor.

Although the location of PEL 82 can be considered to be truly within the Benguela Ecosystem, the warmer waters that occur more than ~100 km offshore provide an entirely different habitat than the Benguela Ecosystem, that despite the relatively high latitude may host some species associated with the more tropical and temperate parts of the Atlantic such as rough toothed dolphins, striped dolphins, Pan-tropical spotted dolphins and short finned pilot whales.

The distribution of cetaceans in Namibian waters can largely be split into those associated with the continental shelf and those that occur in deep, oceanic water. Importantly, species from both environments may be found in the shelf edge area (200-1,000 m) making this the most species-rich area for cetaceans. Cetacean density on the continental shelf is usually higher than in pelagic waters as species associated with the pelagic environment tend to be wide ranging across 1,000s of kilometres. The most common species within the broader project area (in terms of likely encounter rate due to local abundance rather than total population sizes) are likely to be the humpback whale and pilot whale.

Cetaceans comprise two basic taxonomic groups, the mysticetes (filter feeding whales with baleen) and the odontocetes (predatory whales and dolphins with teeth). The term 'whale' is used to describe cetaceans larger than approximately 4 m in length, in both these groups and is taxonomically meaningless (e.g. the killer whale and pilot whale are members of the Odontocetes and the family Delphinidae and are thus dolphins, not whales). Due to large differences in their size, sociality, communication abilities, ranging behaviour and principally, acoustic behaviour, these two groups are considered separately.

From MMO sightings (Figure 4-26) it is evident that many species do occur as far offshore as PEL 82, particularly sei, sperm, fin, pilot and humpback whales.

The South African red list of cetacean fauna was updated in 2016 and global reviews are underway. As the Namibian list has not been updated recently the South African red list ratings are used as the most up to date. Of the 33 species listed, one is 'critically endangered', two are 'endangered' and one is considered 'vulnerable'. Altogether 11 species are listed as 'data deficient', underlining how little is known about cetaceans, their distributions and population trends in Namibian waters. A review of the distribution and seasonality of the key cetacean species likely to be found within the broader project area is provided below, based on information provided by the Sea Search - Namibian Dolphin Project (NDP), which has been conducting research in Namibian waters since 2008. The NDP holds the most up-to-date data of cetacean occurrence and distribution since whaling times, with the records including a total database of over 7,000 records with more than 1,000 sightings made by MMOs on seismic or mining vessels and fisheries observers operating in shelf or pelagic waters.

4.3.4.1 MYSTICETE (BALEEN) WHALES

Most mysticetes whales belong to the Balaenidae family, including blue, fin, sei, Antarctic minke, dwarf minke, humpback, and Bryde's whales in the study area (Table 4-4 provides the scientific names). These species primarily inhabit pelagic waters, migrating between high-latitude feeding grounds and lower-latitude breeding grounds, resulting in either unimodal or bimodal seasonal patterns in Namibian waters. Migration patterns vary, influencing occurrence based on geographic features.

Sei whales, with limited data from Namibian waters, historically migrated through the region, likely showing bimodal peaks in abundance. There is no current information on the abundance or distribution of this species in the region, but a recent sighting of a mother and calf in March 2012 (NDP unpublished data) and a stranding in Walvis Bay in July 2013 (NDP unpublished data) confirms their contemporary and probably year round occurrence on the Namibian continental shelf and beyond. Sei whales are likely to be encountered in the project area.

Bryde's whales consist of two distinct populations: an offshore population that migrates between equatorial west Africa and western South Africa, peaking in abundance from January to March, and a non-migratory inshore population. Sightings of Bryde's whales were made in the vicinity of PEL 82 (Figure 4-26). Bryde's whales are likely to be encountered in the project area.

TABLE 4-4 CETACEANS OCCURRENCE OFF THE SOUTHERN NAMIBIAN COAST

Common Name	Species	Hearing Frequency	Shelf (<200 m)	Offshore (>200 m)	Seasonality	RSA Regional Assessment	IUCN Global Assessment
Delphinids							
Dusky dolphin	Lagenorhynchus obscurus	HF	Yes (0-800 m)	No	Year round	Least Concern	Least Concern
Heaviside's dolphin	Cephalorhynchus heavisidii	VHF	Yes (0-200 m)	No	Year round	Least Concern	Near Threatened
Common bottlenose dolphin	Tursiops truncatus	HF	Yes	Yes	Year round	Least Concern	Least Concern
Common dolphin	Delphinus delphis	HF	Yes	Yes	Year round	Least Concern	Least Concern
Southern right whale dolphin	Lissodelphis peronii	HF	Yes	Yes	Year round	Least Concern	Least Concern
Striped dolphin	Stenella coeruleoalba	HF	No	Yes	Year round	Least Concern	Least Concern
Pantropical spotted dolphin	Stenella attenuata	HF	Edge	Yes	Year round	Least Concern	Least Concern
Long-finned pilot whale	Globicephala melas	HF	Edge	Yes	Year round	Least Concern	Least Concern
Short-finned pilot whale	Globicephala macrorhynchus	HF	Edge	Yes	Year round	Least Concern	Least Concern
Rough-toothed dolphin	Steno bredanensis	HF	No	Yes	Year round	Not Assessed	Least Concern
Killer whale	Orcinus orca	HF	Occasional	Yes	Year round	Least Concern	Data deficient
False killer whale	Pseudorca crassidens	HF	Occasional	Yes	Year round	Least Concern	Near Threatened
Pygmy killer whale	Feresa attenuata	HF	No	Yes	Year round	Least Concern	Least Concern
Risso's dolphin	Grampus griseus	HF	Yes (edge)	Yes	Year round	Data Deficient	Least Concern

Common Name	Species	Hearing Frequency	Shelf (<200 m)	Offshore (>200 m)	Seasonality	RSA Regional Assessment	IUCN Global Assessment
Sperm whales							
Pygmy sperm whale	Kogia breviceps	VHF	Edge	Yes	Year round	Data Deficient	Least Concern
Dwarf sperm whale	Kogia sima	VHF	Edge	Yes	Year round	Data Deficient	Least Concern
Sperm whale	Physeter macrocephalus	HF	Edge	Yes	Year round	Vulnerable	Vulnerable
Beaked whales							
Cuvier's	Ziphius cavirostris	HF	No	Yes	Year round	Data Deficient	Least Concern
Arnoux's	Berardius arnuxii	HF	No	Yes	Year round	Data Deficient	Least Concern
Southern bottlenose	Hyperoodon planifrons	HF	No	Yes	Year round	Least Concern	Least Concern
Layard's	Mesoplodon layardii	HF	No	Yes	Year round	Data Deficient	Least Concern
True's	Mesoplodon mirus	HF	No	Yes	Year round	Data Deficient	Least Concern
Gray's	Mesoplodon grayi	HF	No	Yes	Year round	Data Deficient	Least Concern
Blainville's	Mesoplodon densirostris	HF	No	Yes	Year round	Data Deficient	Least Concern
Baleen whales							
Antarctic Minke	Balaenoptera bonaerensis	LF	Yes	Yes	>Winter	Least Concern	Near Threatened
Dwarf minke	B. acutorostrata	LF	Yes	Yes	Year round	Least Concern	Least Concern
Fin whale	B. physalus	LF	Yes	Yes	MJJ & ON	Endangered	Vulnerable
Blue whale (Antarctic)	B. musculus intermedia	LF	No	Yes	Winter peak	Critically Endangered	Critically Endangered

Common Name	Species	Hearing Frequency	Shelf (<200 m)	Offshore (>200 m)	Seasonality	RSA Regional Assessment	IUCN Global Assessment
Sei whale	B. borealis	LF	Yes	Yes	MJ & ASO	Endangered	Endangered
Bryde's (inshore)	B. edeni (subspp)	LF	Yes	Edge	Year round	Vulnerable	Least Concern
Bryde's (offshore)	B. edeni	LF	Edge	Yes	Summer (JFM)	Data Deficient	Least Concern
Pygmy right	Caperea marginata	LF	Yes	?	Year round	Least Concern	Least Concern
Humpback sp.	Megaptera novaeangliae	LF	Yes	Yes	Year round, SONDJF	Least Concern	Least Concern
Humpback B2 population	Megaptera novaeangliae	LF	Yes	Yes	Spring/Summer peak ONDJF	Vulnerable	Not Assessed
Southern Right	Eubalaena australis	LF	Yes	No	Year round, ONDJFMA	Least Concern	Least Concern

Marine animals do not hear equally well at all frequencies within their functional hearing range. Based on the hearing range and sensitivities, Southall et al. (2019) have categorised noise sensitive marine mammal species into six underwater hearing groups: low-frequency (LF), high-frequency (HF) and very high-frequency (VHF) cetaceans, Sirenians (SI), Phocid carnivores in water (PCW) and other marine carnivores in water (OCW).

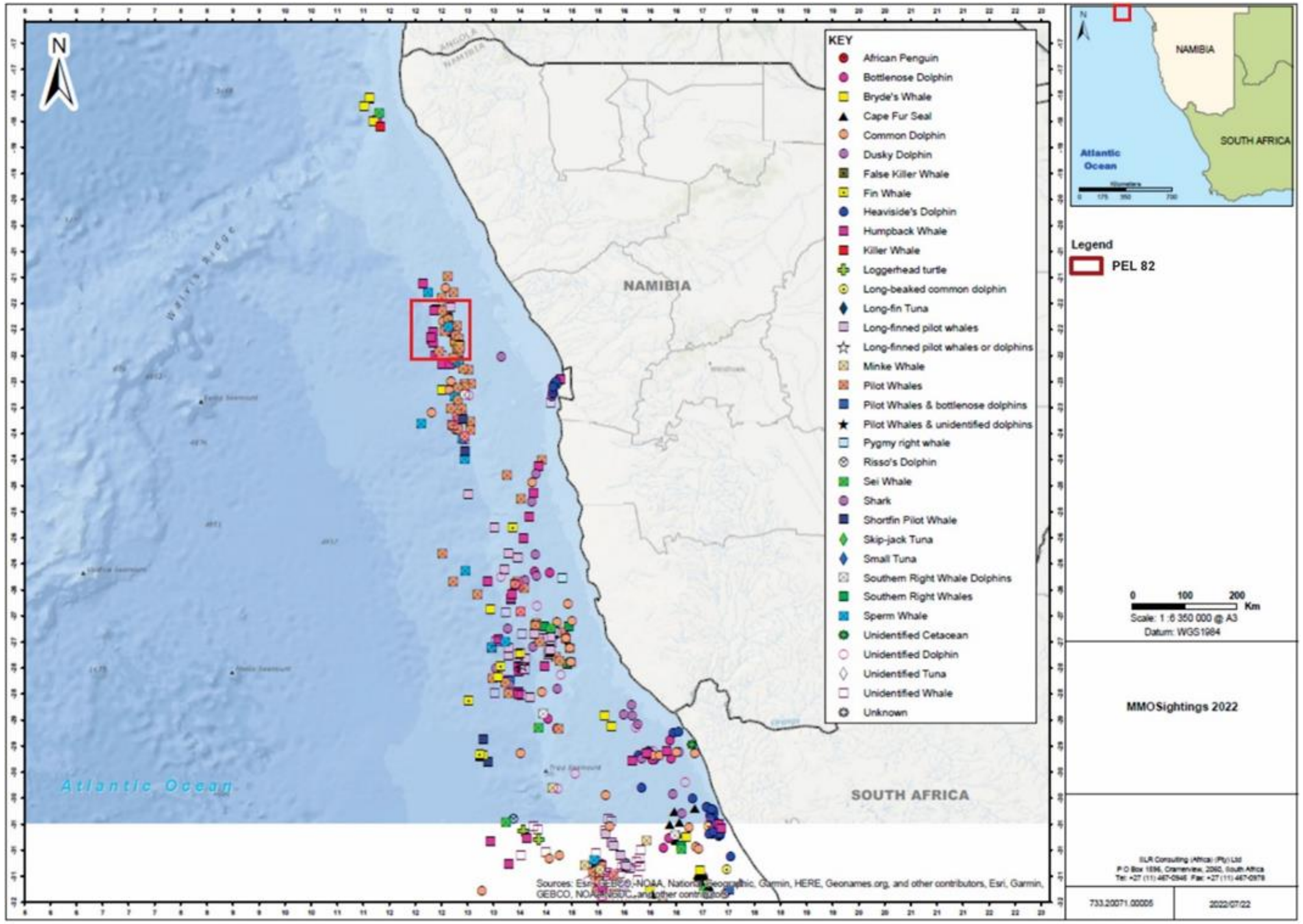
Source: Findlay et al. (1992); Best (2007); Weir (2011); Dr J-P Roux, (MFMR pers comm); unpublished records held by the Namibian Dolphin Project, which includes sightings from fisheries observers and Marine Mammal Observers (MMOs) working on seismic surveys in the area (de Rock et al. 2019); Child et al. 2016; IUCN, 2025

TABLE 4-5 SEASONALITY OF BALEEN WHALES IN THE BROADER PROJECT AREA

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bryde's Inshore	L	L	L	L	L	L	L	L	L	L	L	L
Bryde's Offshore	H	H	H	L	L	L	L	L	L	L	L	L
Sei	L	L	L	L	H	H	L	H	H	H	L	L
Fin	M	M	M	H	H	H	M	H	H	H	M	M
Blue	L	L	L	L	L	H	H	H	L	M	L	L
Minke	M	M	M	H	H	H	M	H	H	H	M	M
Humpback	M	M	L	L	L	H	H	M	M	L	M	H
Southern Right	H	M	L	L	L	H	H	H	M	M	H	H
Pygmy right	H	H	H	M	L	L	L	L	L	L	M	M

Data from multiple sources, predominantly commercial catches (Best 2007 and other sources) and data from stranding events (NDP unpubl data). Values of high (H), Medium (M) and Low (L) are relative within each row (species) and not comparable between species.

FIGURE 4-26 PEL 82 (RED POLYGON) IN RELATION TO THE DISTRIBUTION AND MOVEMENT OF CETACEANS SIGHTED BY MMOS WITHIN THE NAMIBIAN EEZ, COLLATED BETWEEN 2001 AND 2022



Source: SLR MMO DATABASE, 2022

Fin whales were historically caught off South Africa and Namibia, with catch data indicating northward migration for breeding (May-June) before returning to Antarctic feeding grounds (August-October). The breeding ground location remains unknown. Some juveniles may feed year-round in deeper waters. Four strandings occurred between Walvis Bay and the Kunene River in the last decade. Groups of 5-8 whales were observed near Lüderitz in April, May 2014, and January 2015, indicating their presence in Namibian waters and potential feeding in upwelling areas. Most sightings and strandings happen in late summer (April-May), aligning with whaling data. Sightings of fin whales were made in the vicinity of PEL 82 (FIGURE 4-26).

Antarctic blue whales were historically caught in high numbers during commercial whaling activities, with a single peak in catch rates during July in Walvis Bay, Namibia and Namibe, Angola suggesting that in the eastern South Atlantic these latitudes are close to the northern migration limit for the species (Best, 2007). Evidence of blue whale presence off Namibia is rapidly increasing. Recent acoustic detections of blue whales in the Antarctic peak between December and January (Tomisch et al., 2016) and in northern Namibia between May and July (Thomisch, 2017) supporting observed timing from whaling records. Several recent (2014-2015) sightings of blue whales have occurred during seismic surveys off the southern part of Namibia in water >1,000 m deep confirming their current existence in the area and occurrence in Autumn months. Encounters in the project area may occur.

Two minke whale species exist in the Southern Hemisphere: the Antarctic minke whale and the dwarf minke whale, both found in the Benguela. Antarctic minke whales migrate from the Southern Ocean to tropical/temperate waters for breeding, with some juveniles remaining year-round. They are regularly sighted in Lüderitz Bay during summer and have been confirmed in Namibia. Passive acoustic monitoring indicates their presence from June to August and November to December. Dwarf minke whales, with a more temperate range, do not go further south than 60-65°S and are often found closer to shore, occasionally within 2 km of South Africa. Both species are generally solitary, with low densities in the area, but encounters may occur. Both species are generally solitary, and densities are likely to be low in the license area, but encounters may occur.

The pygmy right whale is the smallest of the baleen whales reaching only 6 m total length as an adult (Best, 2007). The species is typically associated with cool temperate waters between 30°S and 55°S and records in Namibia there are the northern most for the species with no confirmed records north of Walvis Bay (Leeney et al., 2013).

The most abundant baleen whales in the Benguela are southern right whales and humpback whales (Figure 4-27). In the last decade, both species have been increasingly observed to remain on the west coast of South Africa well after the 'traditional' South African whale season (June - November) into spring and summer (October - February) where they have been observed feeding in upwelling zones, especially off Saldanha and St Helena Bays (Barendse et al., 2011; Mate et al., 2011). Increasing numbers of summer records of both species, suggest that animals may also be feeding in upwelling areas off Namibia, especially the southern half of the country near the Lüderitz upwelling cell (NDP unpubl. data) and will therefore occur in or pass through the project area.

The southern African population of southern right whales historically extended from southern Mozambique (Maputo Bay) to southern Angola (Baie dos Tigres) and is considered to be a single population within this range (Roux et al., 2015). The most recent abundance estimate for this population is available for 2017 which estimated the population at ~6 100 individuals including all age and sex classes and still growing at ~6.5% per annum (Brandaõ et al., 2017). When the population numbers crashed in response to commercial whaling, the range contracted down to just the south coast of South Africa. As the population recovers following their protection in 1935, it is repopulating its historic grounds including Namibia (Roux et al., 2001, 2015; de Rock et al., 2019) and Mozambique (Banks et al., 2011).

FIGURE 4-27 THE SOUTHERN RIGHT WHALE EUBALAENA AUSTRALIS (LEFT) AND THE HUMPBACK WHALE MEGAPTERA NOVAEANGLIAE (RIGHT)

The whales migrate along the coastal and shelf waters of southern Africa, including Namibia.

Source: Namibian Dolphin Project, 2025

Southern right whales are seen regularly in Namibian coastal waters (<3 km from shore), especially in the southern half of the Namibian coastline (Roux et al., 2001, 2011). Right whales have been recorded in Namibian waters in all months of the year (J-P Roux pers comm) but with numbers peaking in winter (June - August). A secondary peak in summer (November - January) also occurs, probably associated with animals feeding off the west coast of South Africa performing exploratory trips into southern Namibia (NDP unpubl. data). Notably, all available records have been very close to shore with only a few out to 100 m depth, so they are unlikely to be encountered in PEL 82.

Most humpback whales in the Benguela migrate to breeding grounds off tropical West Africa, particularly between Angola and the Gulf of Guinea. Data from Namibia indicates a larger northward migration than southward, with whales striking the coast north of St Helena Bay, leading to increased density toward Angola but no defined migration corridor. During southward migration, some whales follow the Walvis Ridge to feeding grounds, while others take a coastal route, especially mother-calf pairs. There is no clear corridor, as whales are dispersed across shelf and deeper waters. Regular sightings in Namibia suggest summer feeding occurs there, with the West African breeding population estimated at over 9,000 in 2005, likely increasing by 5% annually since then. Humpback whales are thus likely to be the most frequently encountered baleen whale in PEL 82, ranging from the coast out beyond the shelf, with year-round presence but numbers peaking in June – July (northern migration) and a smaller peak with the southern breeding migration around September – October but with regular encounters until February associated with subsequent feeding in the Benguela ecosystem.

FIGURE 4-28 PEL 82 (RED POLYGON) IN RELATION TO 'BLUE CORRIDORS' OR 'WHALE SUPERHIGHWAYS'

Figure showing tracks of Humpback whales (orange) and Southern Right whales (green) between southern Africa and the Southern Ocean feeding grounds

Source: Johnson et al., 2022

4.3.4.2 ODONTOCETE (TOOTHED) WHALES

The Odontoceti are a varied group of animals including the dolphins, porpoises, beaked whales and sperm whales. Species occurring within the broader project area display a diversity of features, for example their ranging patterns vary from extremely coastal and highly site specific to oceanic and wide ranging. Those in the region can range in size from 1.6 m long (Heaviside's dolphin) to 17 m (bull sperm whale).

Sperm whale data in southern Africa is mainly from pre-1985 commercial whaling (Best, 2007). They are the largest toothed whales, with a complex social structure. Typically found in waters deeper than 1,000 m, they occasionally inhabit shallower areas (500-200 m). Globally abundant (Whitehead, 2002), no local population estimates exist. Seasonal patterns show larger males are more common in winter, while females peak in autumn (Best, 2007). They are frequently sighted during offshore seismic surveys between Angola and the Gulf of Guinea, mainly in depths over 780 m, with sightings peaking from April to June (Weir, 2011). Recent sightings near Tripp Sea Mount, Namibia, have been recorded (NDP Unpublished data, De Rock et al. 2019). Their deep feeding habits make visual detection difficult, but acoustic monitoring can detect their echolocation clicks. Sperm whales in the project area are likely to be encountered in deeper waters (>500 m), predominantly in the winter months (April - October).

There are almost no data available on the abundance, distribution, or seasonality of the smaller odontocetes (including the beaked whales and dolphins) known to occur in oceanic waters (greater than 200 m) off the Namibian continental shelf (refer to Table 4-4). Beaked whales are all considered to be true deep-water species, usually recorded in waters in excess of 1,000 – 2,000 m (see various species accounts in Best 2007) and thus may be encountered in the project area.

Beaked whales seem to be particularly susceptible to man-made sounds and several strandings and deaths at sea, often on mass, have been recorded in association with naval mid-frequency sonar (Cox et al., 2006; MacLeod and D'Amico, 2006). Although the exact reason that beaked whales seem particularly vulnerable to man-made noise is not yet fully understood, the existing evidence clearly shows that animals change their dive behaviour in response to acoustic disturbance (Tyack et al., 2011), and all possible precautions should be taken to avoid causing any harm. Sightings of beaked whales in the project area are expected to be very low.

Killer whales have a circum-global distribution being found in all oceans from the equator to the ice edge (Best, 2007). Killer whales occur year round in low densities off western South Africa (Best et al., 2010), Namibia (Elwen and Leeney 2011) and in the Eastern Tropical Atlantic (Weir et al., 2010). Killer whales are found in all depths from the coast to deep open ocean environments and may thus be encountered in the license area at low levels.

False killer whales are recognized as a single species globally, although clear differences in morphological and genetic characteristics between different study sites show that there is substantial difference between populations and a revision of the species taxonomy may be needed (Best, 2007). The species has a tropical to temperate distribution and most sightings off southern Africa have occurred in water deeper than 1000 m but with a few close to shore as well (Findlay et al., 1992; NDP Unpubl. data). False killer whales usually occur in groups ranging in size from 1-100 animals (mean 20.2) (Best, 2007) and are thus likely to be fairly easily seen in most weather conditions. However, the strong bonds and matrilineal social structure of this species makes it vulnerable to mass stranding (8 instances of 4 or more animals stranding together have occurred in the western Cape, South Africa, all between St Helena Bay and Cape Agulhas (Kirkman et al., 2010)), which may aggrandize the consequences of any injury or disturbance by seismic airguns or associated activities. There is no information on population numbers of conservation status and no evidence of seasonality in the region (Best, 2007).

Long- and short-finned pilot whales (*Globicephala melas* and *G.macrorhynchus*) display a preference for temperate waters and are usually associated with the continental shelf or deep water adjacent to it (Mate et al., 2005; Findlay et al., 1992; Weir, 2011; Seakamela et al. 2022). They are regularly seen associated with the shelf edge by MMOs, fisheries observers and researchers operating in Namibian waters (NDP unpubl. data; De Rock et al. 2019). The distinction between long-finned and short finned (*G. macrorhynchus*) pilot whales is difficult to make at sea. Short finned pilot whales are regarded as a more tropical species (Best, 2007), and most sightings within the Benguela Ecosystem are thought to be long-finned pilot whales, however, due to the low latitude and offshore nature of the project, it is likely that either could be encountered. There are many confirmed sighting of pilot whales along the shelf edge of South Africa and Namibia including within the project area since 2010 (de Rock et al., 2019). Observed group sizes range from 8-100 individuals (Seakamela et al., 2022). Pilot whales are commonly sighting by MMOs and detected by PAM during seismic surveys.

Dusky dolphins (*Lagenorhynchus obscurus*) (Figure 4-29, left) are likely to be the most frequently encountered small cetacean in water less than 500 m deep. This species is resident year round throughout the Benguela ecosystem in waters from the coast to at least 500 m deep (Findlay et al., 1992). Although no information is available on the size of the population, they are regularly encountered in near shore waters off South Africa and Lüderitz, although encounters near-shore are rare along the central Namibian coast (Walvis Bay area), with most records coming from beyond 5 nautical miles from the coast (Elwen et al. 2010a; NDP unpubl. data). In a recent survey of the Namibian Islands Marine Protected Area (between latitudes of 24°29' S and 27°57' S and depths of 30-200 m) dusky dolphin were the most commonly detected cetacean species with group sizes ranging from 1 to 70 individuals (NDP unpubl. data), although group sizes up to 800 have been reported in southern African waters (Findlay et al., 1992). However, due to the offshore location of PEL 82, encounters within the project area are unlikely.

Heaviside's dolphins (Figure 4-29, right) are relatively abundant in both the southern and northern Benguela ecosystem within the region of 10,000 animals estimated to live in the 400 km of coast between Cape Town and Lamberts Bay (Elwen et al., 2009a) and several hundred animals living in the areas around Walvis Bay and Lüderitz. Heaviside's dolphins are resident year-round. This species occupies waters from the coast to at least 200 m depth (Elwen et al., 2006; Best, 2007), and may show a diurnal onshore-offshore movement pattern feeding offshore at night, although this varies throughout the range (Elwen et al., 2009b). This species occupies waters from the coast to at least 200 m depth (Elwen et al., 2006; Best, 2007; Elwen et al., 2010), suggesting they are unlikely to be encountered in the project area.

FIGURE 4-29 THE DUSKY DOLPHIN LAGENORHYNCHUS OBSCURUS (LEFT) AND ENDEMIC HEAVISIDE'S DOLPHIN CEPHALORHYNCHUS HEAVISIDII (RIGHT).

Source: Namibian Dolphin Project, 2025

The common dolphin (*Delphinus delphis*) is found offshore in Namibian waters, with two forms present in southern Africa: long-beaked and short-beaked, though they are classified as a single species. The long-beaked form typically inhabits the continental shelf of South Africa and is rarely seen north of St Helena Bay or in depths over 500 m, though recent sightings extend to 1,000 m. Evidence from strandings and MMO reports confirms their presence in the region. Group sizes average 267 in southern Africa and 37 in Namibia, with sightings occurring in warmer, deeper waters. There is no seasonal pattern noted. The short-beaked form is less understood and is difficult to distinguish from the long-beaked form at sea, with larger group sizes, likely found deeper than 2,000 m.

Common bottlenose dolphins (*Tursiops truncatus*) are widely distributed in tropical and temperate waters throughout the world but frequently occur in small (10s to low 100s) isolated coastal populations. Within Nambian waters two populations of bottlenose dolphins occur. A small population inhabits the very near shore coastal waters (mostly <15 m deep) of the central Namibian coastline from approximately Lüderitz in the south to at least Cape Cross in the north, and is considered a conservation concern. The population is thought to number less than 100 individuals (Elwen et al., 2011), but its nearshore habitat makes it unlikely to be impacted by the potential exploration-drilling activities. An offshore 'form' of common bottlenose dolphins occurs around the coast of southern Africa including Namibia and Angola (Best, 2007) with sightings restricted to the continental shelf edge and deeper. Offshore bottlenose dolphins frequently form mixed species groups, often with pilot whales or Risso's dolphins.

The cold waters of the Benguela provide a northwards extension of the normally sub Antarctic habitat of Southern right whale dolphins (*Lissodelphis peronii*) (Best, 2007). Most records in the region originate in a relatively restricted region between 26°S and 30°S roughly between Lüderitz and Tripp Seamount in water 100-2,000 m deep (Rose and Payne 1991; Best 2007; NDP Unpublished data). There has been a recent live stranding of two individuals in Lüderitz Bay in December 2013. They are often seen in mixed species groups with other dolphins such as dusky dolphins. It is possible that the Namibian sightings represent a regionally unique and resident population (Findlay et al., 1992) and as such caution is needed to minimise negative effects of hydrocarbon exploration. Encounters in the project area are likely to be low.

Several other species of toothed whales that might occur in the deeper waters of license area at low levels include the pygmy killer whale, Risso’s, and Striped dolphins, and Cuvier’s and Layard’s beaked whales. Nothing is known about the population size or density of these species in the project area but it is likely that encounters would be rare (Findlay et al., 1992; Best, 2007).

Beaked whales, rarely targeted commercially and difficult to study due to their pelagic nature, are among the most extreme divers, reaching depths over 2 km and lasting over an hour. However, they are particularly vulnerable to anthropogenic noise, with several species stranding or dying in response to man-made sounds, especially naval sonar. While the exact cause of this vulnerability is unclear, evidence indicates susceptibility to noise, necessitating precautions to prevent harm. Beaked whales typically occur in small groups, complicating visual detection, but passive acoustic monitoring (PAM) can enhance detection during foraging dives.

Current data on cetaceans in the project area is scarce, relying on past studies and habitat knowledge. Available information focuses on humpback and southern right whales, primarily found on the continental shelf. These species feed around Cape Columbine from September to February, unlike winter breeding on the South Coast. Whaling data suggests fin whales peak in May-July and October-November, sei whales in May-June and August-October, and Bryde's whales offshore in January-March. Overall, whale numbers are likely highest from October to February.

Of the migratory cetaceans, the Blue whale is considered ‘Critically Endangered’, and Sei and Fin whales are listed as ‘Endangered’ in the IUCN Red Data book. All whales and dolphins are given protection under the Namibian Law. The regulations under the Namibian Marine Resources Act, 2000 (No. 27 of 2000) states that no whales or dolphins may be harassed, killed or fished.

4.3.4.3 SEALS

The Cape fur seal (*Arctocephalus pusillus pusillus*) (Figure 4-30) is the only species of seal resident along the west coast of Africa, occurring at numerous breeding and non-breeding sites on the mainland and on nearshore islands and reefs (refer to Figure 4-40). Vagrant records from four other species of seal more usually associated with the sub Antarctic environment have also been recorded: southern elephant seal (*Mirounga leoninas*), sub Antarctic fur seal (Arctocephalus tropicalis), crabeater (*Lobodon carcinophagus*) and leopard seals (*Hydrurga leptonyx*) (David 1989).

FIGURE 4-30 COLONY OF CAPE FUR SEALS (ARCTOCEPHALUS PUSILLUS PUSILLUS)

Source: Photo by J. Kemper, 2014

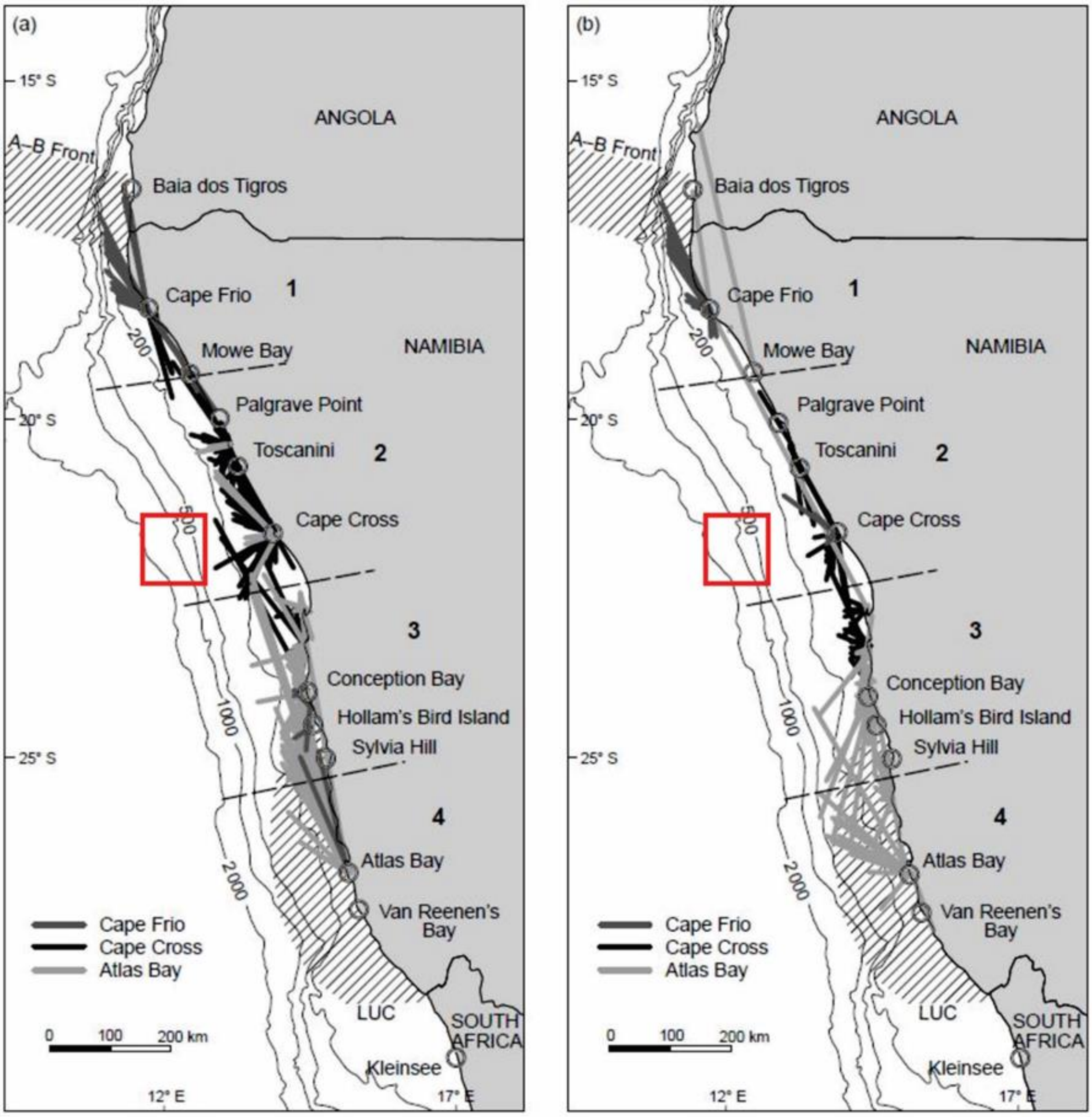
The southern colonies (Spencer Bay to Baker’s Bay) historically contributed ~62% to the overall seal population in Namibia. With the distributional shift of the seal population northwards in response to environmental change and altered prey distributions, the southern colonies currently comprise just less than a third of the total Namibian seal population (J-P Roux pers comm.). Population estimates fluctuate widely between years in terms of pup production, particularly since the mid-1990s (MFMR unpubl. Data; Kirkman et al., 2007). The colony closest to PEL 82 is at Cape Cross approximately 100 km inshore of the license area where about 51,000 pups are born annually (MFMR unpubl. Data). The colony supports an estimated 157,000 adults (Hampton, 2003), with unpublished data from Marine and Coastal Management (MCM, South Africa) suggesting a number of 187,000 (Mecenero et al., 2006). A further colony of ~9,600 individuals exists on Hollamsbird Island south of Sandwich Harbour, approximately 285 km south-east of PEL 82. There are also seal colonies at Cape Frio and Möwe Bay, which are located approximately 360 km and 240 km north of PEL 82, respectively. The colony at Pelican Point in Walvis Bay is primarily a haul-out site. The mainland seal colonies present a focal point of carnivore and scavenger activity in the area, as jackals and hyena are drawn to this important food source.

The Cape fur seal population in the Benguela is regularly monitored by the South African and Namibian governments (e.g. Kirkman et al., 2012). Surveys of the full species range are periodically undertaken providing data on seal pup production (which can be translated to adult population size), thereby allowing for the generation of data on the population dynamics of this species. The population is considered to be healthy and stable in size although there has been a northward shift in the distribution of the breeding population (Kirkman et al., 2007; Skern-Mauritzen et al. 2009; Kirkman et al. 2012).

Seals are highly mobile animals with a general foraging area covering the continental shelf up to 120 nautical miles (~220 km) offshore (Shaughnessy, 1979), with bulls ranging further out to sea than females. The foraging area of tracked seals from Namibian colonies and the South African West Coast colonies was provided in Skern-Mauritzen et al. (2009) (Figure 4-31). PEL 82 lies well offshore of the foraging ranges from these colonies. The timing of the annual breeding cycle is very regular occurring between November and January. Breeding success is highly dependent on the local abundance of food, territorial bulls and lactating females being most vulnerable to local fluctuations as they feed in the vicinity of the colonies prior to and after the pupping season (Oosthuizen, 1991).

There is a controlled annual quota, determined by government policy, for the harvesting of Cape fur seals on the Namibian coastline. The Total Allowable Catch (TAC) for 2020 and 2021 stands at 60,000 pups and 8 000 bulls, distributed among seven license area holders at Cape Cross and a further three in Lüderitz. The annual quotas are seldom filled with concessionaires typically only harvesting 50% of the bulls and 30% of the pups. The seals are exploited mainly for their pelts (pups), blubber and genitalia (bulls). The pups are clubbed and the adults shot. These harvesting practices have raised concern among environmental and animal welfare organisations (Molloy and Reinikainen, 2003).

FIGURE 4-31 PEL 82 (RED POLYGON) IN RELATION TO FORAGING TRIPS OF (A) FEMALES AND (B) MALES OF CAPE FUR SEALS AT THE CAPE FRIO, CAPE CROSS AND ATLAS BAY COLONIES



Note: Trips are depicted as straight lines between the start location and the location where the seals spent most time during a trip.

Source: Skern-Mauritzen et al. 2009

4.3.5 DEMERSAL COMMUNITIES

4.3.5.1 BENTHIC INVERTEBRATE MACROFAUNA

The seabed communities in the PEL 82 area lie within the Namib sub-photic and continental slope biozones, which extend from a 30 m depth to the shelf edge, and beyond to the lower deep sea slope, respectively. The benthic and coastal habitats of Namibia were mapped as part of the Benguela Current Commission’s Spatial Biodiversity Assessment (BCC-SBA) (Holness et al., 2014) (Figure 4-32). The benthic habitats were subsequently assigned an ecosystem threat status based on their level of protection (Table 4-6). Submarine canyons were also mapped as biodiversity features, although descriptions of their geographical situations were not sufficiently accurate to include them in the benthic habitat map[6] (Figure 4-32). PEL 82 mostly overlaps with benthic habitat considered of 'Least Concern', however, those along the 500 m depth contour in the eastern portion of PEL 82 have been assigned a threat status of 'Vulnerable', with those further inshore to the 100 m depth contour considered 'Endangered' by the Benguela Current Commission (BCC) Spatial Biodiversity Assessment (Holness et al. 2014) (Figure 4-32).

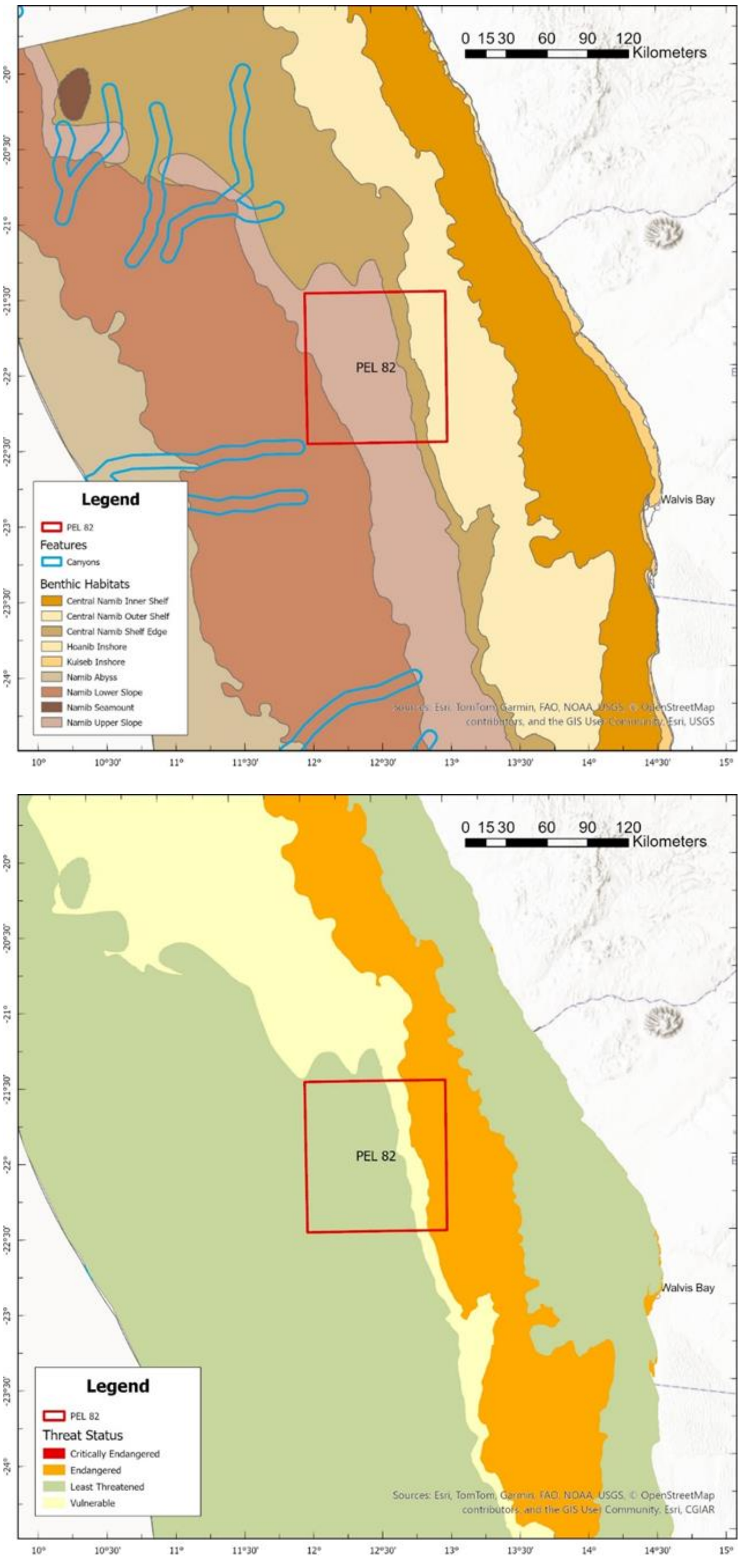
The benthic biota of unconsolidated marine sediments constitute invertebrates that live on (epifauna) or burrow within (infauna) the sediments and are generally divided into macrofauna (animals >1 mm) and meiofauna (<1 mm). Numerous studies have been conducted on southern African West Coast continental shelf benthos, mostly focused on mining, pollution or demersal trawling impacts (Christie and Moldan, 1977; Moldan, 1978; Jackson and McGibbon, 1991; Environmental Evaluation Unit, 1996; Parkins and Field, 1997; 1998; Pulfrich and Penney, 1999; Goosen et al., 2000; Savage et al., 2001; Steffani and Pulfrich, 2004a, 2004b; 2007; Steffani, 2007a; 2007b; Atkinson, 2009; Steffani, 2009a, 2009b, 2009c, 2010a, 2010b, 2010c; Atkinson et al., 2011; Steffani, 2012a, 2012b, 2014; Karenyi, 2014; Steffani et al., 2015; Biccard and Clark, 2016; Biccard et al., 2016; Duna et al., 2016; Karenyi et al., 2016; Biccard et al., 2017, 2018; Gihwala et al., 2018; Biccard et al., 2019; Giwhala et al., 2019). The description below is drawn from the various baseline and monitoring surveys conducted by diamond mining companies (Bickerton and Carter, 1995; Steffani and Pulfrich, 2007; Steffani, 2007a; 2007b). These studies, however, concentrated on the continental shelf and nearshore regions, and consequently the benthic fauna of the outer shelf and continental slope (beyond ~450 m depth) are very poorly known. This is primarily due to limited opportunities for sampling as well as the lack of access to Remote Operated Vehicles (ROVs) for visual sampling of hard substrata. To date very few areas of the continental slope off the southern African West Coast have been biologically surveyed.

Polychaetes, crustaceans and molluscs make up the largest proportion of individuals, biomass and species on the west coast. The distribution of species within these communities are inherently patchy reflecting the high natural spatial and temporal variability associated with macro-infauna of unconsolidated sediments (e.g. Kenny et al., 1998; Kendall and Widdicombe, 1999; van Dalfsen et al., 2000; Zajac et al., 2000; Parry et al., 2003), with evidence of mass mortalities and substantial recruitments recorded on the South African West Coast (Steffani and Pulfrich, 2004a). Generally species richness increases from the inner shelf across the mid shelf and is influenced by sediment type (Karenyi unpublished data). The highest total abundance and species diversity was measured in sandy sediments of the mid-shelf. Biomass is highest in the inshore (± 50 g/m^2 wet weight) and decreases across the mid-shelf averaging around 30 g/m^2 wet weight. The midshelf mudbelt, however, is a particularly rich benthic habitat where biomass can attain 60 g/m^2 dry weight (Christie, 1974; see also Steffani 2007b). The comparatively high benthic biomass in this mudbelt region represents an important food source to carnivores such as the mantis shrimp, cephalopods and demersal fish species (Lane and Carter, 1999). In deeper water beyond this rich zone biomass declines to

6 Marine canyons identified by the international Deep Ocean project mapped them as lines. The lines were buffered by 5 km to include both the canyon and its associated adjacent ecosystems.

4.9 g/m^2 at 200 m depth and then is consistently low (<3 g/m^2) on the outer shelf (Christie, 1974).

FIGURE 4-32 PEL 82 IN RELATION TO THE NAMIBIAN BENTHIC HABITATS (TOP) AND THEIR ECOSYSTEM THREAT STATUS (BOTTOM).



Source: Holness et al. 2014

TABLE 4-6 ECOSYSTEM THREAT STATUS FOR MARINE HABITAT TYPES ON THE NAMIBIAN COAST (ADAPTED FROM HOLNESS ET AL. 2014)

Habitat Type	Threat Status	Area (km^2)
Namib Abyss	Least Threatened	800.93
Namib Lower Slope	Least Threatened	1,380.13
Namib Upper Slope	Least Threatened	590.66
Namaqua Shelf Edge	Endangered	44.40
Namaqua Outer Shelf	Least Threatened	175.29
Namaqua Inner Shelf	Least Threatened	69.48
Namaqua Inshore	Vulnerable	4.45
Namib Seamount	Least Threatened	26.83
Lüderitz Shelf Edge	Critically Endangered	87.55
Lüderitz Outer Shelf	Vulnerable	184.70
Lüderitz Inner Shelf	Least Threatened	62.91
Lüderitz Islands	Least Threatened	13.32
Central Namib Shelf Edge	Vulnerable	327.46
Central Namib Outer Shelf	Endangered	409.40
Central Namib Inner Shelf	Least Threatened	382.44
Kuiseb Inshore	Least Threatened	29.11
Hoanib Inshore	Least Threatened	7.85
Cunene Abyss	Least Threatened	2,488.57
Cunene Lower Slope	Least Threatened	308.96
Cunene Upper Slope	Least Threatened	113.21
Cunene Shelf Edge	Vulnerable	116.62
Cunene Outer Shelf	Endangered	54.61
Cunene Inner Shelf	Least Threatened	43.75
Cunene Inshore	Least Threatened	10.18

Note: The habitats potentially affected by the potential well drilling are shaded. The threat status is based on regional assessment
Source: Holness et al. 2014

Whilst many empirical studies related community structure to sediment composition (e.g. Christie, 1974; Warwick et al., 1991; Yates et al., 1993; Desprez, 2000; van Dalfsen et al., 2000), other studies have illustrated the high natural variability of soft-bottom communities, both in space and time, on scales of hundreds of metres to metres (e.g. Kenny et al., 1998; Kendall and Widdicombe, 1999; van Dalfsen et al., 2000; Zajac et al., 2000; Parry et al., 2003), with evidence of mass mortalities and substantial recruitments (Steffani and Pulfrich, 2004a). It is likely that the distribution of marine communities in the mixed deposits of the coastal zone is controlled by complex interactions between physical and biological factors at the sediment–water interface, rather than by the granulometric properties of the sediments alone (Snelgrove and Butman, 1994; Seiderer and Newell, 1999). For example, off central Namibia it is likely that periodic intrusion of low oxygen water masses is a major cause of this variability (Monteiro and van der Plas, 2006; Pulfrich et al., 2006). Although there is a poor understanding of the responses of local continental shelf macrofauna to low oxygen conditions, it is safe to assume that in areas of frequent oxygen deficiency the communities will be characterised by species able to survive chronic low oxygen conditions, or colonising and fast-growing species able to rapidly recruit into areas that have suffered complete oxygen depletion. Local hydrodynamic conditions, and patchy settlement of larvae, will also contribute to small-scale variability of benthic community structure.

It is evident that an array of environmental factors and their complex interplay is ultimately responsible for the structure of benthic communities. Yet the relative importance of each of these factors is difficult to determine as these factors interact and combine to define a distinct habitat in which the animals occur. However, it is clear that water depth and sediment composition are two of the major components of the physical environment determining the macrofauna community structure off the west coast of southern Africa (Steffani and Pulfrich, 2004a, 2004b, 2007; Steffani, 2007a, 2007b, 2009a, 2009b, 2009c, 2010). However, in the deepwater shelf areas off central and Northern Namibia, the occurrence of Oxygen Minimum Zones (OMZs), the periodic intrusion of low oxygen water masses and diffusive hydrogen sulphide flux have been found to play a major role in determining variability in community structure (Monteiro and van der Plas, 2006; Zettler et al., 2009, 2013; Eisenbarth and Zettler, 2016; Amorim and Zettler, 2023).

Specialised benthic assemblages (protozoans and metazoans) can thrive in OMZs (Levin, 2003) and many organisms have adapted to low oxygen conditions by developing highly efficient ways to extract oxygen from depleted water. Within OMZs, benthic foraminiferans, meiofauna and macrofauna typically exhibit high dominance and relatively low species richness. In the OMZ core, where oxygen concentration is lowest, macrofauna and megafauna (>10 cm) often have depressed densities and low diversity, despite being able to form dense aggregations at OMZ edges (Levin, 2003; Levin et al., 2009). Taxa most tolerant of severe oxygen depletion (~0.2 ml/l) include calcareous foraminiferans, nematodes, and polychaetes, with agglutinated protozoans, harpacticoid copepods, and calcified invertebrates typically being less tolerant. Small-bodied animals, with greater surface area for O_2 adsorption, are thought to be more prevalent than large-bodied taxa under conditions of permanent hypoxia as they are better able to cover their metabolic demands and often able to metabolise anaerobically (Levin, 2003). Meiofauna may thus increase in dominance in relation to macro- and megafauna. This was not the case, however, within the lower OMZs of the Oman (Levin et al. 2000) and Pakistan margins (Levin et al., 2009), where the abundant food supply in the lower or edge OMZs is thought to be responsible for promoting larger macrofaunal body size.

There is a poor understanding of the responses of local continental shelf macrofauna to low oxygen conditions, as very little is known about the benthic fauna specific to the Namibian OMZ. It is safe to assume that in areas of frequent oxygen deficiency the communities will be characterised by species able to survive chronic low oxygen conditions, or colonising and fast-growing species able to rapidly recruit into areas that have suffered complete oxygen depletion. Local hydrodynamic conditions, and patchy settlement of larvae, will also contribute to small-scale variability of benthic community structure.

Data collected from between 150 m and 300 m depth offshore of the area between Meob Bay and Conception Bay showed that overall species richness of benthic macrofauna assemblages was relatively low and strongly dominated by polychaetes, particularly the spionid polychaete Paraprionospio pinnata. This species is dominant in oxygen-constrained environments worldwide. Crustaceans were poorly represented, both in terms of abundance and biomass (Steffani, 2011). The phyla distribution is generally in common with other OMZs around the world.

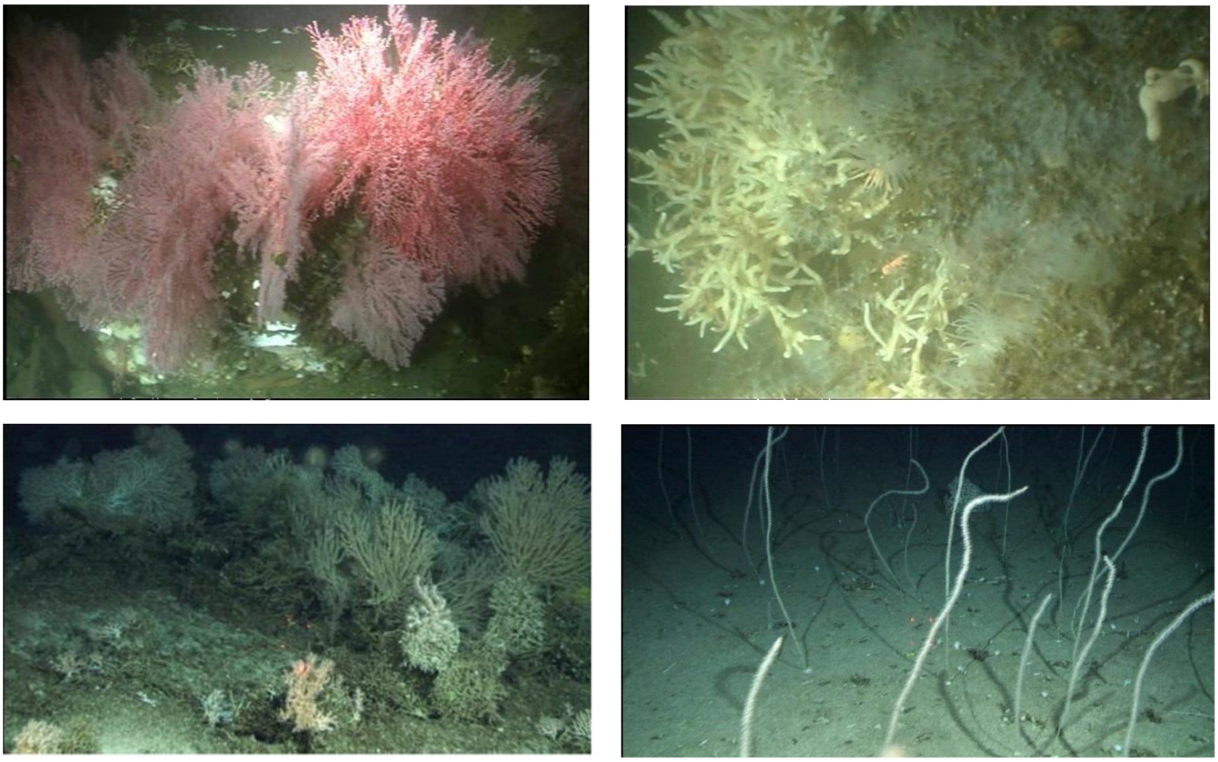
In contrast, Amorim and Zettler (2023), who studied the distribution of macrofaunal assemblages between 17°S and 25°S latitudes and between 25 m and 1,523 m water depth off northern Namibia, reported that the Namibian benthic macrofauna, in general, shows high total biomasses and high representativeness of molluscs compared to OMZs worldwide. Deep communities tended to show high diversity but low biomass. A further study that sampled stations between 30 m to 2,513 m depth at 20°S found 5 different communities along the depth gradient with three shelf communities, one continental margin community and one deep-sea community. Species richness was highest along the continental margin between 400 and 1,300 m water depth. Polychaetes and molluscs contributed most to the biomass on the shelf (Eisenbarth and Zettler, 2016). These authors concluded that macrozoobenthic diversity off northern Namibia is strongly affected by temporary oxygen deficiency.

Also associated with soft-bottom substrates are demersal communities that comprise epifauna and bottom-dwelling invertebrate and vertebrate species, many of which are dependent on the invertebrate benthic macrofauna as a food source. An invertebrate demersal species of commercial importance in Namibia is the deep sea red crab *Chaceon maritae*, which occurs at depths of 300-1,000 m along the entire west coast of Africa from West Sahara to central Namibia. In Namibia, densities are highest between the Kunene and latitude 18°S. Larger animals tend to occur more frequently between latitudes 20° - 23°S, where densities are lower. The species is slow-growing taking up to 25-30 years to reach maximum size. Females occur at depths of 350-500 m, whereas males become more dominant in deeper water (Le Roux, 1998). Spawning occurs throughout the year.

4.3.5.2 DEEP-WATER CORAL COMMUNITIES

There has been increasing interest in deep-water corals in recent years because of their likely sensitivity to disturbance and their long generation times. These benthic filter-feeders generally occur at depths exceeding 150 m. Some species form reefs while others are smaller and remain solitary. Corals add structural complexity to otherwise uniform seabed habitats thereby creating areas of high biological diversity (Breeze et al., 1997; MacIssac et al., 2001). Deep water corals establish themselves below the thermocline where there is a continuous and regular supply of concentrated particulate organic matter, caused by the flow of a relatively strong current over special topographical formations which cause eddies to form. Nutrient seepage from the substratum might also promote a location for settlement (Hovland et al., 2002). Substantial shelf areas in the productive Benguela region should thus potentially be capable of supporting rich, cold water, benthic, filter-feeding communities. Such communities would also be expected with topographic features such as the Walvis Ridge (and its associated seamounts) to the north and west of PEL 82 (Figure 4-33). The high habitat heterogeneity of the ridge supports moderately diverse biological communities, including benthic macrofauna such as brachiopods, sponges, octocorals, deep-water hexacorals, gastropods, bivalves, polychaetes, bryozoans, cirriped crustaceans, basket stars, ascidians, isopods and amphipods (GEOMAR, 2014), which are assumed to extent along the full extent of the ridge. The Ridge as a whole remains largely unexplored. Productivity along Walvis Ridge increases from SW to NE, with sediment organic carbon and the abundance and diversity of phytoplankton communities increasing towards the Namibian shelf. This is thought to reflect patterns of nutrient transport and upwelling in the north-flowing Benguela Current that are more intense closer to the African continent (GEOMAR, 2014).

FIGURE 4-33 TOP: GORGONIANS RECORDED ON DEEP-WATER REEFS (100-120 M) OFF THE SOUTHERN AFRICAN WEST COAST. BOTTOM: VME INDICATOR SPECIES RECORDED FROM THE WALVIS RIDGE



Source: De Beers Marine and Ramil & Gil 2015

4.3.5.3 DEMERSAL FISH SPECIES

Up to 110 fish species inhabit the demersal communities on the southern African West Coast continental shelf (Roel, 1987). Changes in fish communities occur with increasing depth (Roel 1987; Smale *et al*. 1993; MacPherson and Gordoa 1992; Bianchi *et al*. 2001; Atkinson 2009), with the most substantial change in species composition occurring in the shelf break region between 300 m and 400 m depth (Roel 1987; Atkinson 2009). Common commercial species include shallow-water hake (*Merluccius capensis*), deep-water hake (*Merluccius paradoxus*), monkfish (*Lophius vomerinus*), and kingklip (*Genypterus capensis*), alongside various bycatch species and cephalopods (Compagno et al., 1991). Roel (1987) showed seasonal variations in the distribution ranges shelf communities, with species such as the pelagic goby (*Sufflogobius bibarbatus*), and West Coast sole (*Austroglossus microlepis*) occurring in shallow water during summer only. Atkinson (2009) identified two long-term community shifts in demersal fish communities; the first (early to mid-1990s) being associated with an overall increase in density of many species, whilst many species decreased in density during the second shift (mid-2000s). These community shifts correspond temporally with regime shifts detected in environmental forcing variables (Sea Surface Temperatures and upwelling anomalies) (Howard *et al*. 2007) and with the eastward shifts observed in small pelagic fish species and rock lobster populations (Coetzee *et al*. 2008, Cockcroft *et al*. 2000).

4.3.5.4 SEAMOUNT COMMUNITIES

Features such as banks, knolls and seamounts (referred to collectively here as 'seamounts'), which protrude into the water column, are subject to, and interact with, the water currents surrounding them. The effects of such seabed features on the surrounding water masses can include the up-welling of relatively cool, nutrient-rich water into nutrient-poor surface water thereby resulting in higher productivity (Clark *et al.* 1999), which can in turn strongly influences the distribution of organisms on and around seamounts. Evidence of enrichment of bottom-associated communities and high abundances of demersal fishes has been regularly reported over such seabed features.

The enhanced fluxes of detritus and plankton that develop in response to the complex current regimes lead to the development of detritivore-based food-webs, which in turn lead to the presence of seamount scavengers and predators. Seamounts provide an important habitat for commercial deepwater fish stocks such as orange roughy, oreos, alfonsino and Patagonian toothfish, which aggregate around these features for either spawning or feeding (Koslow 1996).

Such complex benthic ecosystems in turn enhance foraging opportunities for many other predators, serving as mid-ocean focal points for a variety of pelagic species with large ranges (turtles, tunas and billfish, pelagic sharks, cetaceans and pelagic seabirds) that may migrate large distances in search of food or may only congregate on seamounts at certain times (Hui 1985; Haney *et al.* 1995). Seamounts thus serve as feeding grounds, spawning and nursery grounds and possibly navigational markers for a large number of species (SPRFMO 2007).

Enhanced currents, steep slopes and volcanic rocky substrata, in combination with locally generated detritus, favour the development of suspension feeders in the benthic communities characterising seamounts (Rogers 1994). Deep- and cold-water corals (including stony corals, black corals and soft corals) are a prominent component of the suspension-feeding fauna of many seamounts, accompanied by barnacles, bryozoans, polychaetes, molluscs, sponges, sea squirts, basket stars, brittle stars and crinoids (reviewed in Rogers 2004). There is also associated mobile benthic fauna that includes echinoderms (sea urchins and sea cucumbers) and crustaceans (crabs and lobsters) (reviewed by Rogers 1994). Some of the smaller cnidarians species remain solitary while others form reefs thereby adding structural complexity to otherwise uniform seabed habitats. The coral frameworks offer refugia for a great variety of invertebrates and fish (including commercially important species) within, or in association with, the living and dead coral framework thereby creating spatially fragmented areas of high biological diversity. Compared to the surrounding deep-sea environment, seamounts typically form biological hotspots with a distinct, abundant and diverse fauna, many species of which remain unidentified. Consequently, the fauna of seamounts is usually highly unique and may have a limited distribution restricted to a single geographic region, a seamount chain or even a single seamount location (Rogers *et al.* 2008). Levels of endemism on seamounts are also relatively high compared to the deep sea. As a result of conservative life histories (*i.e*. very slow growing, slow to mature, high longevity, low levels of recruitment) and sensitivity to changes in environmental conditions, such biological communities have been identified as Vulnerable Marine Ecosystems (VMEs). They are recognised as being particularly sensitive to anthropogenic disturbance (primarily deep-water trawl fisheries and mining), and once damaged are very slow to recover, or may never recover (FAO 2008).

It is not always the case that seamount habitats are VMEs, as some seamounts may not host communities of fragile animals or be associated with high levels of endemism. Evidence from video footage taken on hard-substrate habitats in 100 - 120 m depth off southern Namibia suggest that vulnerable communities including gorgonians, octocorals and reef-building sponges occur on the continental shelf. Similar communities have been reported on the seamounts associated with the Walvis Ridge, with *Lophelia*, gorgonian and bamboo corals being among those which have been discovered growing at various heights on the seamounts Ramil & Gil (2015) reported that VME indicators have been located in all seamounts prospected but differences in structure and development state were observed. In some seamounts coral rubble, sediment-clogged, mostly dead coral framework and living coral framework were observed from the base to the summit all along the slope.

4.3.6 SEABIRDS

The Namibian coastline sustains large populations of breeding and foraging seabird and shorebird species, which require suitable foraging and breeding habitats for their survival. In total, 11 species of seabirds are known to breed along the Namibian coast (Table 4-7). Most seabirds breeding in Namibia are restricted to areas where they are safe from land predators, although some species are able to breed on the mainland coast in inaccessible places. In general most breed on the islands off the southern Namibian coast, or on the man-made guano platforms in Walvis Bay, Swakopmund and Cape Cross, approximately 272 km to the southeast and 120 km to the east of PEL 82, respectively. The southern Namibian islands and guano platforms therefore provide a vital breeding habitat to most species of seabirds that breed in Namibia. However, the number of successfully breeding birds at the particular breeding sites varies with food abundance (J. Kemper, MFMR Lüderitz, pers. comm.). With the exception of Kelp Gull and White-breasted Cormorants all the breeding are listed in the threatened categories in Namibia.

Most of the seabird species breeding in Namibia feed relatively close inshore (10-30 km), although exceptions occur (Ludynia et al., 2012), particularly when birds are forced to alter their dispersal patterns in response to environmental change (Sherley et al., 2017). Cape Gannets (Figure 4-34, left), however, are known to forage up to 140 km offshore (Dundee, 2006; Ludynia, 2007) (Figure 4-35) and African Penguins (Figure 4-34, right) have also been recorded as far as 60 km offshore (Ludynia et al., 2012). The closest Cape Gannet and African penguin colonies to PEL 82 are at Mercury and Ichaboe Islands some 345 km and 460 km to the southeast, with smaller penguin colonies reported at Hollamsbird Island, at the caves at Sylvia Hills and Oyster Cliffs and on Neglectus Islet. As the project area is ~72 km offshore at its closest point and north of the northern-most islands, encounters with these species during exploration drilling operations in PEL 82 is likely to be rare.

TABLE 4-7 NAMIBIAN BREEDING SEABIRD SPECIES WITH THEIR NAMIBIAN AND IUCN CLASSIFICATION

Species	Namibian	Global IUCN
*African Penguin Spheniscus demersus	Endangered	Endangered
*Bank Cormorant Phalacrocorax neglectus	Endangered	Endangered
*Cape Cormorant Phalacrocorax capensis	Endangered	Endangered
*Cape Gannet Morus capensis	Critically Endangered	Endangered
*Crowned Cormorant Microcarbo coronatus	Near Threatened	Near Threatened
*African Black Oystercatcher Haematopus moquini	Near Threatened	Near Threatened
White-breasted cormorant Phalacrocorax lucidus	Least Concern	Least Concern
Kelp Gull Larus dominicanus	Least Concern	Least Concern
*Hartlaub's Gull Chroicocephalus hartlaubii	Vulnerable	Least Concern
Caspian Tern Hydroprogne caspia	Vulnerable	Least Concern
*Greater Crested (Swift) Tern Thallaseus bergii bergii	Least Concern	Least Concern
*Damara Tern Sternula balaenarum	Near Threatened	Vulnerable

Notes:
In the IUCN scheme Endangered is a more extinction-prone class than Vulnerable, and differences between Namibia and global classifications are the result of local population size, and the extent and duration of declines locally.

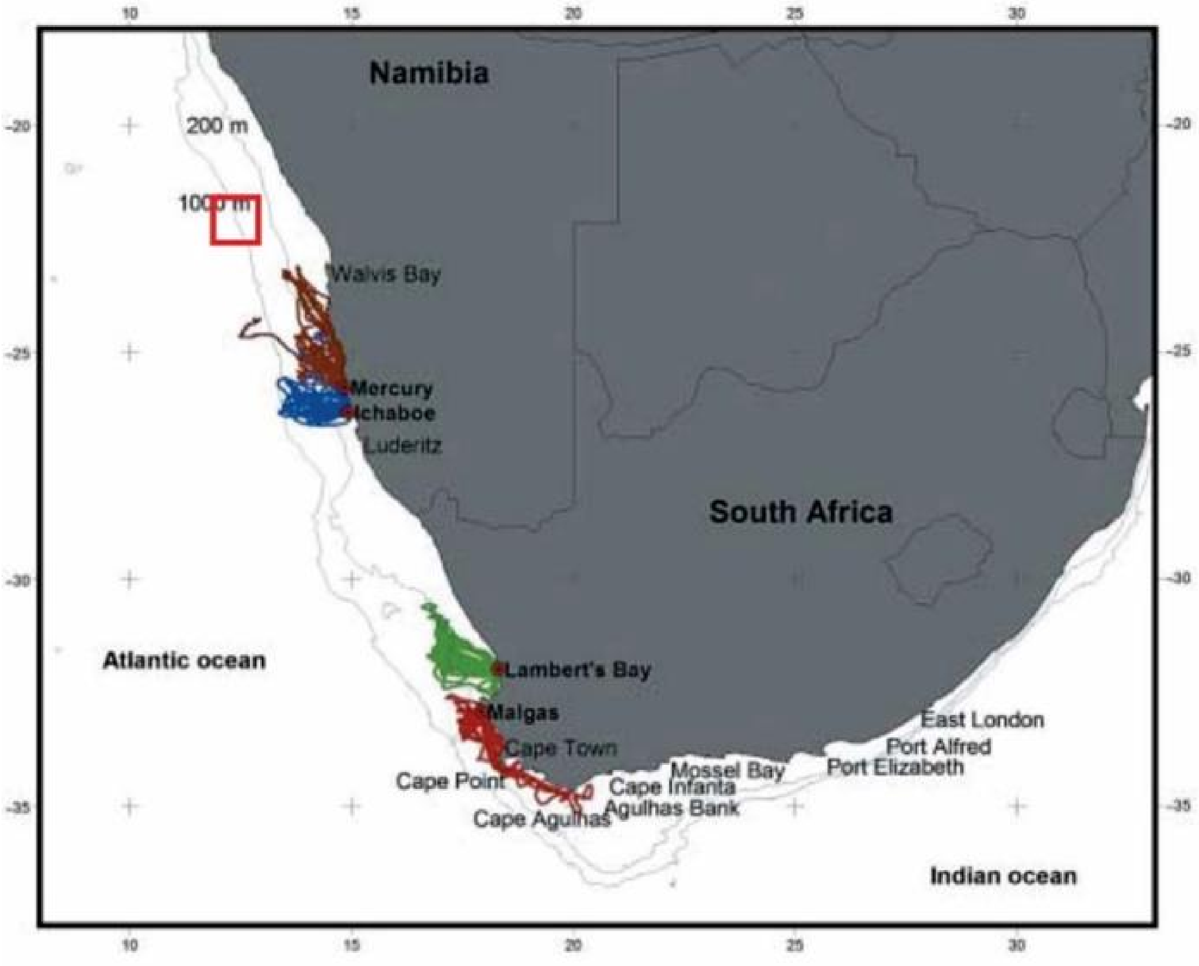
Source: Kemper et al. 2007; Simmons et al. 2015

FIGURE 4-34 CAPE GANNETS MORUS CAPENSIS (LEFT) AND AFRICAN PENGUINS SPHENISCUS DEMERSUS (RIGHT)

Breed primarily on the offshore islands.

Source: NACOMA, 2025

FIGURE 4-35 PEL 82 (RED POLYGON) IN RELATION TO GPS TRACKS RECORDED FOR 93 CAPE GANNETS FORAGING OFF FOUR BREEDING COLONIES IN SOUTH AFRICA AND NAMIBIA



Source: Grémillet et al. 2008

Other Red-listed species found foraging, or roosting along the coastline of southern and central Namibia are listed in Table 4-8. Among the other species present off Namibia's coast there are at least nine species of albatrosses, petrels or giant-petrels recorded (Boyer and Boyer, 2015, Benthic Solutions Ltd, 2019). However, none of these species breed in Namibia, and the numbers foraging in Namibian waters are poorly known, although some tracking data are available (Figure 4-36). Forty-nine species of pelagic seabirds have been recorded in the region, of which 14 are resident. Highest pelagic seabird densities occur offshore of the shelf-break in winter. Pelagic seabirds potentially encountered in PEL 82 are provided in Table 4-8.

In central Namibia, the 30 km long shoreline between Walvis Bay and Swakopmund has the highest linear count of birds in southern Africa at ~450 birds/km with totals exceeding 13,000 shorebirds of 31 species, most of which are Palearctic migrants (Simmons et al., 1999; Molloy and Reinikainen 2003). Individual 10 km sections, peak even higher at 770 birds/km. Birds reported from the 30 km stretch of coast between Walvis Bay and Swakopmund include African Black Oystercatcher, Kelp Gull, Cape cormorant, Turnstone (*Arenaria interpres*), Curlew

Sandpiper (*Calidris ferruginea*), Grey plover (*Pluvialis squatarola*), Swift Tern, Damara tern and Common Tern (*Sterna hirundo*) (Simmons et al. 1999).

TABLE 4-8 OTHER RED-LISTED BIRD SPECIES THAT OCCUR IN NAMIBIA, WITH THEIR NAMIBIAN AND IUCN CLASSIFICATION

Species	Namibian	Global IUCN
Tristan Albatross Diomedea dabbenena	Critically Endangered	Critically Endangered
Atlantic Yellow-nosed Albatross Thalassarche chlororhynchos	Endangered	Endangered
Black-browed Albatross Thalassarche melanophrys	Endangered	Least Concern
Wandering Albatross Diomedea exulans	Vulnerable	Vulnerable
Shy Albatross Thalassarche cauta	Near Threatened	Near Threatened
White-capped Albatross Thalassarche sneadi	Near Threatened	Near Threatened
Spectacled Petrel Procellaria conspicillata	Vulnerable	Vulnerable
Northern Giant-Petrel Macronectes halli	Near Threatened	Least Concern
Southern Giant-Petrel Macronectes giganteus	Not listed	Least Concern
Cape (Pintado) Petrel Daption capense	Not listed	Least Concern
Kerguelen Petrel Aphrodroma brevirostris	Not listed	Least Concern
Great-winged Petrel Pterodroma macroptera	Not listed	Least Concern
Soft-plumaged Petrel Pterodroma mollis	Not listed	Least Concern
White-chinned Petrel Procellaria aequinoctialis	Vulnerable	Vulnerable
Leach's Storm-Petrel Oceanodroma leucorhoa	Not listed	Vulnerable
Wilson's Storm-Petrel Oceanites oceanicus	Not listed	Least Concern
European Storm-Petrel Hydrobates pelagicus	Not listed	Least Concern
Sabine's Gull Xema sabini	Not listed	Least Concern
Arctic Tern Sterna paradisaea	Not listed	Least Concern
Red Phalarope Phalaropus fulicarius	Not listed	Least Concern
Brown (Sub-Antarctic) Skua Catharacta antarctica	Not listed	Least Concern
Pomarine Jaeger (Skua) Stercorarius pomarinus	Not listed	Least Concern
Antarctic Prion Pachyptila desolata	Not listed	Least Concern

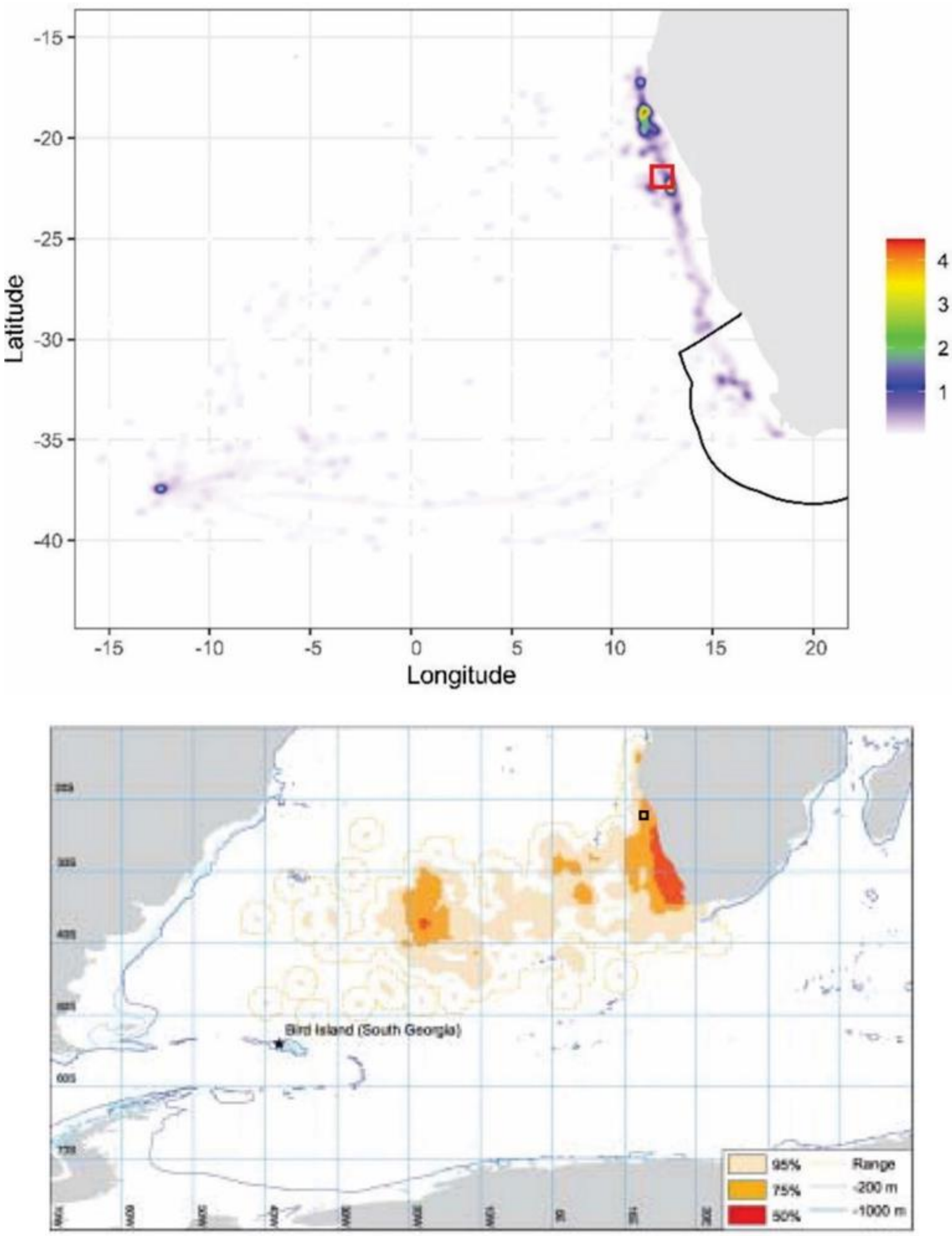
Species	Namibian	Global IUCN
Long-Tailed Jaeger (Skua) Stercorarius longicaudus	Not listed	Least Concern
Sooty Shearwater Ardenna grisea	Near Threatened	Near Threatened
Cory's Shearwater Calonectris borealis	Not listed	Least Concern
Scopoli's Shearwater Calonectris diomedea	Not listed	Least Concern
Manx Shearwater Puffinus puffinus	Not listed	Least Concern
Great Shearwater Ardenna gravis	Not listed	Least Concern
Notes: In the IUCN scheme 'Endangered' is a more extinction-prone class than 'Vulnerable', and differences between Namibia and global classifications are the result of local population size and importance, and the extent and duration of declines locally / globally.		

Source: Kemper et al., 2007; Simmons et al., 2015; IUCN 2025

The coastline between Walvis Bay and Cape Cross also boasts three man-made guano platforms: "Bird Rock" north of Walvis Bay is 200 m offshore, whereas those north of Swakopmund and at Cape Cross have been erected in salt pans. The platforms are unique in the world and produce about 2,500 tons of guano per season. About 99% of the birds occurring on the platforms are Cape Cormorants, although White-breasted Cormorants, Crowned Cormorants and Great White Pelicans also breed on the platforms.

The Kunene River mouth and its estuary at the border with Angola also serves as an extremely important wetland for coastal birds, particularly the near threatened Damara Tern, which has been recorded in high numbers (2,000 – 5,000) within and to the south of the mouth.

FIGURE 4-36 PEL 82 (RED AND BLACK POLYGONS) IN RELATION TO THE UTILIZATION DISTRIBUTION OF INCUBATING ATLANTIC YELLOW-NOSED ALBATROSSES FROM GOUGH ISLAND (TOP), SOUTHERN OCEAN, AND BLACK-BROWED ALBATROSS FROM BIRD ISLAND, SOUTH GEORGIA (BOTTOM)



Source: BIRDLIFE AFRICA 2004, 2022

4.4 OTHER USES OF THE POTENTIAL LICENSE AREA

4.4.1 BENEFICIAL USES

The license area is located well offshore at depths beyond 200 m. Other users of the area include the commercial fishing industry (see Specialist Report on Fisheries), and oil and gas license area holders. In Namibia various restrictions apply to areas permittable to commercial fisheries. No trawling or long-lining is permitted inshore of the 200 m depth contour, and south of 25°S no freezer trawlers or hake trawlers are permitted inshore of the 350 m depth contour. Marine mining (diamonds and marine phosphates) concessions and Exclusive Prospecting License areas (EPLs) are located inshore of PEL 82 (Figure 4-37). Current activities in the EPLs are minimal to non-existent, the only active operations being diamond mining south of Lüderitz. Recreational use of the coastline and inshore areas is negligible and restricted primarily to the area around Henties Bay, Swakopmund, Walvis Bay and Lüderitz, all of which lie well inshore and to the southeast of PEL 82. Recreational activities offshore of the Namib-Naukluft and the Skeleton Coast National Park are similarly limited.

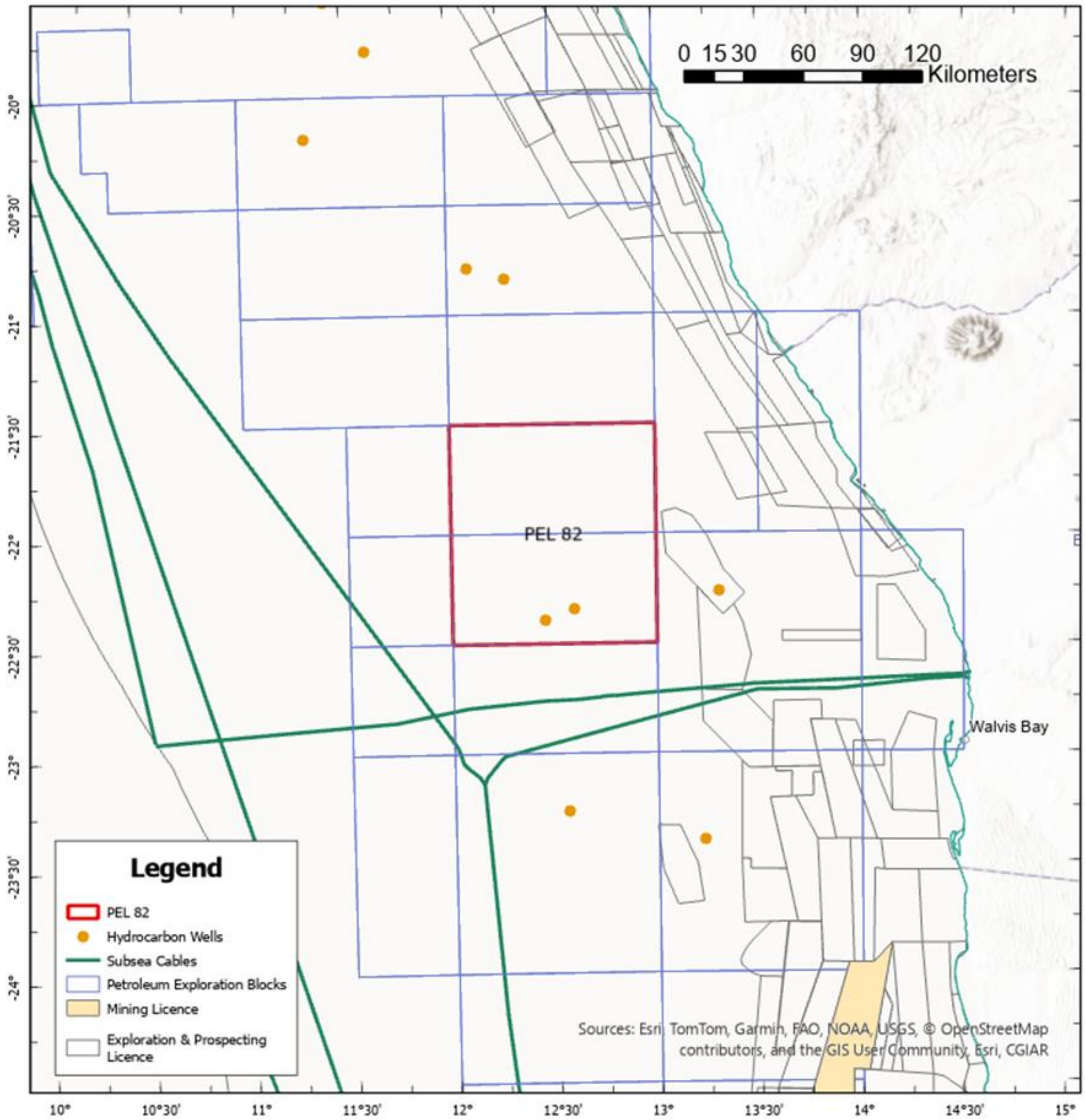
The main shipping lanes around southern Africa lie seawards of PEL 82, however, the license area lies within the main trawling lanes and traffic routes into and out of Walvis Bay. Both coastal shipping and fishing craft may therefore be encountered in the license area, particularly the eastern portion of PEL 82 (Figure 4-38).

Various subsea telecommunications cable traverse across the Namibian EEZ, of which two come ashore at Swakopmund. These cables, however all lie south and offshore of PEL 82.

Other current and proposed industrial uses of the marine environment include the intake of cooling water for power plants, intake of feed-water for desalination plants, and seawater intakes for fish processing, or mariculture operations. There is also limited guano harvesting on the guano platforms and salt production in Walvis Bay, Swakopmund and at Cape Cross. These activities are all located well inshore of PEL 82 and should in no way be affected by offshore well-drilling activities.

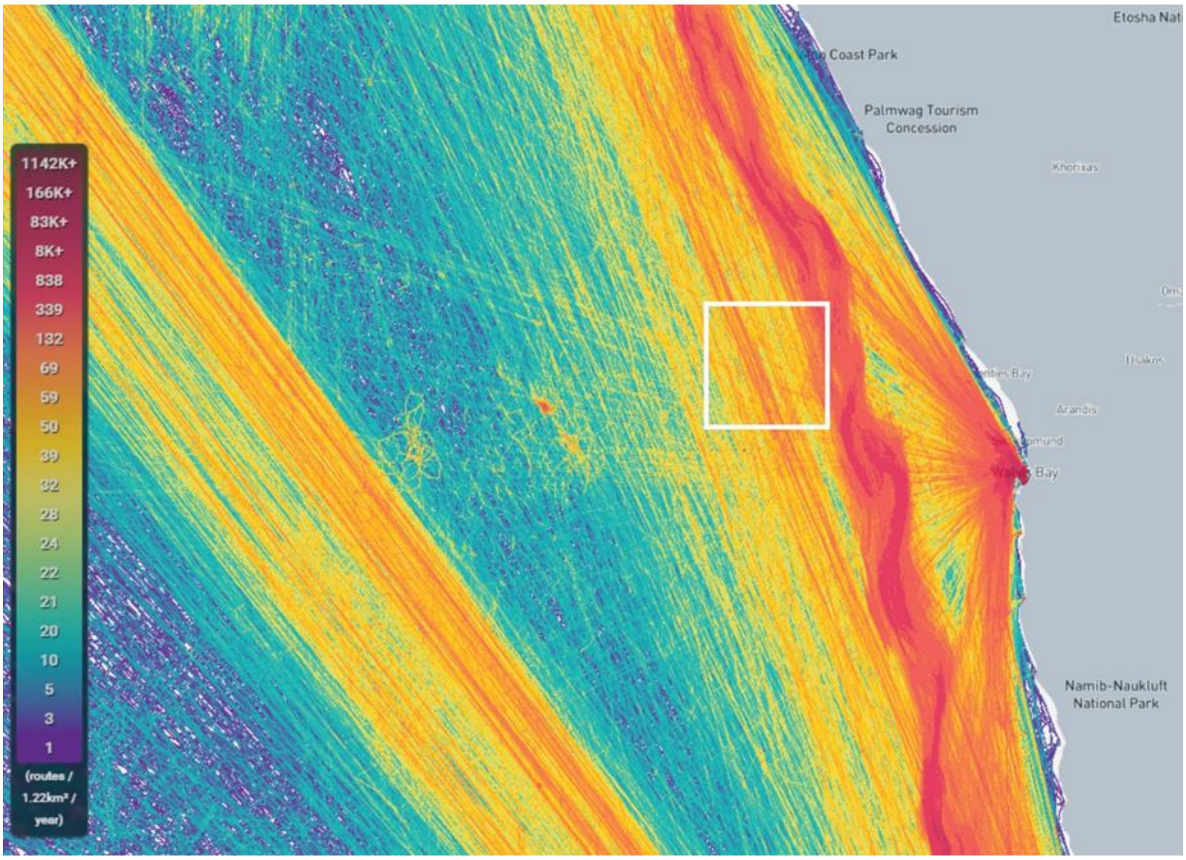
Mariculture activities are being conducted at an increasing scale in Walvis Bay, and at present there are over 20 companies engaged in cultivation of Pacific oyster (*Crassostrea gigas*) and European flat oyster (*Ostrea edulis*) in the bay. Oyster cultivation is also conducted in the feed-water ponds of the Walvis Bay and Swakopmund salt works. These various mariculture activities should likewise not be affected in any way by offshore exploration well-drilling.

FIGURE 4-37 MARINE DIAMOND MINING CONCESSIONS AND OTHER USERS OF THE MARINE ENVIRONMENT IN THE PROJECT AREA



Source: Chamber of Mines, 2024

FIGURE 4-38 PEL 82 (WHITE POLYGON) IN RELATION TO OFFSHORE VESSEL TRAFFIC



Source: Marine Traffic, 2025

4.4.1.1 OVERVIEW OF NAMIBIAN FISHERIES

The Namibian fishing industry is a major contributor to the country's Gross Domestic Product (GDP), ranking among the top ten fishing countries globally (FAO, 2022). Supported by the high productivity of the Benguela upwelling ecosystem, abundant fish stocks have historically supported intensive commercial fisheries in Namibia. Although varying in importance at different times in history, Namibian fisheries have focused on demersal species, small pelagic species, large migratory pelagic fish, line-fish (caught both commercially and recreationally) and crustacean resources (e.g. lobster and crabs). Mariculture production is a developing industry based predominantly in Walvis Bay and Lüderitz Bay. The management of fish stocks for commercial purposes is overseen by the Ministry of Fisheries and Marine Resources (MFMR), which receives guidance from the National Marine Information and Research Centre (NatMIRC) in Swakopmund under the Ministry.

The Confederation of Namibian Fishing Industries represents commercial fisheries at the industry level, whilst sector-specific associations, such as the Namibian Hake Association and the Pelagic Fishing Association of Namibia, represent different fish species.

To preserve marine ecosystems, there is a strict prohibition on bottom trawling shallower than 200 m, enforced by Namibian regulations. Monitoring of adherence to these restrictions is undertaken by the Namibian compliance units and their Vessel Monitoring System (VMS).

Namibia has only two major fishing ports from which all the main commercial fishing operations are based namely, Walvis Bay and Lüderitz. In central Namibia, the major port is Walvis Bay, and it is from this port that the majority of fishing vessels operate. Most of the fishing conducted from this port is, for economic and logistical reasons, directed at fishing grounds in the central and northern part of Namibia and to a lesser extent the southerly fishing grounds towards the South African border.

Key species caught by Namibian fisheries include sardine, cape horse mackerel, hake, monkfish, deep-sea crab, orange roughy, rock lobsters, and various large pelagic species (tuna, shark, swordfish).

Commercial fishing sectors in Namibia include:

- Large pelagic longline;
- Small pelagic purse-seine;
- Mid-water trawl;
- Demersal trawl;
- Demersal longline;
- Tuna pole-line;
- Linefish;
- Deep-sea crab;
- Deep-water trawl; and
- Rock lobster.

Each sector is described in detail within the Specialist Report on Fisheries (Appendix G). Hake is the most commercially important sector within the Namibian context. Cape horse mackerel is the largest sector by catch volume and the second highest contributor by value to the Namibian fishing industry.

MFMR conducts regular research (biomass) surveys for demersal, mid-water and small pelagic species. In some years the Benguela Current Commission may conduct “transboundary” surveys. Swept-area biomass surveys for hake are conducted annually to obtain an index of abundance, determine the geographical distribution and collect biological information of the stock. Scientific acoustic surveys are carried out each year to estimate the biomass of small pelagic species. These surveys cover the Namibian shelf from the coastline to the 500 m depth contour (and up to the 2000 m contour northwards of 18°30´S).

4.4.2 CONSERVATION AREAS AND MARINE PROTECTED AREAS

4.4.2.1 NATIONAL PARKS

Inshore of PEL 82, the coastline of Namibia is part of a continuum of protected areas that stretch along the entire Namibian coastline, a distance of about 1,570 km, from Southern Angola into Namaqualand in South Africa. Recently proclaimed as the Namib-Skeleton Coast National Park it incorporates four terrestrial Management Areas, namely the Skeleton Coast National Park, the Dorob National Park, the Namib-Naukluft National Park and the Tsau//Khaeb-Sperrgebiet National Park (refer to Figure 4-41). The Namib-Skeleton Coast National Park is the 8th largest protected area in the world, the 6th largest terrestrial protected area globally and the largest park in Africa, covering an area of 107,540 km.

Of the three designated coastal Ramsar sites in Namibia, the Walvis Bay wetlands and Sandwich Harbour fall within the broader project area and are described briefly below.

The Walvis Bay Wetland is one of the most important coastal wetlands in Southern Africa. As the largest single area of shallow sheltered water along the Namibian coastline, it encompasses the lagoon and mudflats exposed at low tide, and sandbars serving as roosting and feeding sites for resident and migratory birds, Paaltjies beach on the Pelican Point peninsula, the Walvis Bay saltworks, and sand dunes and gravel fields extending to the boundary of the Namib-Naukluft Park (Barnard, 1998; www.nacoma.org.na). The estimated total area for these wetlands is 35 - 40 km^2. It was proclaimed a Ramsar site in 1995.

Sandwich Harbour, located 55 km south of Walvis Bay, is one of southern Africa’s richest and most unique coastal wetlands. Situated within the Namib-Naukluft Park, the area consists of two distinct parts. Firstly, a northern saltmarsh and adjoining intertidal sand flat area (5 km x 300 m), which supports emergent freshwater vegetation (37 species) and 4,000 – 5,500 wetlands birds. The more extensive (40 km^2) southern area of unvegetated tidal mudflats and raised shingle bars supports up to 175,000 birds, mainly waders, terns, pelicans and flamingos. Although the area is not directly associated with a river, water from an inland aquifer seeps into the northern portion of Sandwich Harbour, filling the lagoon and sustaining freshwater vegetation at the base of the dunes. Also 36 species of fish and eight Namibian Red Data bird species can be found at Sandwich Harbour.

The Namib-Naukluft National Park has an area of 49,800 km^2 and encompasses part of the Namib Desert, the Naukluft mountain range, Sandwich Harbour and Sossusvlei, which is a main visitor attraction in Namibia.

4.4.2.2 MARINE SANCTUARIES

Sanctuaries are considered a type of management area within Namibia's multi-purpose National Park and MPA network in which access and/or resource use is prohibited.

The Lüderitz Bay and Ichaboe Island Rock-Lobster Sanctuaries were proclaimed by South Africa in 1939 and 1951, respectively (Matthews and Smit, 1979), and subsequently maintained as reserves by MFMR after Namibian independence. There is no restriction on other activities within these reserves. These sanctuaries are well to the south of PEL 82.

4.4.2.3 MARINE PROTECTED AREAS

The first (and to date only) Namibian MPA was launched on 2 July 2009 under the Namibian Marine Resources Act (No. 29 of 1992 and No. 27 of 2000), with the purpose of protecting sensitive ecosystems and breeding and foraging areas for seabirds and marine mammals, as well as protecting important spawning and nursery grounds for fish and other marine resources (such as rock lobster). The MPA comprises a coastal strip extending from Hollamsbird Island (24°38´S) in the north, to Chamais Bay (27°57´S) in the south, spanning approximately three degrees of latitude and an average width of 30 km, including 16 specified offshore islands, islets and rocks (Currie et al., 2009). The Namibian Islands' Marine Protected Area (NIMPA) spans an area of 9,555 km², and includes a rock-lobster sanctuary constituting 478 km² between Chameis Bay and Prince of Wales Bay. The offshore islands, whose combined surface area amounts to only 2.35 km² have been given priority conservation and highest protection status (Currie et al., 2009). The area has been zoned into four degrees of incremental protection. These are detailed in Currie et al. (2009).

The NIMPA lies ~260 km southeast of PEL 82.

4.4.2.4 SENSITIVE AREAS

Despite the current lack of knowledge of the community structure and endemicity of southern African macro-infauna off the edge of the continental shelf, the spatial marine biodiversity assessment (Holness et al., 2014), rated the Namib upper and lower slope unconsolidated habitat types that characterise depths beyond 1.000 m, as being of 'Least concern' (Figure 4-32), reflecting the great extent of these habitats in the Namibian Exclusive Economic Zone (EEZ). However, those ecosystem types occurring along the shelf edge in the Central Namib biozone are considered 'Vulnerable, with those on the outer shelf rated as 'Endangered'. PEL 82 spans all three of these habitats.

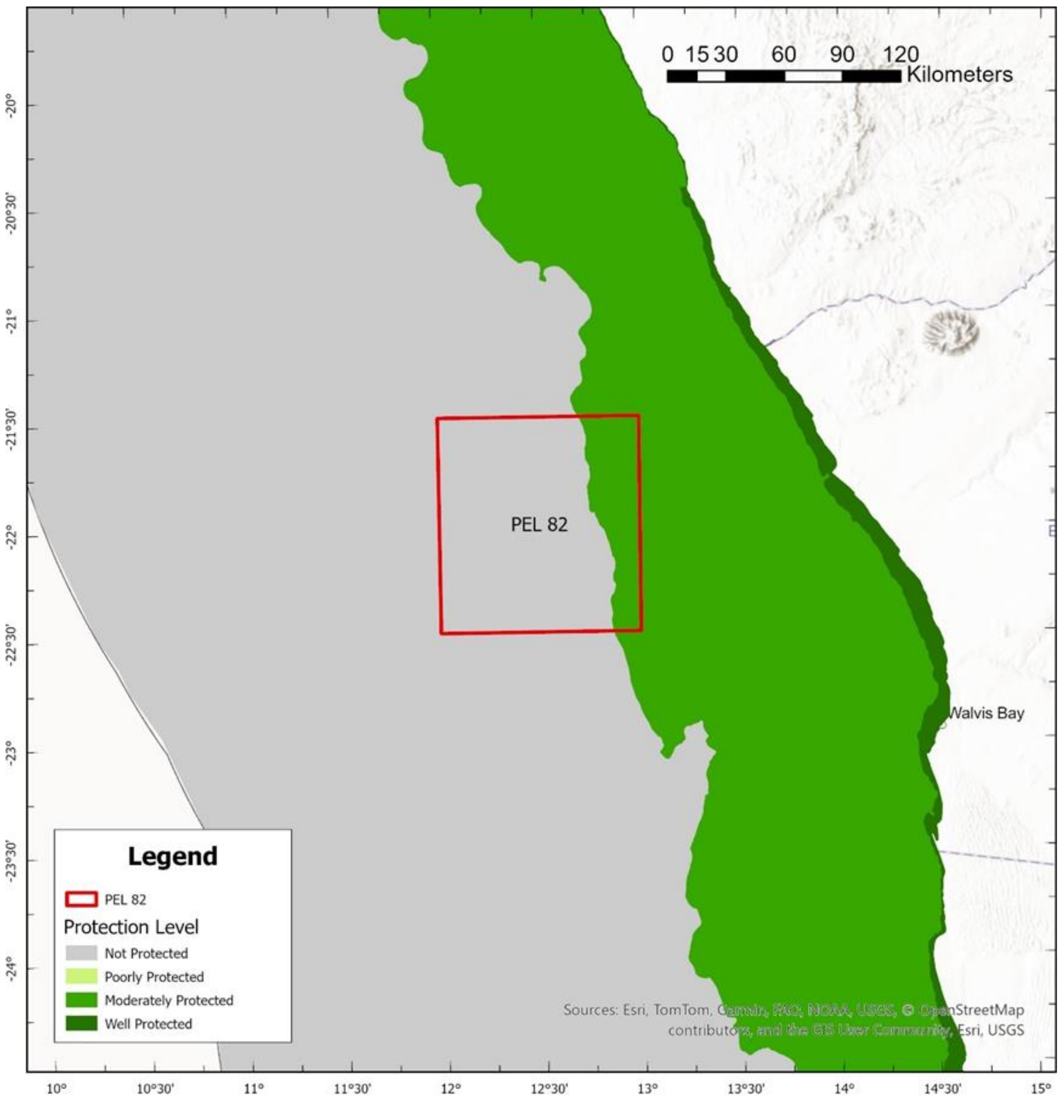
Despite the development of the offshore EBSAs a number of 'Vulnerable' ecosystem types in the broader project area are currently considered 'not well protected' or 'moderately protected' and further effort is needed to improve protection of these threatened ecosystem types (Holness et al., 2014) (Figure 4-39). Ideally, all highly threatened ('Critically Endangered' and 'Endangered') ecosystem types should be well protected. Currently, however, most of the upper and lower slope of the Namib biozone receives no protection at all, with the 'Endangered' Outer Shelf being 'moderately protected'. Most of PEL 82 lies within an area receiving no protection, with only the eastern portion being 'moderately protected'.

4.4.2.5 ECOLOGICALLY OR BIOLOGICALLY SIGNIFICANT AREAS

In the spatial marine biodiversity assessment undertaken for Namibia (Holness et al., 2014), a number of offshore and coastal area were identified as being of high priority for place-based conservation measures. To this end, Ecologically or Biologically Significant Areas (EBSA) spanning the coastline between Angola and South Africa were proposed and inscribed under the Convention of Biological Diversity (CBD). The principal objective of the EBSAs is identification of features of higher ecological value that may require enhanced conservation and management measures. No specific management actions have been formulated for the EBSAs at this stage and they carry no legal status. Any future decisions in relation to management of the areas and possible restrictions of human activities are within the mandate of the responsible authorities.

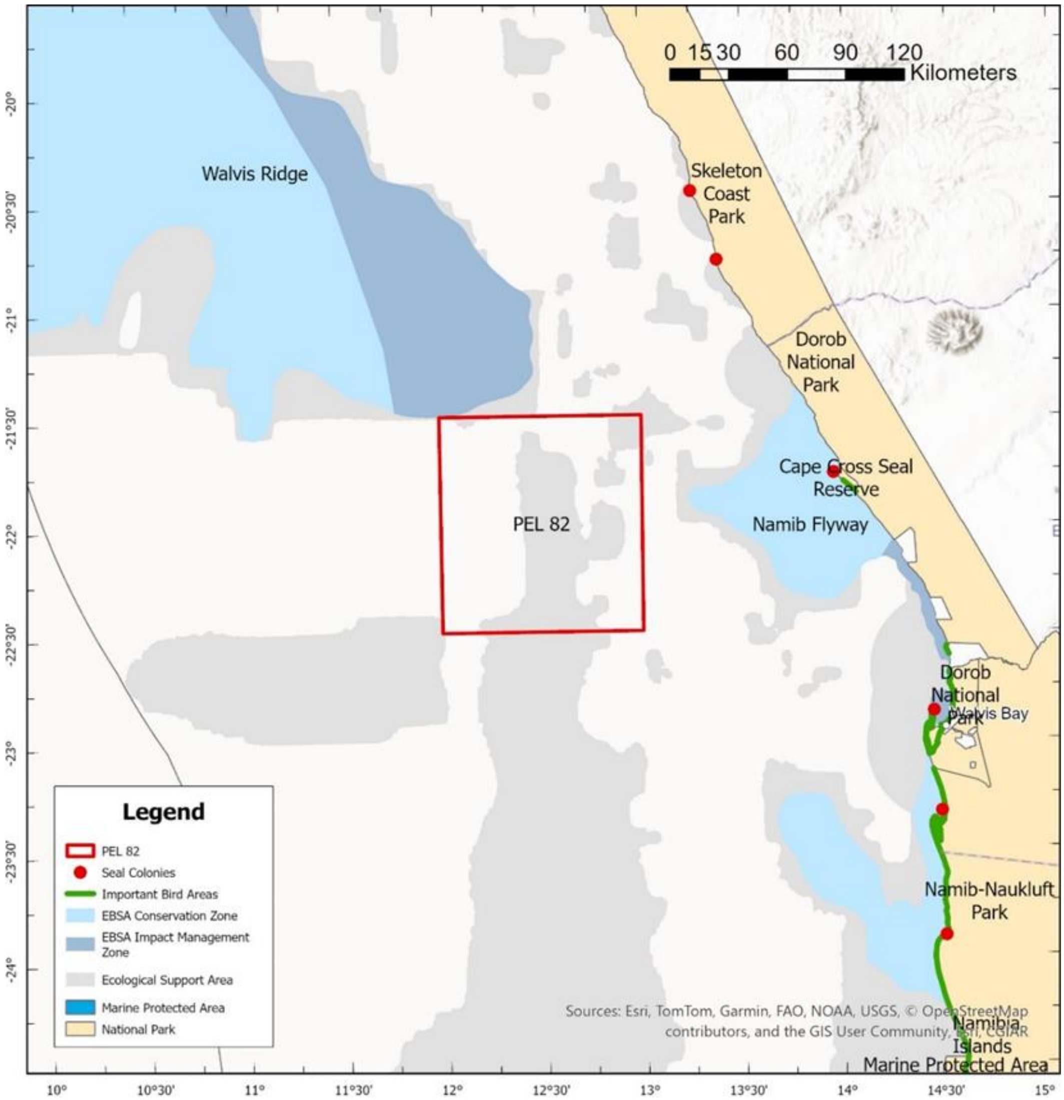
Of the eight identified EBSAs off Namibia, two fall solely within Namibian national jurisdiction (Namib Flyway and Namibian Islands), while one is shared with Angola (Namibe) and two are shared with South Africa (Orange Shelf Edge and Orange Cone) (Figure 4-40). The Benguela Upwelling System transboundary EBSA extends along the entire southern African West Coast from Cape Point to the Kunene River and includes a portion of the high seas beyond the Angolan EEZ.

FIGURE 4-39 PEL 82 IN RELATION TO THE PROTECTION LEVELS OF BENTHIC HABITAT TYPES



Source: Holness et al., 2014.

FIGURE 4-40 SEAL COLONIES, IBAS, MPAS & EBSAS IN THE PROJECT AREA



Source: Esri, 2025; FAO, 2025; NOAA 2025.

The Walvis Ridge Namibia EBSA lies contiguous to the Walvis Ridge EBSA in the high seas (Figure 4-40). Together, these two EBSAs span the full extent of the significant hotspot track (seamount chain formed by submarine volcanism) that comprises the aseismic Walvis Ridge and the Guyot Province. This unique feature forms a submarine ridge running north-east to south-west from the Namibian continental margin to Tristan da Cunha and Gough islands at the southern Mid-Atlantic Ridge. The Walvis Ridge Namibia EBSA encompasses the globally rare connection of a hotspot track to continental flood basalt in the Namibian EEZ. Given the high habitat heterogeneity associated with the complex benthic topography, it is likely that the area supports a relatively higher biological diversity, and is likely to be of special importance to vulnerable sessile macrofauna and demersal fish associated with seamounts. Productivity in the Namibian portion of Walvis Ridge is also particularly high because of upwelling resulting from the interaction between the geomorphology of the feature and the nutrient-rich, north-flowing Benguela Current.

The Namib Flyway is a highly productive area in the Benguela system that attracts large numbers of sea- and shorebirds, marine mammals, sea turtles and other fauna. PEL 82 lies offshore of this EBSA.

The Benguela Upwelling System is a transboundary EBSA and is globally unique as the only cold-water upwelling system to be bounded in the north and south by warm-water current systems, and is characterized by very high primary production (>1,000 mg C/m²/day). It includes important spawning and nursery areas for fish as well as foraging areas for threatened vertebrates, such as sea- and shorebirds, turtles, sharks, and marine mammals. Another key characteristic feature is the diatomaceous mud-belt in the Northern Benguela, which supports regionally unique low-oxygen benthic communities that depend on sulphide oxidising bacteria. PEL 82 falls within this EBSA.

4.4.2.6 BIODIVERSITY PRIORITY AREAS AND MARINE SPATIAL PLANNING

In addition to EBSAs, Ecological Support Areas (ESAs) have been identified. Although these areas do not meet the EBSA criteria they reflect secondary priority conservation areas with special attributes that support a healthy and functioning marine ecosystem (Figure 4-40). ESAs cover 37.4% of the total area of PEL 82.

Namibia recently embarked on a Marine Spatial Planning (MSP) process implemented as a development planning approach to organize the use of the country's marine territory in such way that comprehensive, integrated and complementary planning and management across sectors and for all ocean uses is enabled. MSP in Namibia is highly precautionary and forward-looking given the relatively low intensity of current uses, has a strong ecosystem-based perspective due to the fairly pristine environment, is driven by a social equity and distributive justice agenda, and features a strong collaborative process governance (Finke et al., 2020a, 2020b). Although at this stage MSP lacks legislation and has only weak links to broader ocean governance, the MSP process has resulted in a clear framework for the development of the first marine plan (MFMR, 2019), as it was linked to a systematic conservation planning process from the outset.

The objectives and principles for MSP, as well as the steps each planning process is expected to follow, are set out in the National MSP Framework (MFMR, 2019). The Framework provides high-level direction to ensure consistent and coherent plan development, implementation and review across Namibia's marine space and its three proposed planning areas: a northern, central and southern area. It also describes the background to MSP and its overarching objectives in Namibia and identifies relevant institutional structures, roles and responsibilities (MFMR, 2022). The first MSP for Namibia is being developed for the central area, followed by the northern and the southern areas. Although all three areas have sites of high ecological sensitivity and importance, growing economic interests and increasingly overlapping human uses, particularly in the central and southern MSP areas call for improved management.

The Marine Spatial Plans in each of the three planning areas will translate the National Framework for MSP into integrated and strategic sustainable development plans that guide users, developers and regulators in their decision-making, setting out which activities should take place where, when and under what conditions. Any future licensing decisions would need to be in line with the provisions set out in the respective plans.

4.4.2.7 RAMSAR SITES AND IMPORTANT BIRD AREAS

The Walvis Bay wetland was proclaimed a Ramsar site in December 1995, supporting up to 250,000 birds at peak times during the summer season and about 80,000 to 100,000 birds during winter (Wearne and Underhill 2005). The wetland serves primarily as a dry-season and drought refuge for intra-African migrants and as a non-breeding area for Palaearctic migrants.

Sandwich Harbour, a natural tidal lagoon, is located 55 km south of Walvis Bay. The area hosts upwards of 70,000 birds, mostly seasonal migrants from the northern hemisphere (Kolberg, 2015). It was proclaimed a Ramsar site in December 1995.

These coastal Ramsar sites all lie more than 100 km to the east and south of PEL 82.

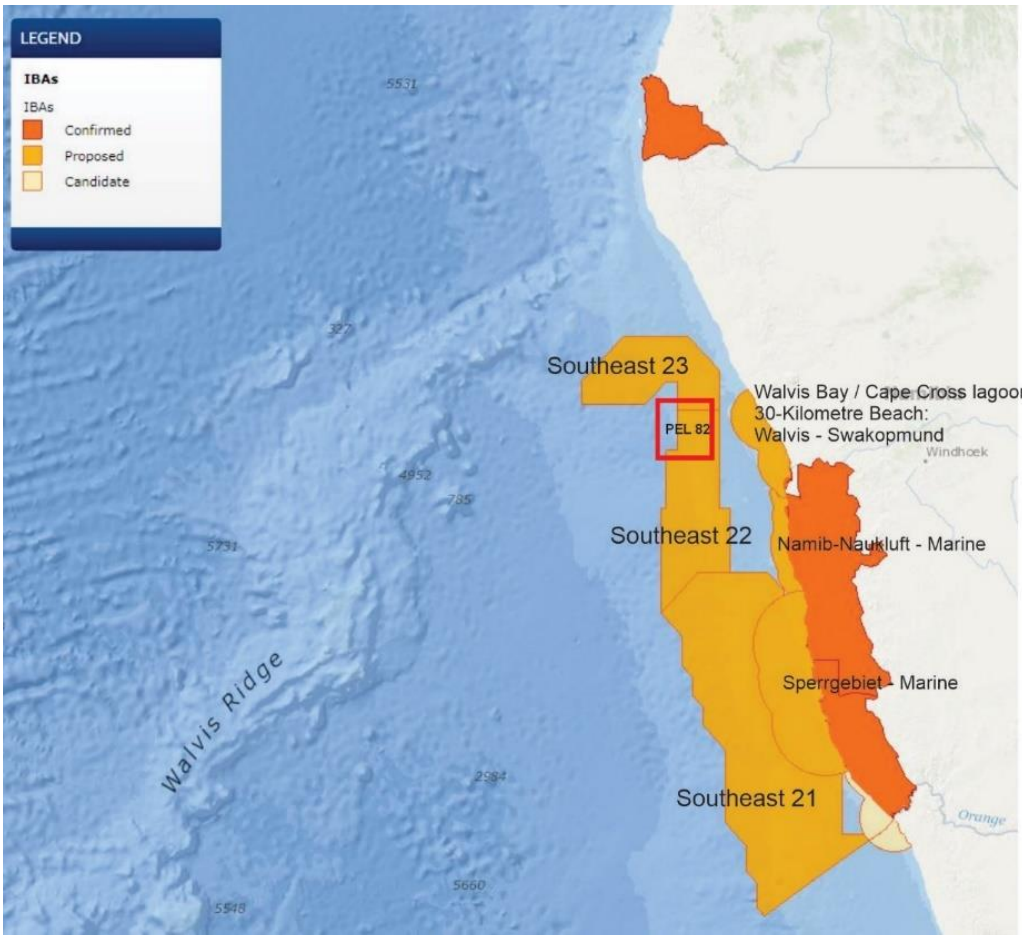
TABLE 4-9 LIST OF COASTAL RAMSAR SITES IN THE AREA OF INFLUENCE OF PEL 82.

Name	Size (ha)	Description
Walvis Bay Wetlands	10,550	Ramsar site no. 742. A tidal lagoon consisting of adjacent intertidal areas, Pelican Point, mudflats exposed at low tide, and sandbars serving as roosting sites. The site supports varying numbers of wetland birds (37,000 to 79,000 individuals); some species such as flamingos occur in large numbers. Eleven endangered bird species are regularly observed. Human activities include recreation and salt production. Residential development exists along the lagoon, and natural siltation may eventually lead to its infilling.
Sandwich Harbour	13,825	Ramsar site no. 743. Two distinct wetlands and associated mudflats. One is aquifer-fed and supports typical emergent vegetation, but is slowly disappearing due to natural causes. The second, under tidal influence, consists of mudflats and raised shingle bars. One of Namibia's most important coastal wetlands, supporting eight endangered species among the large numbers of wading birds. Several archaeological sites dating back 1,000 years exist within the site. The site is used for scientific research, with surrounding areas used for tourism, recreation, and angling.

Source: Ramsar, 2025

Various marine IBAs have also been proposed in Namibian territorial waters, with a candidate trans-boundary marine IBA suggested off the Orange River mouth (Figure 4-41). PEL 82 overlaps with the proposed Southeast 22 and Southeast 23 Marine IBAs to protect Atlantic Yellow-nosed Albatross and White-chinned Petrel.

FIGURE 4-41 PEL 82 IN RELATION TO COASTAL AND MARINE IBAS IN NAMIBIA



Source: BirdLife, 2025

4.5 SOCIO-ECONOMIC AND CULTURAL ENVIRONMENT

The section provides the socio-economic and cultural context within which the project will be developed. This baseline focuses on the Erongo Region as this is the location of the town of Walvis Bay which is the largest settlement closest to PEL 82 and is the location of the port which will be used as the logistics and aviation base for project activities. Project support facilities such as worker accommodation will also be located in the Walvis Bay area.

4.5.1 SOCIAL AREA OF INFLUENCE

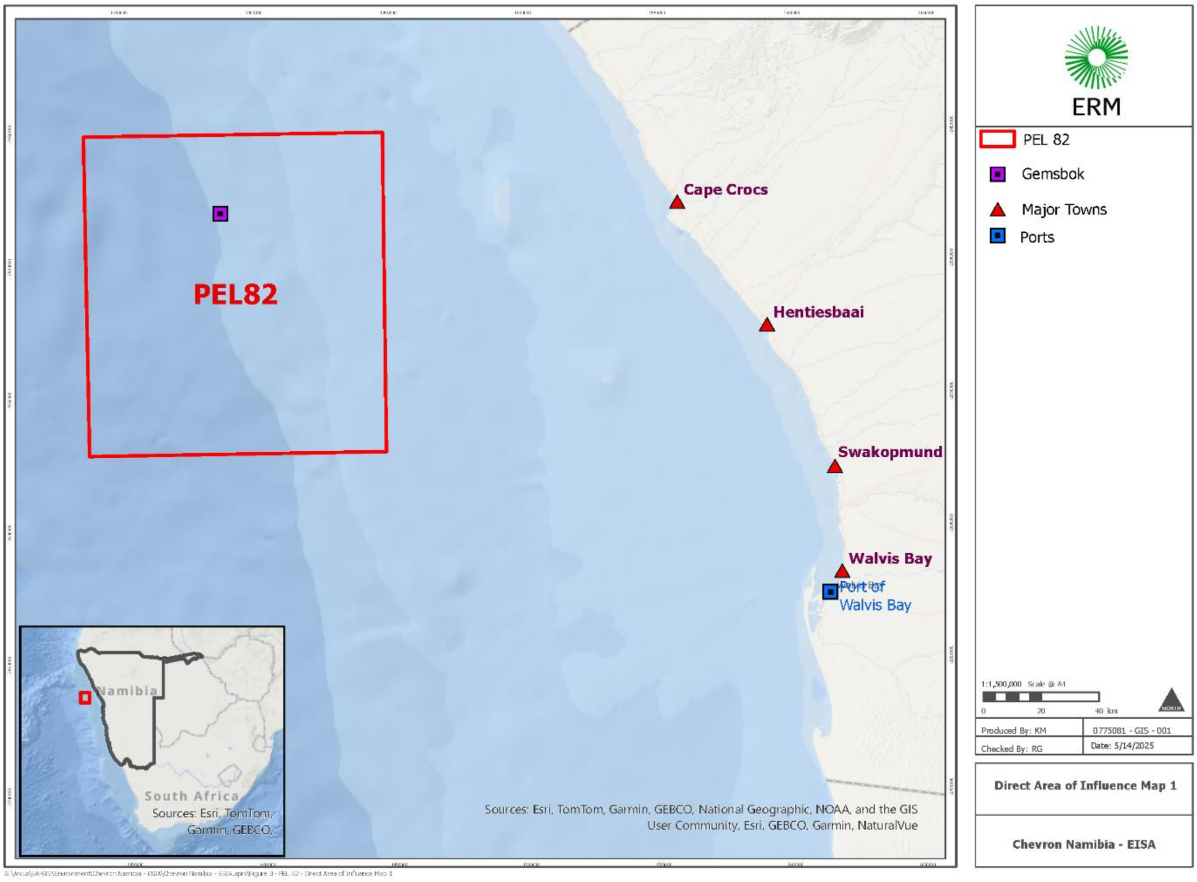
The Social AoI for the potential project depicts the geographical extent of the potential direct and indirect socio-economic risks and potential impacts. An AoI can vary depending on the type of potential impact being considered and the attributes of the potentially affected receptors. The social footprint which has been considered in defining the AoIs for this socio-economic baseline encompasses:

- Onshore and offshore physical project footprints;
- Associated facilities whose viability and existence depend exclusively on the project and without which the project would not be viable (when applicable);
- Areas potentially affected by impacts from unplanned but predictable events caused by the Project that may occur in the future or at a different location; and

- The project's primary labour-sending areas and areas where income generated from project employment is spent, i.e. the towns and communities that are likely to experience economic benefits following from construction of the project.

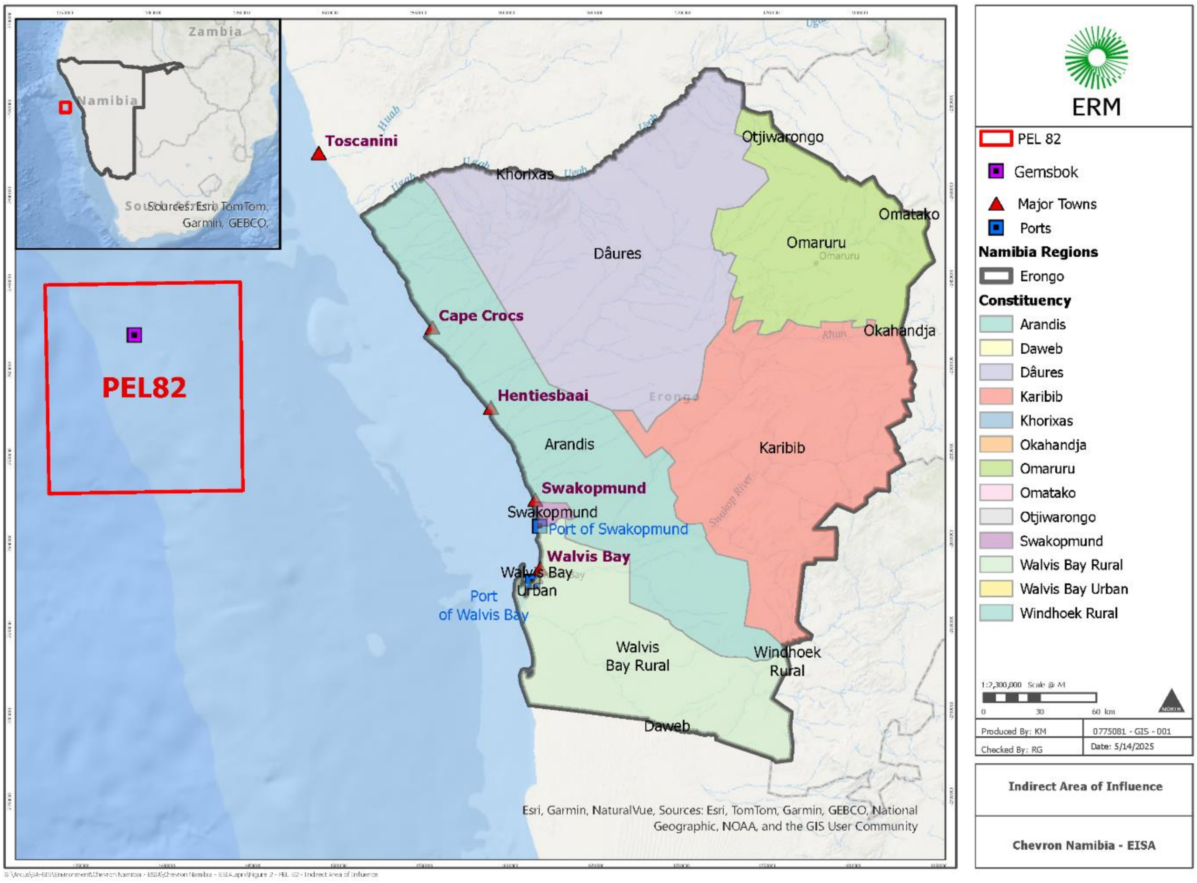
The direct Social AoI is characterised as the area subject to direct effects arising from the implementation of the project. These potential impacts may occur during mobilisation, drilling and demobilisation phases of the project. The direct Social AoI for the project will include the physical footprint of all project facilities and adjacent areas using a 5 km buffer for onshore project components, taking into account critical infrastructure such as the Port of Walvis Bay, schools, hospitals, and religious sites as well as sensitive receptors such as settlements. For offshore components, the direct Social AoI will be inclusive of the PEL 82 License area and the exclusion zone. The Direct Social AoI is shown in Figure 4-42.

FIGURE 4-42 DIRECT SOCIAL AREA OF INFLUENCE



The indirect Social AoI is characterised as a more distant area, which may feel the effects of the project on the socio-economic environment. This includes key labour-sending areas (e.g. Swakopmund and Henties Bay) for the project and areas that will potentially benefit from economic development associated with the project. The indirect AoI therefore extends to the Urban Constituency of Walvis Bay and the Erongo Region. For the indirect AoI, the effects are perceived in a secondary manner, arising from the most diverse activities related to the project. It must be noted however, that significant socio-economic potential impacts may still occur in the indirect AoI. The indirect Social AoI is shown in Figure 4-43.

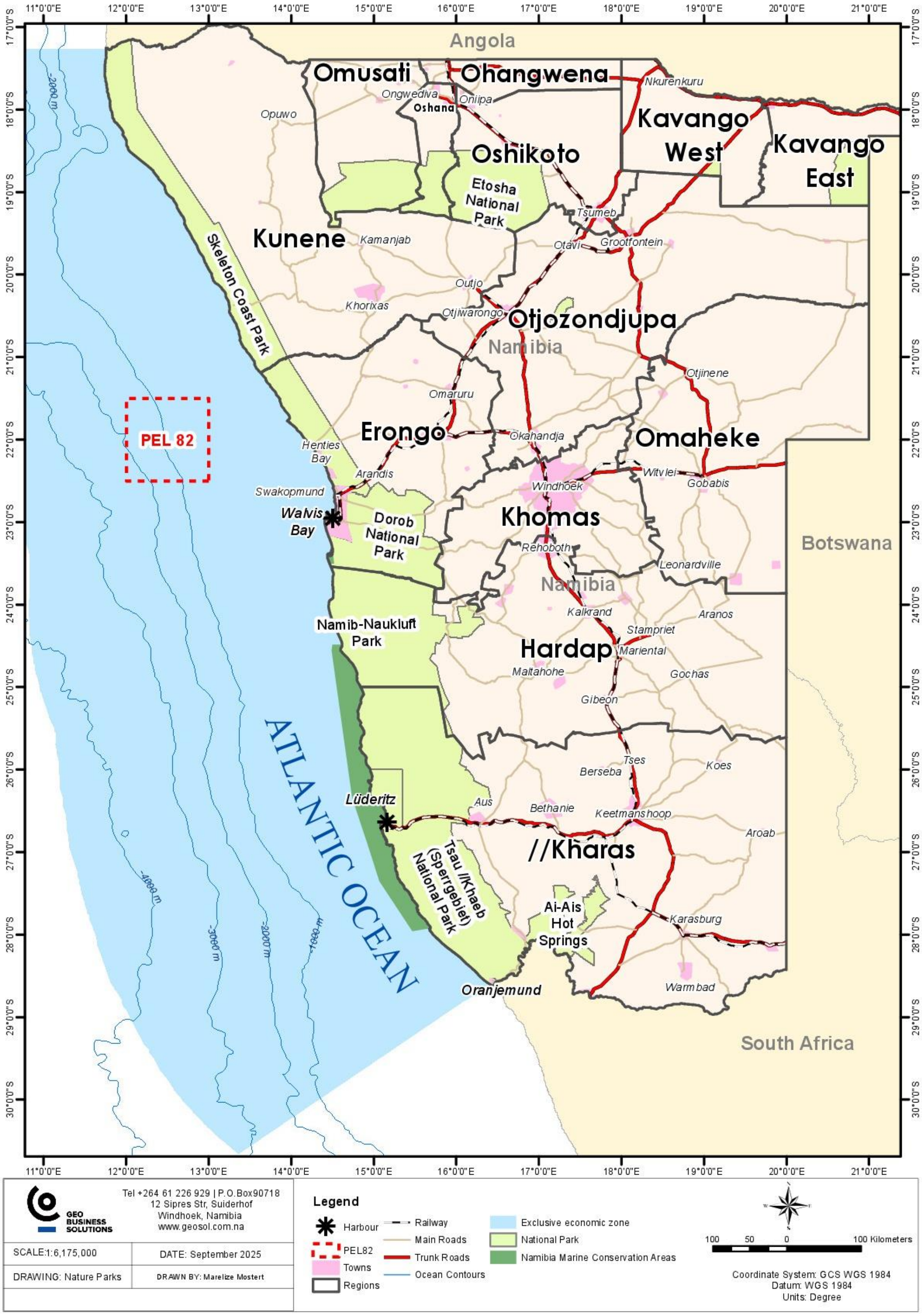
FIGURE 4-43 INDIRECT SOCIAL AREA OF INFLUENCE



4.5.2 GOVERNANCE AND ADMINISTRATION

Namibia is a democratic republic. In Namibia, the first level of local administration are regions. There are 14 regions in the country (refer to Figure 4-44) which are further subdivided into 121 constituencies for electoral purposes.

FIGURE 4-44 LOCALITY OF PEL 82 AND REGIONS IN NAMIBIA



Source: Geo Business Solutions, 2025

Each region is governed by a Regional Council which acts as the institutional link between central government and local communities, with responsibilities for regional development planning, decentralisation and the coordination of service delivery in sectors such as education, health and infrastructure (Republic of Namibia, 2010). Local governance is further structured according to settlement type: Municipal Councils administer larger urban areas, Town Councils manage proclaimed towns, Village Councils oversee villages, and settlement areas fall directly under the jurisdiction of Regional Councils.

The locality of PEL 82 license area is shown in Figure 4-44. Along Namibia's 1,500 km long coastline, permanent settlements are few and concentrated in urban areas that connect the hinterland to the sea. Walvis Bay, Swakopmund and Henties Bay are the main socio-economic centres. These towns host the bulk of Namibia's coastal population and provide the base for the fishing, logistics, tourism and offshore exploration industries. There are no permanent towns south of Walvis Bay and north of Henties Bay as they fall within protected areas such as the Skeleton Coast National Park, Namib-Naukluft National Park and the Namib Sand Sea.

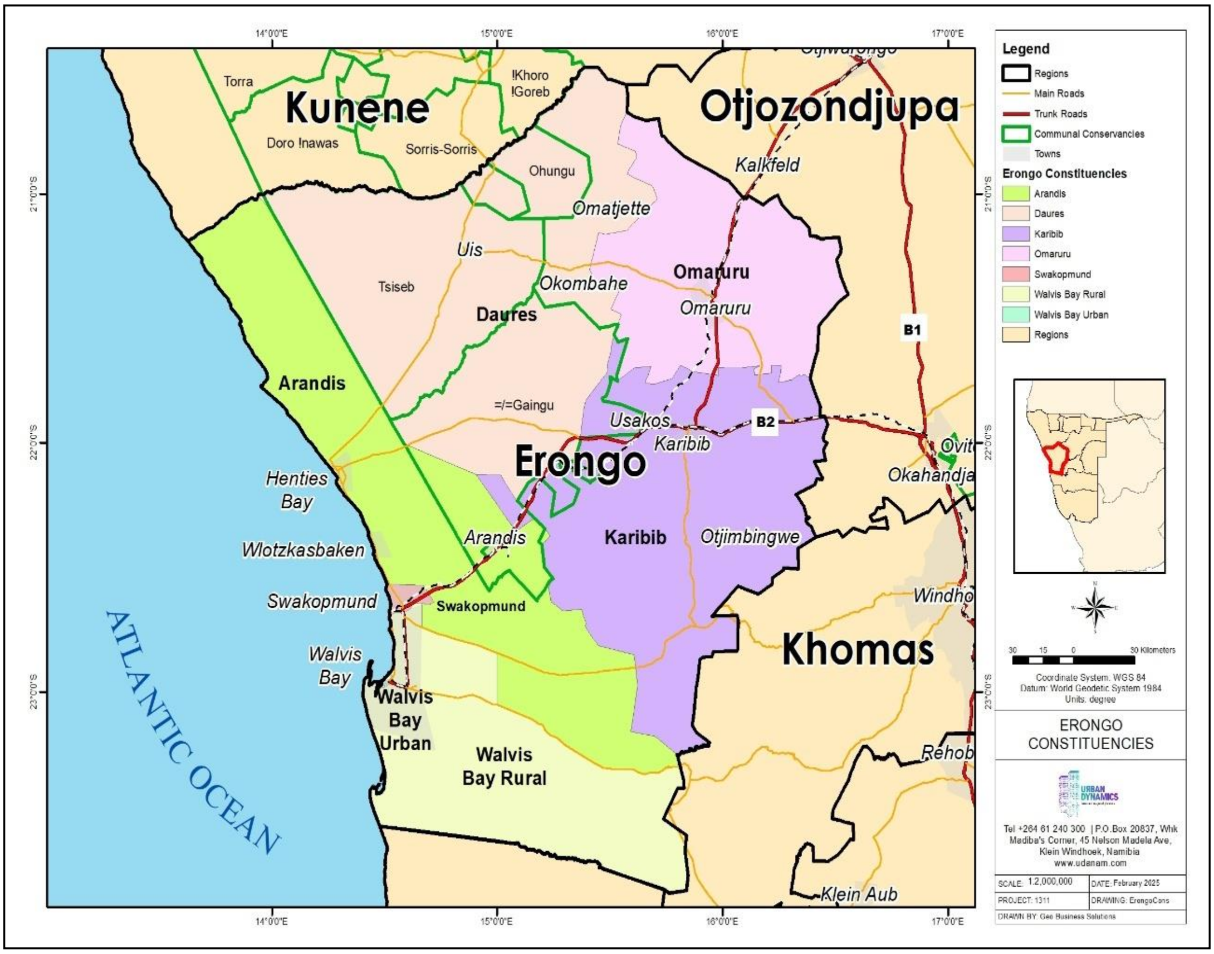
The onshore activities of the project are located in the Erongo Region and the Walvis Bay Urban Constituency. The Erongo Region comprises seven constituencies: Walvis Bay Urban, Walvis Bay Rural, Swakopmund, Arandis, Daures, Karibib and Omaruru. Its municipalities and town councils include Walvis Bay, Swakopmund, Henties Bay, Arandis, Karibib, Usakos and Omaruru. Settlement areas such as Uis, Okombahe and Otjimbingwe, are directly administered by the Regional Council. Swakopmund serves as the administrative centre of the region and houses the Erongo Regional Council. Figure 4-45 shows the map of the region with constituencies and towns.

TABLE 4-10 ERONGO REGION CONSTITUENCIES

Region	Constituency
Erongo	Arandis
	Dâures
	Karibib
	Omaruru
	Swakopmund
	Walvis Bay Rural
	Walvis Bay Urban*

*Indicates the constituency where onshore project activities will occur.

FIGURE 4-45 EONGO REGION AND ITS CONSTITUENCIES AND TOWNS



Source: Geo Business Solutions, 2025

4.5.3 HISTORY OF OIL AND GAS EXPLORATION IN NAMIBIA AND THE ERONGO REGION

Oil exploration in Namibia began in the 1970s with the discovery by Texaco of the Kudu gas field in 1974 in the shallow waters of the coast of the ǁKharas Region, near the town of Oranjemund. This discovery was not developed for several decades and additional exploration by major international oil and gas companies was limited to sporadic exploration drilling that did not yield any promising results. BW Energy is the latest operator to attempt commercialisation of the Kudu gas field. This has focused on a gas-to-power development (Beckman, 2022).

In 2012, new deposits were observed following exploration by the Brazilian company HRT Oil and Gas in the Walvis Basin. However, these deposits were determined to be sub-commercial but encouraged further exploration from other oil and gas companies (Thom, 2023).

In 2022, it was announced by Shell and TotalEnergies that large deposits of oil and gas have been discovered at their exploration well sites in the Orange Basin that could potentially be exploited. The discover of potentially commercial deposits led to a significant increase in exploration activity in Namibian waters by international companies. Further major oil deposit discoveries have been made by Galp Energia in 2024 in the Mopane field. Currently, Namibia has 230,000 km^2 of licensed acreage where companies have been granted the right to exploration and potential extraction of oil and gas. It is expected that further significant exploration will take place (Milewski, 2025).

Exploration is at a relatively early stage and there is still a high level of uncertainty about how the oil and gas fields may be developed in terms of design concepts, timing and production levels, among others.

PEL 82 in the Walvis Basin, which includes the mopane field previously explored by Galp Energia, has now been acquired by Chevron who hold a majority participating interest and operatorship. Custos Energy and the National Petroleum Corporation of Namibia have also retained a minority interest in the block. PEL 90 has also been explored by Chevron. PEL 87 was expected to have exploration drilling in 2025 by Woodside. It is not clear at this stage if this exploration will take place (Terblanche, 2025).

It is unclear how much the oil and gas sector contributes to the Namibian economy currently as exploration is still at an early stage and large-scale operations have not started. An Oil and Gas Industrial Baseline Survey conducted by Deloitte Namibia has estimated that the sector (based on a single potential project) may contribute an average of US$648 million to GDP per year during production. During the construction phase, it is expected that the sector will contribute US$113 million per year. The primary drivers for GDP growth from the sector will be gross operating surplus and an increase in income for skilled labour. Key sectors expected to benefit from a growth in the oil and gas sector include transport, wholesale and retail trade, and private services (Mining and Energy, 2024).

4.5.4 DEMOGRAPHICS

A population and housing census was conducted in Namibia in 2023. According to the Namibia Statistics Agency (NSA), this census recorded the population of Namibia at 3,002,401. This is an increase from 2,113,077 in 2011, reflecting an annual average growth rate of 3.0%. This is the largest percentage change in population size that has been observed in the country. Females account for 51.2% of the population while males account for 48.8%. There is a relatively even split between the urban and rural populations in the country. The census recorded an urban population of 1,512,685 and a rural population of 1,509,716. There are 756,339 households in Namibia. Around 0.9% of households are child-headed (17 years or younger). This is a reduction from 1.1% in 2011. Child-headed households are more common in rural areas. Persons with disabilities are present in 11.9% of households in Namibia. In rural areas, 16.4% of households have persons with disabilities. Elderly people (aged 60 and above) headed 18.1% of households in the country. Significantly more households in rural areas are headed by elderly people (27.7%) than in urban areas (10.1%).

The Erongo Region has a population of 240,206, the majority of which is male (50.9%). The population of the Erongo Region has grown by 59.2% since 2011 and accounts for 7.9% of the total population of Namibia. Erongo is the 5th most populous region within Namibia and one of the fastest growing. There are 74,795 households in Erongo with 42.7% of households being female-headed. Around 0.5% of households in Erongo are child-headed. Persons with disabilities are present in 7% of households in the region. Elderly people (aged 60 and above) headed 10.9% of households in the region (similar to the national average for urban areas).

Walvis Bay is located on the coastline of the Erongo Region and is the second largest city in the country after Windhoek (when combining the Walvis Bay urban and rural constituencies). It is the largest coastal city. The urban constituency is home to Namibia's largest commercial port (The Port of Walvis Bay).

At constituency level, Walvis Bay Urban and Rural together accounted for 102,704 residents in 2023, representing 42.8% of the regional population. The town of Walvis Bay makes up virtually the entire population of these constituencies, having grown from 62,096 in 2011, an average annual growth rate of 4.23% (NSA, 2025). Swakopmund Constituency recorded 75,921 residents in 2023 compared to 44,725 in 2011, reflecting the fastest growth rate in the region at 4.5% per annum. The Arandis Constituency, which incorporates both the inland mining town of Arandis and the coastal settlement of Henties Bay, recorded 13,542 residents in 2023 compared to 10,093 in 2011, an annual growth rate of 2.5%. Henties Bay alone accounted for 7,569 residents (NSA, 2025).

TABLE 4-11 MEAN ANNUAL RATES OF POPULATION GROWTH BETWEEN 2011 AND 2023

Area / Constituencies	Percentage of Growth		
	POPULATION 2011	POPULATION 2023	MEAN ANNUAL RATE OF GROWTH
Namibia	2,113,077	3,022,041	3.0
Erongo	150,809	240,206	3.9
Walvis Bay (Urban & Rural)	62,096	102,704	4.23
Swakopmund	44,725	75,921	4.5
Arandis*	10,093	13,542	2.5

**Includes Arandis town (5,726), Henties Bay (7,569) and Wlotzkasbaken (holiday village).*
Source: NSA, 2025

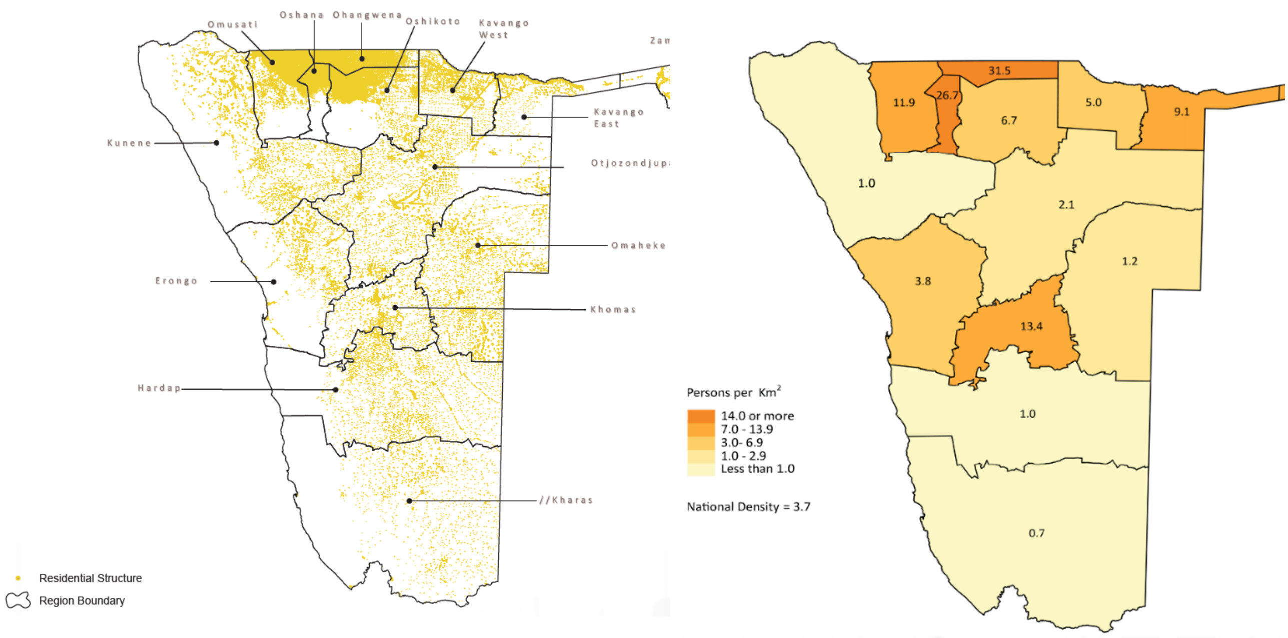
The pattern that emerges is one of rapid, migration-driven growth in Walvis Bay and Swakopmund, while Henties Bay and Arandis have grown more slowly, reflecting their distinct settlement character.

4.5.4.1 POPULATION DENSITY

Namibia is a sparsely populated country with the highest population densities seen in the Onhangwnea and Oshana Regions. The Khomas Region, which includes the National Capital of Windhoek, has a density of 13.48 people per square kilometre. The Erongo Region has a population density of 3.8 people per square kilometre. However, the population densities are significantly high in urban settlements with the Swakopmund Constituency having a density of 386.7 people per square kilometre and Walvis Bay Urban having a density of 2,730.8 people per square kilometre (NSA, 2024).

Figure 4-46 provides an indication of the population density and distribution in Namibia and the Erongo Region. The national mean density in 2023 was 3.7 persons per kilometer square, while Erongo recorded a slightly higher density of 3.8 persons per kilometer square (NSA, 2024).

FIGURE 4-46 POPULATION DENSITY AND DISTRIBUTION ACROSS NAMIBIA



Source: NSA, 2024

However, these averages mask highly uneven settlement patterns. In Walvis Bay Urban, density reached 461 persons per kilometer square in 2023, making it the most densely populated constituency in Erongo and among the densest in Namibia (NSA, 2025). Swakopmund recorded a density of 389 persons per kilometer square, consistent with its role as a compact urban centre and tourism hub. Walvis Bay Rural recorded only 19 persons per kilometer square, reflecting its extensive land area and scattered peri-urban and communal settlements. The Arandis Constituency, which incorporates both the inland town of Arandis and the coastal settlement of Henties Bay, recorded an overall density of 0.7 persons per kilometer square. While Henties Bay itself is relatively dense as a proclaimed town with more than 7,500 residents, the surrounding desert areas and the negligible permanent population of Wlotzkasbaken result in a very low constituency-wide density (NSA, 2022; NSA, 2025).

Smaller clusters such as Wlotzkasbaken are not included in census records but function primarily as holiday villages with very few permanent residents and no formal municipal services. They are therefore not considered direct socio-economic receptors for offshore activities. This demonstrates that while Walvis Bay and Swakopmund concentrate most of Erongo's population and act as the main socio-economic receptors for CNEL's offshore exploration, Henties Bay also plays a significant role within the project's AoI, reflecting its distinctive tourism and fisheries-based economy.

However, indirect social receptors also include residents of the Erongo Regions on the one hand but also the citizens of Namibia.

4.5.4.2 AGE DISTRIBUTION

Namibia has a relatively young population which is also reflected within the Erongo Region. A significant proportion of the population is aged between 15-34 years while the population aged over 60 years is small. The Walvis Bay Urban Constituency has a slightly older population than the Namibian and Erongo averages. However, the population aged over 60 years in the urban constituency is smaller. The population in the rural parts of Walvis Bay is younger than in the urban constituency as shown in Table 4-12.

TABLE 4-12 PERCENTAGE AGE DISTRIBUTION, 2023

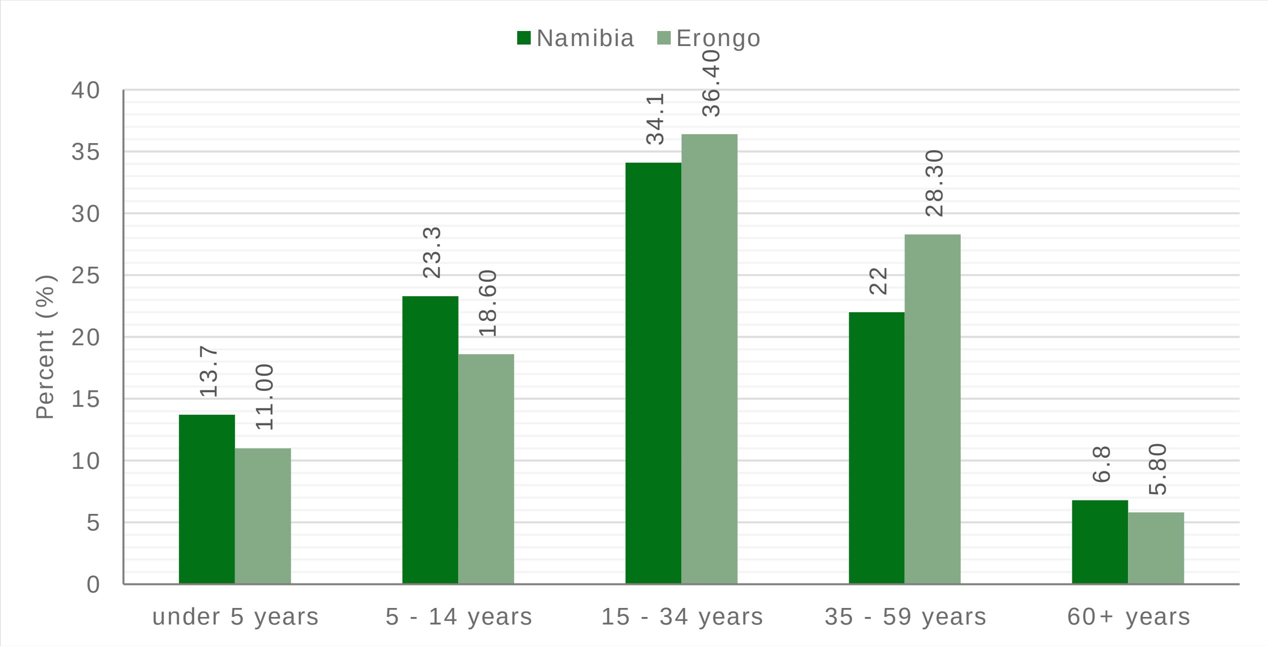
Age Groups	Namibia	Erongo	Walvis Bay Urban	Walvis Bay Rural
0-4 years	13.7%	11%	9.7%	11.2%
5-14 years	23.3%	18.6%	17.2%	19.5%
15-34 years	34.1%	36.4%	36.7%	37.9%
35-59 years	22%	28.3%	31.8%	29%
60+ years	6.8%	5.8%	4.7%	2.4%

Source: NSA, 2024

The elderly population is Namibia is most likely to live in rural areas while the working age population (15-59 years) is most likely to live in urban areas where this age group constitutes 63.2% of the population compared to only 49.1% of the rural population.

Figure 4-47 shows the age distribution of the Erongo Region compared with the national distribution. Namibia’s population remained relatively young, with 38.5% under the age of 19, 54.1% in the working-age group (20–59 years), and 7.5% aged 60 years and older (NSA, 2024).

FIGURE 4-47 AGE COMPOSITION FOR NAMIBIA AND THE ERONGO REGION

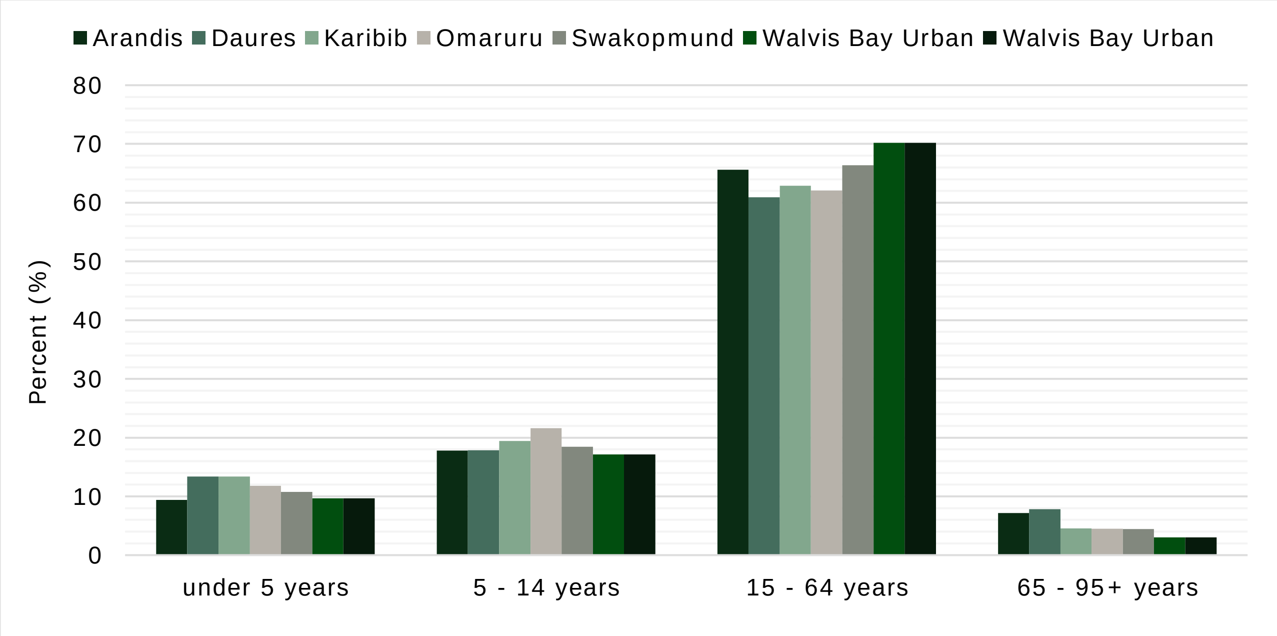


Source: NSA, 2024

The Erongo Region reflects a similar structure but with a higher percentage of working-age residents. In 2023, 36.7% of the population was younger than 19,57.4% were aged 20–59, and only 5.8% were aged 60 or older (NSA, 2024). This higher share of working-age residents underscores the region's role as an economic hub, attracting labour for port, fishing, mining and logistics activities. Figure 4-47 highlights that while Erongo and Namibia share a broadly similar demographic profile, the population bulge in Erongo is more clearly concentrated in the 20–59 age category.

At constituency level, distinct variations are evident (NSA, 2025). Walvis Bay Urban had the most pronounced working-age profile, with 66.6% of its residents aged 20–59, compared to 25.4% under 19 and 8.0% aged 60+. This reflects its role as Namibia's main port town and the concentration of associated employment opportunities. Walvis Bay Rural also had a strong working-age share at 66.0%, with 29.2% under 19 and 4.8% aged 60+, shaped by its mix of peri-urban settlements and dispersed households. Swakopmund showed a slightly different structure, with 58.5% of the population aged 20–59, 30.9% under 19, and a comparatively higher elderly share of 10.5%, consistent with its role as a tourism centre and residential hub. By contrast, the Arandis Constituency (including Henties Bay) recorded 60.7% in the working-age group, 25.8% under 19, and 13.5% aged 60+, reflecting both Arandis's mining-linked working-age base and Henties Bay's attraction as a retirement and seasonal settlement (NSA, 2025).

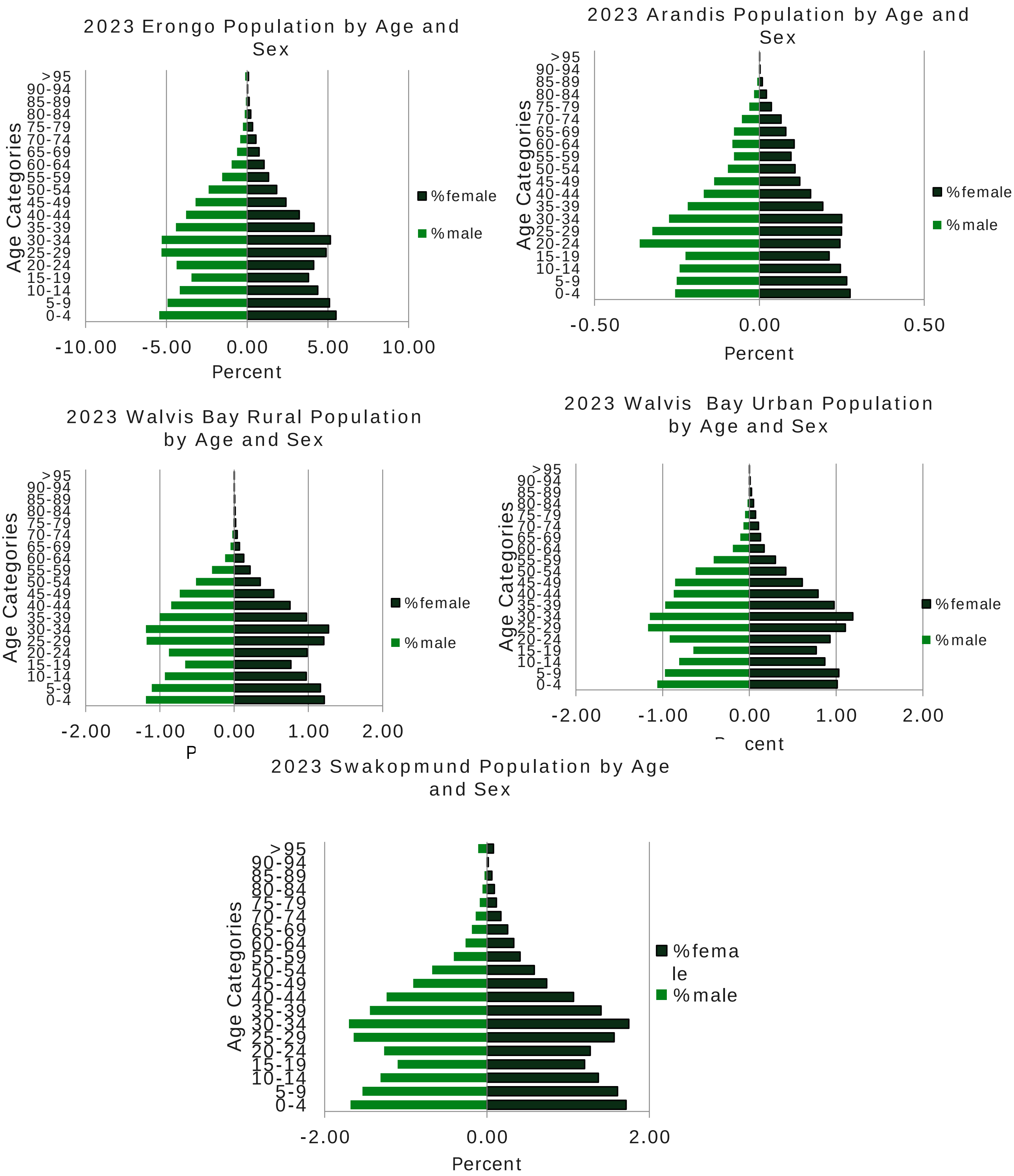
FIGURE 4-48 AGE DISTRIBUTION IN THE ERONGO REGION



Source: NSA, 2025

Figure 4-48 presents age–sex pyramids for Erongo and its main constituencies, illustrating the strong working-age bulge in Walvis Bay and Swakopmund, contrasted with the higher elderly share in Henties Bay.

FIGURE 4-49 AGE AND SEX PYRAMIDS FOR THE REGION AND THE MAIN CONSTITUENCIES



Source: NSA, 2025

4.5.4.3 ETHNICITY AND LANGUAGE

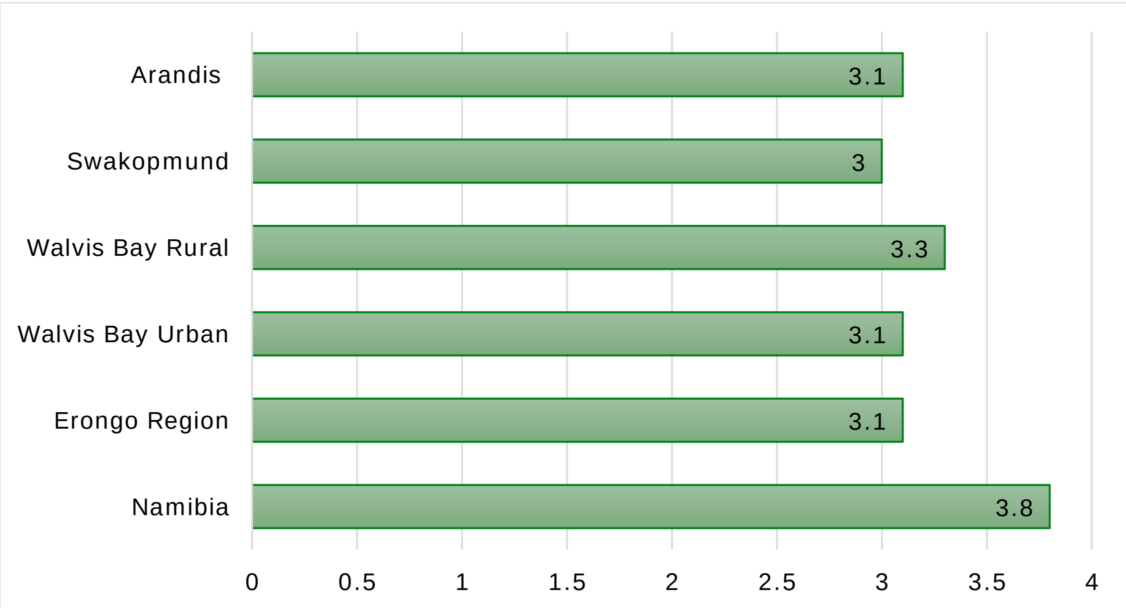
The population of Namibia is ethnically diverse. The Aakwanyama ethnic group accounts for the highest percentage of the population with 23.6%, followed by Aandonga (10.3%), OvaHerero (5.9%), and Damara (5.6%) (NSA, 2024). At the time of the 2011 census, Oshiwambo was spoken as the main language by 38.8% of households in the Erongo Region. This was followed by Afrikaans (20.4%), and Nama / Damara (18.8%) (NSA, 2014).

4.5.4.4 HOUSEHOLD SIZE

Household sizes in Namibia have declined over the past decade, reflecting decreased fertility and the shift towards smaller family structures. Nationally, the average household size fell from 4.4 persons in 2011 to 3.8 persons in 2023. In the Erongo Region, household sizes have consistently been lower than the national average, decreasing from 3.3 in 2011 to 3.1 in 2023 (NSA, 2024).

At constituency level, differences are modest but reflect settlement patterns. In 2023, Walvis Bay Rural recorded the largest average household size at 3.3 persons per household, shaped by peri-urban and communal living structures. Swakopmund households were the smallest at 3.0, consistent with its compact urban environment. Walvis Bay Urban and Arandis (including Henties Bay) both averaged 3.1 persons per household (NSA, 2024).

FIGURE 4-50 MEAN HOUSEHOLD SIZES IN NAMIBIA, ERONGO AND ITS CONSTITUENCIES IN 2023



Source: NSA, 2024

4.5.5 VULNERABLE GROUPS

Vulnerable people or groups are those who may be more adversely affected by project impacts than others by virtue of characteristics such as their gender, gender identity, sexual orientation, religion, ethnicity, Indigenous status, age (including children, youth and the elderly), physical or mental disability, literacy, political views, or social status. Vulnerable individuals and/or groups may include, but are not limited to, people living below the poverty line, the landless, single-headed households, natural resource dependent communities, migrant workers, refugees, internally displaced people, or other displaced persons who may not be protected through national legislation and/or public international law.

Vulnerable groups (Table 4-13) which may be present within the Social AoI the elderly, people with disabilities, people living on low incomes, and foreign nationals. These groups of people may disproportionately experience impacts from the project or may not be able to easily access benefits associated with the project.

TABLE 4-13 POTENTIALLY VULNERABLE GROUPS IN THE PROJECT AOI

Vulnerable Group	Description and Relationship to the Project
Elderly	The elderly may be vulnerable in terms of access to assets. Elderly people tend to live on low incomes (e.g. from pensions). Additionally, elderly people will have a baseline health status that may make them more vulnerable to health impacts from environmental changes generated by the project. By virtue of their age, elderly people may not be able to fully benefit from the project as positive impacts will be predominantly liked with employment.
People with Disabilities	People with disabilities can have various barriers that can obstruct their full and effective participation in society compared to other people. As such, people with disabilities may not be able to fully benefit from the project (e.g. employment) or may be vulnerable to exploitation within the community or workplace (including in the project supply chain). People with disabilities are present throughout the Social AoI.
People Living on Low Incomes	Low-income households have fewer resources on which to rely and are less likely to have savings and/or access to credit, which makes them vulnerable to shocks and change. Low-income households are present in the Social AoI and may be directly affected by the project's employment opportunities, including negatively due to unequal opportunity or positively if they can access employment.

4.5.6 ECONOMY AND LIVELIHOODS

Namibia's rich mineral base and small population of about 3 million gives it a World Bank classification of a lower-middle-income country. Political stability and social policies, such as public spending on pensions and welfare grants since Independence in 1990, have reduced poverty.

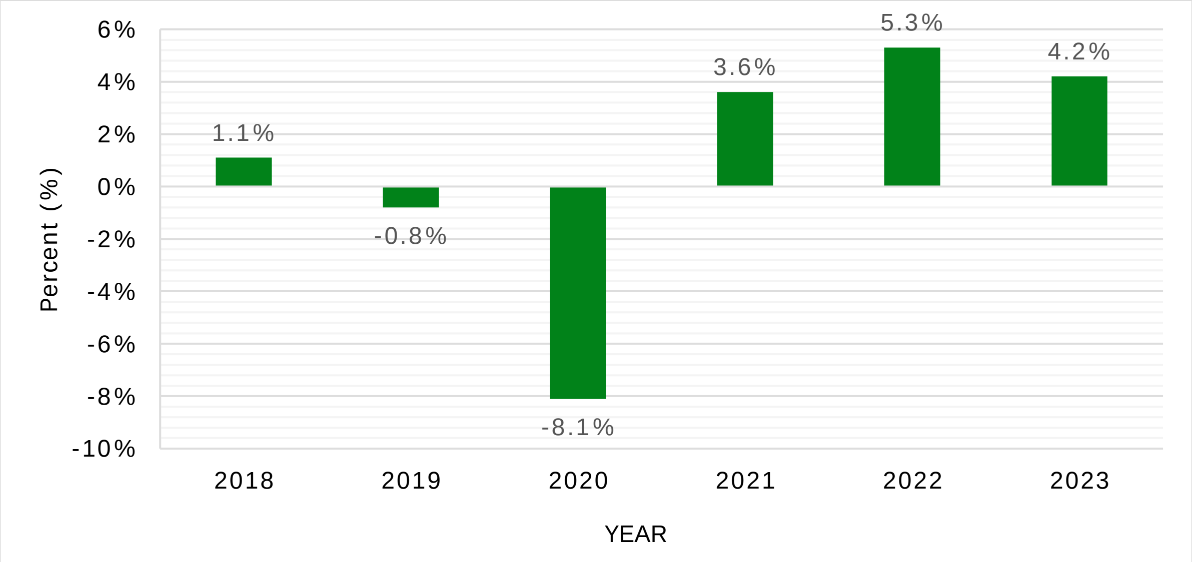
However, socio-economic inequalities inherited from the past apartheid system remain extremely high and structural constraints to growth have hampered job creation. Economic advantage remains in the hands of a relatively small segment of the population, and the large income disparities have led to a dual economy - a highly developed modern sector co-existing with an informal subsistence-oriented one. The duality of the labour market, combined with slow job creation and low primary-sector productivity, results in very high unemployment[7].

Poverty levels and the cost of living are high and thus the quality of life for many are not in unison with the country's macro-economic indicators. The economy grew between 2010 and 2015 by an average of 5.3% per annum, but since 2016, it has not come out of recession. COVID-19 negatively impacted commodity export markets, tourism and local consumption patterns and service industries and these resulted in a further 8.5% contraction of the economy in 2020 (IPPR, 2021).

[7] Namibia Overview: Development news, research, data | World Bank accessed on 4/10/2022

According to the 2023 Annual National Accounts, the Country's GDP grew at a rate of 1.1% in 2018, whereafter it contracted by 0.8% in 2019 and by 8.1% (Figure 4-51). Thereafter, the GDP grew again by 3.6% in 2021, 5.3% in 2022 and 4.2% in 2023.

FIGURE 4-51 NAMIBIAN GDP GROWTH, 2018 – 2023



Source: NSA, 2024a

The size of the Namibian economy expanded from N$171,570 billion in 2017 to N$227,831 billion in 2023.

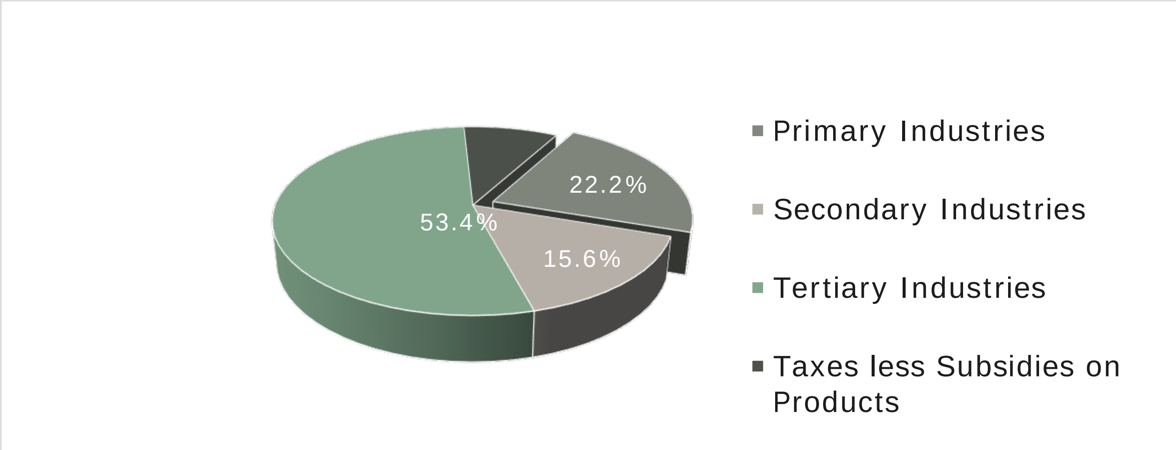
Tertiary industries have always been the most significant contributor to Namibia's GDP in recent years, contributing 53.4%, in 2023. These industries include the public sector, retail and wholesale, transport and services sectors.

Secondary industries contributed 18% to GDP and include manufacturing such as meat and other food processing, beverages, mineral processing, electricity generation and construction.

The primary industries, such as mining and agriculture, contributed 22.2% to GDP (NSA, 2024(a)).

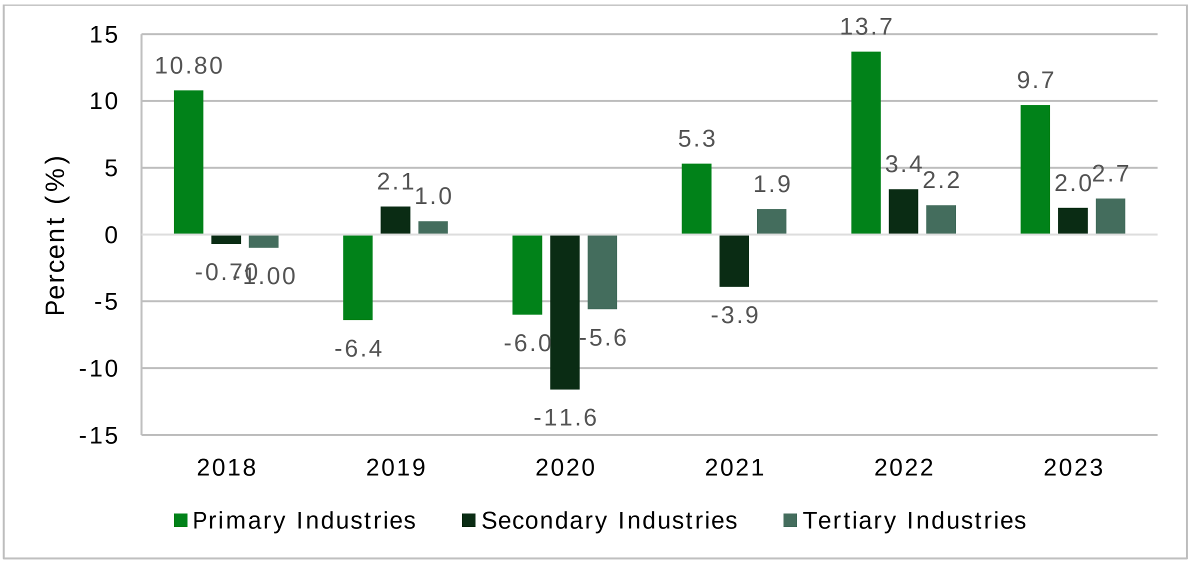
It is, however, important to take note of the trends that the various types of industries contribute to GDP. From the data in Figure 4-52, it is clear that the primary industry contribution to GDP is on the increase while the contributions of secondary and tertiary industries are on the decrease. From 2015 to 2023, the primary sector contribution to GDP increased from 15.53% to 22.2% while the secondary sector contribution declined from 18.68% to 15.6% and the tertiary sector from 57.94% to 53.4%.

FIGURE 4-52 INDUSTRY CONTRIBUTION TO GDP, 2023



Source: NSA, 2024a

FIGURE 4-53 GROWTH RATES OF INDUSTRIES



Source: NSA, 2024a

The country has good mineral resources, substantial fish stocks, widespread livestock production, an increasingly urban population and high school attendance of both girls and boys up to Grade 11. However, the Government is under more pressure than ever before to improve the lives of Namibians. There is widespread rural and urban poverty, shortage of technical skills, a major housing backlog and deepening unemployment.

4.5.6.1 COMMERICIAL AND ARTISANAL FISHING

Namibia is the second largest exporter of fish and other seafood products in Africa. The industry contributes significantly to national food security, economic growth, job creation, and foreign earnings through exports. The commercial fishing industry is mostly focused on horse mackerel and cape hake. However, the commercial fishing industry is under strain as previous overfishing has led to depleting fish reserves. The government has responded by reducing fishing quotas which has led to a decline in landings. There has been some offset as high demand and growing prices have compensated for smaller catches. Potential impacts to the fishing industry associated with the offshore oil and gas industry, such as seismic impacts, will need to be monitored as further exploration takes place and potential projects may move into operations.

In order to compensate for the pressures on traditional commercial fishing, there are plans to grow the aquaculture sector for the farming of oysters and abalone in the nearshore environment. However, this is in conflict with the offshore mining prospects in Namibian waters (typically in shallow-water/ nearshore). There is also a growing interest in the cultivation of seaweed and kelp.

Commercial fishing in Namibia is done by foreign companies such as Oceana (South African) and NovaNam (Spanish), the state-owned National Fishing Corporation (Fishcor) as well as smaller local companies such as Tunacor and Etosha Fishing.

In recent years, there have been a series of scandals where fishing companies have been paying bribes to government officials in order to secure more fishing quotas. Some species of fish are being caught at unsustainable levels by foreign vessels.

Artisanal fishing in Namibia includes small-scale and community-based fishing activities that use simple technology and traditional methods the catch marine resources. Fish and other seafood products caught by artisanal fishers are typically for local consumption and trading. In Namibia, artisanal fishers mostly catch species such as snoek, kob, and linefish. According to the Food and Agriculture Organisation (FAO,) small-scale and artisanal fisheries contribute positively to the lives of at least 40,000 Namibians through directly supporting livelihoods in fishing, processing and trading. This contributes positively to food security and poverty alleviation (The Namibian, 2022).

The Topnaar community in Erongo are known to be engaged in artisanal fishing. Communities such as the Topnaar face challenges in artisanal fishing due to their marginalised status. These communities tend to have high rates of poverty and are sometimes exploited by middlemen and other merchants that unfairly control the trade of fish and other seafood products in local markets. Other challenges faced by artisanal fishers include rising costs for fishing equipment, overfishing, and variabilities in catch. This has made artisanal fishers particularly vulnerable as their livelihoods are uncertain. According to the Hanganeni Artisanal Fishing Association (HAFA), artisanal fishers can earn up to N$20,000 per month. Artisanal fishing associations such as HAFA provide support to members through providing spaces for them to sell fish. HAFA has also established a take-away food business in Henties Bay that prepares and sells fish dishes using fish caught by their members. The association has also bought boats and other fishing equipment and employs members as full-time crew to catch fish and work in processing facilities (Daniels, 2020). Women tend to play a vital role in handling and processing of the catch of artisanal fishers. Given the nature of artisanal fishing and the methods and equipment used, these activities do not take place in deepwater. Therefore, any interactions between artisanal fishers and the Project (which is primarily occurring in deep-water offshore blocks (PEL 82)) will be limited.

4.5.6.2 ECONOMY OF WALVIS BAY

The economy of the Erongo Region, and particularly the Walvis Bay Urban Constituency, is among the most developed and diversified in Namibia. While the regional economy is still strongly tied to the primary sector, notably uranium mining, commercial and small-scale fishing, and—Walvis Bay also functions as the country's main port and logistics hub. The port anchors a wide range of industrial, commercial, and service activities that make Walvis Bay a key driver of regional and national growth.

The economy of Walvis Bay revolves around the Port of Walvis Bay, Namibia's largest commercial port, which received between 1,800 and 2,500 vessel calls each year and handles about 5 million tonnes of cargo. The Namibia Ports Authority (Namport) handles container imports, exports and transshipments, as well as bulk and breakbulk volumes of various commodities. The port serves a wide range of industries such as mining, petroleum, salt, and fishing. Namport is a major employer in the region, employing most of its 841 staff in Walvis Bay (NAMPORT, 2019; NAMPORT, 2025). The expanded container harbour at the port was in response to growth in port related activity serving the Southern African Development Community (SADC) region.

Industrial activities largely centre around the Namibian Export Processing Zone and secondary / service sector businesses (finance, retail, accommodation and food). The fishing industry is however, considered a critical economic sector (Walvis Bay Municipality, 2020) and provides an estimate of 8,000 local jobs.

The fishing sector is critical for the economy of Walvis Bay and warrants more consideration. The Food and Agriculture Organisation (FAO) recognises that Namibia has one of the most productive fishing grounds in the world, with 20 fish species that are commercially exploited (FAO, 2020). Most catches are landed at either Walvis Bay or Lüderitz; however, because of its strategic location in the middle of the fishing grounds, most of the landings and processing plants are in Walvis Bay (FAO, 2020). Walvis Bay and Lüderitz support businesses in both primary commercial fishing as well secondary fish processing.

During the 2020/21 financial year, a total of 207 vessels were licensed to operate in the Namibian Exclusive Economic Zone (Ministry of Fisheries and Marine Resources, 2021) with the majority based at Walvis Bay.

4.5.6.3 ECONOMY OF SWAKOPMUND

The economy of Swakopmund is similarly diverse but more oriented toward the service sector, reflecting its dual role as the regional capital and Namibia's premier coastal tourism destination. While it supports the broader Erongo economy through commerce and services to the mining sector, Swakopmund is most closely associated with tourism, retail, accommodation, and hospitality, complemented by construction and light manufacturing.

According to the Erongo Regional Profile, Swakopmund hosts 35.7% of all business establishments in the region (NSA, 2022), the largest share in Erongo. These are concentrated in wholesale and retail trade, accommodation and food services, construction, and manufacturing, alongside smaller but important clusters in professional services and finance. The town also houses 33.8% of Erongo's large business establishments, underscoring its importance as a service hub for the mining sector inland (NSA, 2022).

Tourism is a key driver. Swakopmund attracts both international and domestic visitors, offering historic architecture, coastal recreation, and a range of accommodation and restaurant offerings. The Mole serves as the main beachfront and tourism centre, while adventure-based tourism (quad biking, desert tours, water sports) has grown steadily.

The town also supports the inland uranium industry by providing housing, logistics, and engineering services to mines such as Rössing and Husab. As such, Swakopmund combines tourism, commerce, and mining support services, making it one of Namibia's most economically versatile towns.

4.5.6.4 ECONOMY OF HENTIES BAY

The economy of Henties Bay is narrower in scope and strongly defined by tourism, recreational fishing, and seasonal residence (NSA, 2022). Unlike Walvis Bay and Swakopmund, Henties Bay lacks large-scale industrial or port activity, but it serves as Namibia's "angling capital," drawing thousands of visitors and line-fishers each year, targeting species such as Cob, Steenbras and Black Bream. Its economy therefore revolves around hospitality, small-scale retail, and services linked to leisure and retirement living, making it more seasonal and less diversified than the other coastal centres. The town has a permanent population of just over 7,500 but swells during peak holiday seasons when visitors arrive for angling and leisure.

Unlike Walvis Bay or Swakopmund, Henties Bay has no major fish landing or processing plants. Instead, its economy depends on tourism-related fishing activities, holiday accommodation, and the retirement / second-home market. This is reflected in its demographic profile, with 13.5% of residents aged 60 or older, a significantly higher share than in other Erongo constituencies (NSA, 2022).

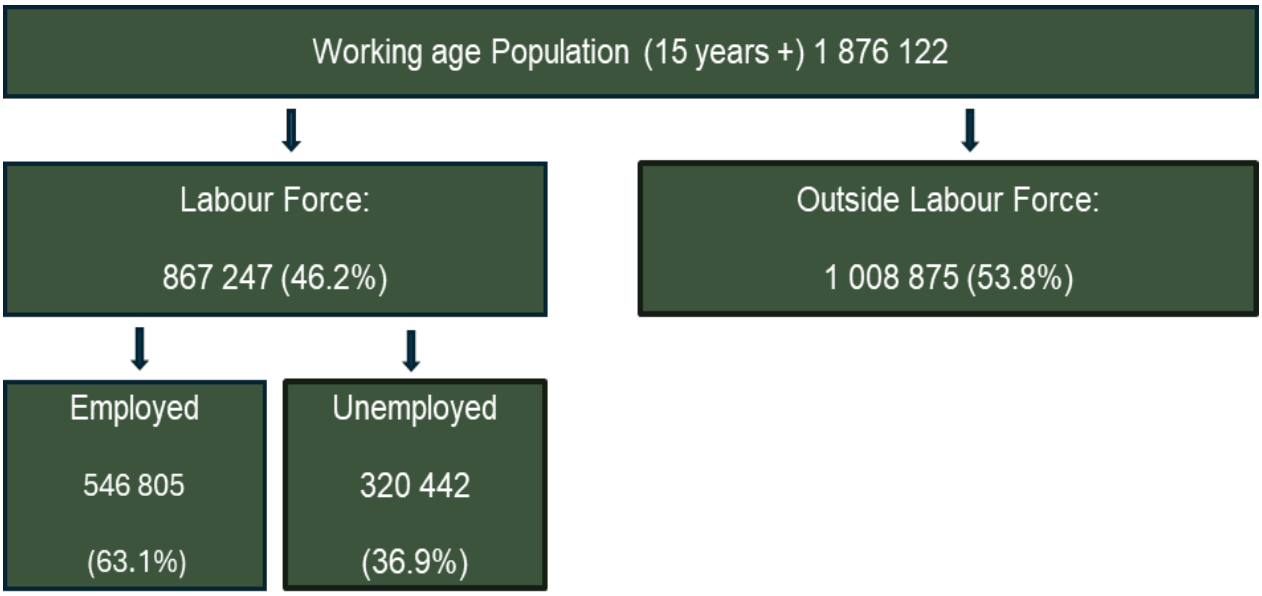
While service levels in Henties Bay are relatively high compared to rural hinterland settlements, the town's economy is vulnerable to fluctuations in tourism demand and marine resource availability, making it less resilient than the economies of Walvis Bay and Swakopmund.

4.5.6.5 EMPLOYMENT

In Namibia, the working-age population is defined as all persons aged 15 years and older. Out of a total national population of 3,022,401, the working-age population stood at 1,876,122 in 2023 (NSA, 2024(b))[8]. Figure 4-54 shows the structure of the national labour force, showing the share of employed, unemployed, and those outside the labour market.

[8] Those outside the labour force are defined as those that do not want employment and those that are not actively seeking employment.

FIGURE 4-54 NAMIBIAN LABOUR FORCE



Source: NSA, 2024b

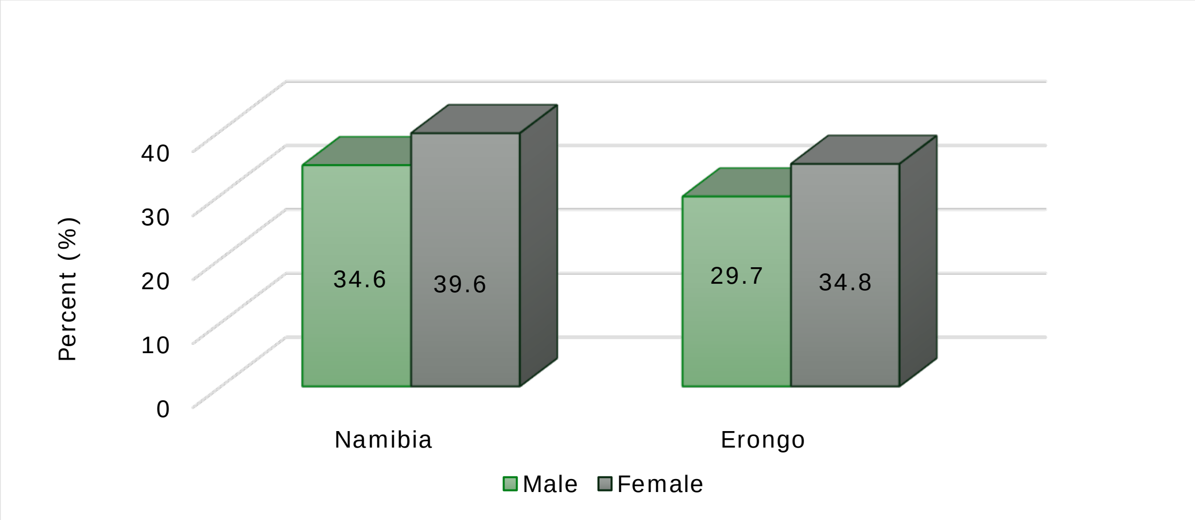
Within the labour force, 63.1% are currently employed while 36.9% are unemployed. The labour force is concentrated in urban areas (66.7%) and is dominated by men (53%). The largest segment of the labour force is in the 30-34 age group. Females have the largest share of the population outside the labour force (58.3%). Factors that contribute to the larger number of females outside of the labour force include societal expectations around gender roles, domestic duties, and family responsibilities such as childcare. Women tend to be primary care givers within their households which limits their opportunities to enter the labour force (Oyadele and Amulungu, 2025). Additionally, 66.7% of the working age rural population are outside the labour force compared to 42.7% of the urban working age population.

The Erongo Region has 8.8% of the national working age population, 12.3% of the national labour force, and 5.8% of the national population outside of the labour force. Erongo has the second highest proportion of the labour force after the Khomas Region which is significant given that it is only the 5th most populous region. In Erongo, 35.6% of the working age population are outside of the labour force, this is the lowest share observed across all regions in Namibia. The Region has a labour force participation rate of 64.4% which is higher than the national average (46.2%) (NSA, 2024).

The Erongo Region had one of the largest economically active populations in the country in 2023, with a labour force of 106,518 persons and a labour force participation rate (LFPR) of 64.4% (69.1% among males; 59.4% among females). This was well above the national LFPR of 46.2% (NSA, 2024(b)).

Despite strong participation, unemployment remains a concern. In 2023, Erongo recorded an unemployment rate of 32.0% (29.7% for males; 34.8% for females). Using the broad definition, which also includes people available for work but not actively seeking employment, the unemployment rate rises to 41.9% (38.0% for males; 46.3% for females). The gender divide in access to employment opportunities is shown in Figure 4-55, which compares Namibia and Erongo.

FIGURE 4-55 LEVELS OF UNEMPLOYMENT (STRICT DEFINITION)



Source: NSA, 2024b

At constituency level, patterns reflect both industrial concentration and settlement dynamics. Walvis Bay Urban recorded the lowest broad unemployment rate at 38.3%, while Walvis Bay Rural recorded the highest at 42.6%, reflecting its dispersed peri-urban and communal population. Swakopmund (40.7%) and Arandis, including Henties Bay (43.5%) were close to the regional mean. These differences are illustrated in Figure 4-56 and summarised in Table 4-14.

TABLE 4-14 UNEMPLOYMENT AND YOUTH UNEMPLOYMENT IN ERONGO AND KEY CONSTITUENCIES, 2023

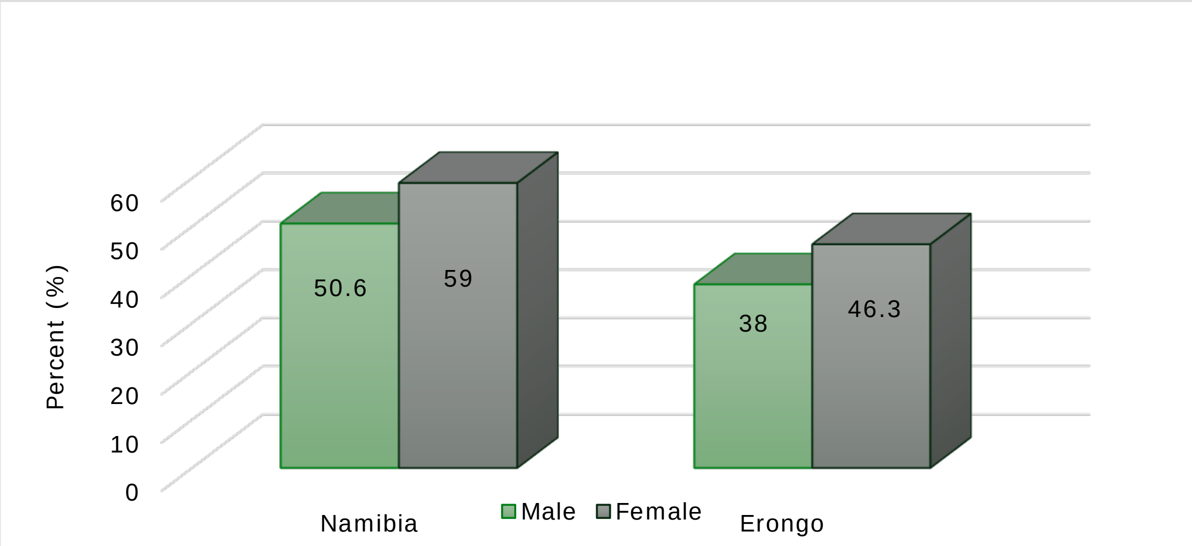
Area	Unemployment Rate	Broad Unemployment Rate	Youth Unemployment	Youth Broad Unemployment
Erongo Region	32.0%	41.9%	40.7%	50.6%
Walvis Bay Urban	–	29.8%	40.1%	49.5%
Walvis Bay Rural	–	34.6%	44.9%	53.1%
Swakopmund	–	31.7%	40.3%	49.4%
Arandis (incl. Henties Bay)	–	32.9%	40.3%	50.6%

Source: NSA, 2024b

Broad unemployment includes people actively seeking work as well as those available for work but not actively looking (potential labour force).

Youth unemployment is particularly concerning. Across Erongo, 40.7% of young people (aged 15–34 years) were unemployed in 2023. In the main coastal constituencies, youth unemployment stood at 40.1% in Walvis Bay Urban, 44.9% in Walvis Bay Rural, 40.3% in Swakopmund, and 40.3% in Arandis / Henties Bay. When combined with the potential labour force (youth available for work but not actively seeking work), youth unemployment rises above 50% in several constituencies, peaking at 53.1% in Walvis Bay Rural.

FIGURE 4-56 LEVELS OF UNEMPLOYMENT IN NAMIBIA AND ERONGO (BROAD)



Source: NSA, 2024b

Employment in Namibia is mostly derived from the agriculture, forestry and fishing sectors as shown in Table 4-15. In the Erongo Region, key sectors include manufacturing, wholesale and retail trade, and agriculture, forestry, and fishing (NSA, 2022).

TABLE 4-15 EMPLOYMENT BY INDUSTRY SECTORS

Sector	% of Employment in Namibia (2023)	% of Employment in Erongo (2021)
Agriculture, forestry, and fishing	16.%	14%
Mining and quarrying	2.6%	1%
Manufacturing	9.8%	17%
Electricity, gas, steam, air conditioning supply	0.3%	0%
Water, sewerage, waste management, remediation	0.4%	0%
Construction	5.2%	3%
Wholesale and retail trade, repair of motor vehicles and motorcycles	10%	19%
Transport and storage	3.3%	5%
Accommodation and food	5.4%	9%
Information and communication	1.5%	0%

Sector	% of Employment in Namibia (2023)	% of Employment in Erongo (2021)
Financial and insurance	3.1%	1%
Real estate	0.2%	0%
Professions, scientific, and technical	2.9%	2%
Administrative and support services	9.3%	7%
Public administration and defense, compulsory social security	6.6%	6%
Education	7%	7%
Human health and social work	3.4%	3%
Arts, entertainment, and recreation	0.6%	1%
Other services	4.4%	2%
Subsistence production	7.9%	-
Extraterrestrial organisations	0.1%	0%

Source: NSA, 2024

The Erongo Region has a share of 16.7% of the total employment within the manufacturing sector. This is the largest share of all the regions in the country. Erongo has 12.1% of the share of employment in agriculture, forestry, and fishing, having the largest percentage of people employed in fishing at 5,285 from the total of 8,391 for the whole country.

Agriculture in the Erongo Region is dominated by livestock rearing (primarily sheep and goats), followed by crop farming (maize, sorghum, and wheat) and poultry. However, the agricultural sector within Walvis Bay is relatively small. At the time of the 2011 census, only 2.1% of households in Walvis Bay Urban and 5.2% in Walvis Bay Rural were engaged in livestock rearing (NSA, 2014). Given the urban and peri-urban nature of these two constituencies, the low engagement in agriculture is expected.

Of the employed persons in Namibia, 17.9% earn a gross monthly salary/wage of N$1,000 or less, 16.2% earn N$1,000 to N$2,000, 11% earn N$2,001 to N$3,000, and 10% earn N$3,001 to N$5,000. Only 2.6% of those who are employed earn more than N$40,000 per month (NSA, 2024).

Most households in Namibia derive their livelihoods from wages or salaries (46.6%), followed by pensions (13.8%), subsistence or commercial farming (10.6%), business activities (9%), social grants (2.6%), and child support (2.4%). In rural areas, pensions (21.8%) and farming (22.2%) are more common sources of income for households with salaries and wages supporting 30.8% of household’s livelihoods.

The unemployment rate in Namibia was 36.9% in 2023, an increase from 33.4% in 2018. Unemployment is marginally higher in rural areas (38%) compared to urban areas (36.4%). The unemployment rate in the Erongo Region is 32%, the fourth lowest rate seen nationally. Lower unemployment rates are seen in the ǁKharas Region (29.7%), Omaheke Region (30.3%), and Otjozondjupa Region (31.2%). The highest unemployment rate is observed in the Kavango West Region (52.8%). Nationally, unemployment is most pervasive amongst younger persons, especially the 15-19 year age group (57.7%). Females generally experience higher unemployment (39.6%) than men (34.6%). Individuals that are able to attain a tertiary education have the lowest level of unemployment (17.7%) compared to a 42.6% unemployment rate for individuals who have only completed a primary level education.

The informal economy in Namibia is significant. It has been reported that in 2023, informal economic activities contributed to around 24.7% of the country's GDP. The informal sector is also one of the key sectors for employment. In countries with high population growth like Namibia, the informal economy is vital for absorbing the growing labour force. However, there are no safeguards within the informal economy to ensure decent work (working hours, income, skills development, etc.). Therefore, engagement with the informal economy is often linked with vulnerabilities and poverty.

The informal economy in Namibia includes subsistence agriculture, artisanal mining, trading (markets, street vendors, hawkers, rural retail stores, etc.), transport (unregistered taxis), and small loan and savings schemes. Informal employment accounts for 57.7% of total employment in Namibia. Informal employment is more common amongst females (Ministry of Industrialisation and Trade, 2024).

The informal sector within the Erongo Region is not considered a major component but does contribute to the local economy and employment creation. The informal economy is primarily centred on trade where individuals by good from wholesalers and suppliers within the formal sector and then resell the goods within informal markets. Overall, the informal sector in Namibia is estimated to contribute around 24% to national GDP. However quantitative data on the contributions of this sector are not accounted for in national statistics. People in this sector face numerous challenges due to a lack of labour rights, poor social protection, and lack of access to finance and credit (The Brief, 2025).

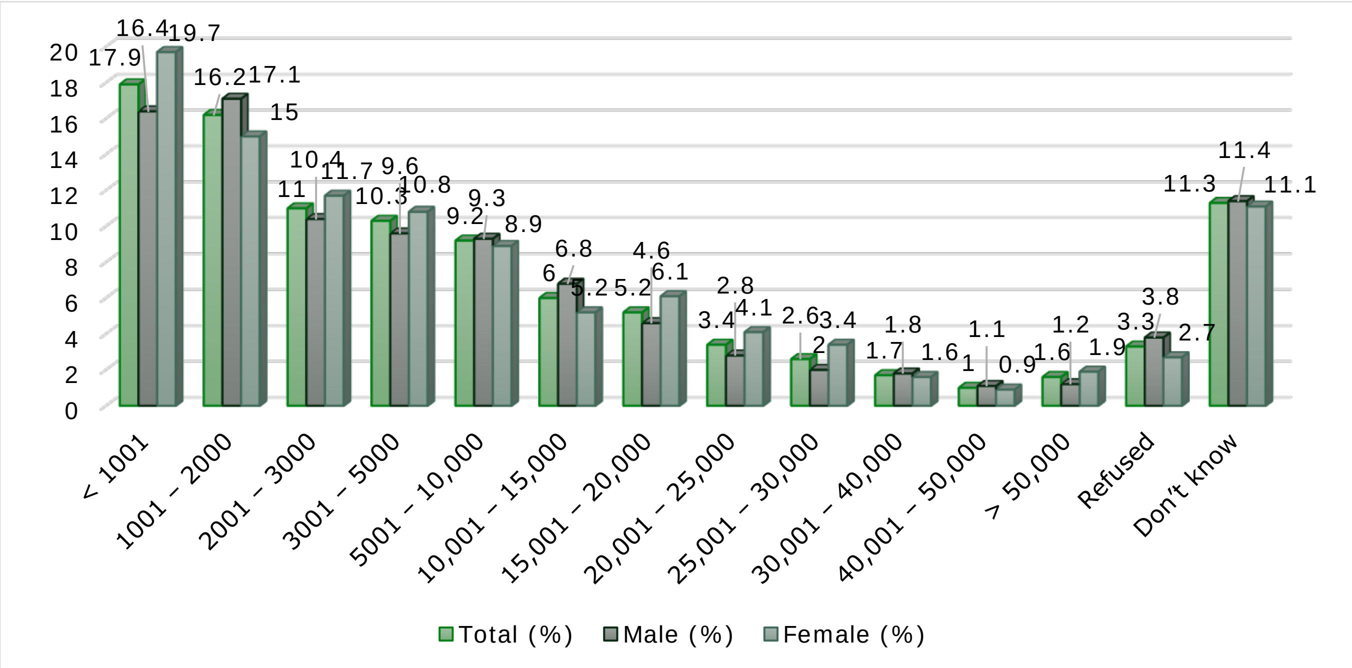
In 2023 Namibia had a Human Development Index (HDI) value of 0.665. This equated to a medium level of development. Namibia's HDI score has been steadily improving since 1990 which has been linked to improving life expectancy and education access (United Nations Development Programme, 2025). However, this development has not been experienced equally across the country. When the HDI score is adjusted for inequality, it falls considerably. Inequality in Namibia are often tied to income, wealth distribution and the availability of opportunities differing significantly between men and women, urban and rural areas, and different groups in society. When people do not have the same opportunities as others, they are limited in their ability to benefit from advancements in HDI dimensions. Further challenges are faced due to disparities in access to land and housing. Women tend to be particularly disadvantaged in respect to income, health, and security. The urban-rural divide is particularly apparent in the disparities in access to education (United Nations Namibia, 2020).

According to a report on the Multidimensional Poverty Index (MPI) from 2021, more than 43.3% of the population of Namibia live in multidimensional poverty. The MPI score for Namibia in 20221 was 0.191 with an intensity of poverty of 44%. This means that poor people in Namibia on average experience 44% of the weighted deprivations considered within the index. Poverty in rural areas is much higher than in urban areas of the country (59.3% and 25.3% respectively). Poverty is higher in female-headed households and larger households (NSA, 2021).

4.5.6.6 HOUSEHOLD INCOME

The income that a household earns provides further indication of the well-being of such a household. Household incomes in Namibia, according to the 2023 Population and Housing Census Labour Force Report, is low for the majority of households in the country. Figure 4-57 provides a comparison between the percentages in each category for all individuals as well as for males and females separately. It is concerning that 45.1% of people earned less than N$ 3,000 per month while very few (4.3%) earn more than N% 30,000 per annum.

FIGURE 4-57 GROSS MONTHLY INDIVIDUAL INCOME FOR NAMIBIA



Source: NSA, 2024b

4.5.7 POVERTY AND INEQUALITY

Namibia was reclassified by the World Bank in July 2025 as a lower-middle-income country, having fallen below the upper-middle-income threshold due to slower economic growth and revised population figures. This underscores the vulnerability of Namibia's development trajectory (World Bank, 2025).

As mention in Section 4.5.6.5 Namibia in the medium human development category for HDI. When adjusted for inequality, Namibia's IHDI declines to 0.402, reflecting the country's persistently high inequality (UNDP, 2022).

Poverty remains a challenge. Based on the international poverty line of USD 2.15 per day (2017, PPP), the World Bank estimated that 19.6% of Namibians lived in poverty in 2025, equivalent to around 606,000 people. Poverty incidence had declined from 19.5% in 2009/10 to 17.4% in 2015/16 but increased sharply to 26.9% in 2022, largely due to the socio-economic impacts of COVID-19 (NPC, 2021; World Bank, 2024; AfDB, 2024).

Income inequality remains among the highest in the world. Namibia's Gini coefficient fell slightly from 0.59 in 2009/10 to 0.57 in 2015/16, but by 2022 it had risen again to 0.61, signaling a widening gap between rich and poor (AfDB, 2024). Vulnerable households — including female-headed households, those with low education levels, large families, children and elderly members, and those dependent on subsistence or informal activities — are particularly exposed to poverty risks (World Bank, 2024).

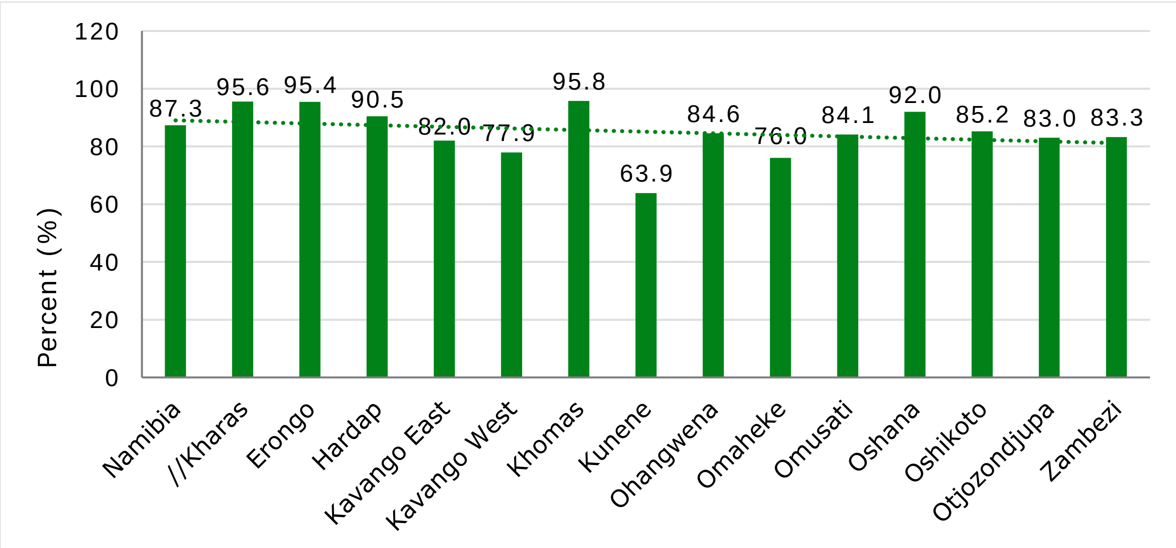
Within Namibia, the Erongo Region performs relatively well. Poverty mapping shows that only 2.4% of Erongo's population was below the national poverty line in 2011, making it the second least deprived region (NPC, 2011). At constituency level, Walvis Bay Urban ranked as the fifth least deprived constituency nationally, with Swakopmund and Arandis also reflecting relatively strong socio-economic conditions due to their urban and industrial bases (NPC, 2015).

4.5.8 EDUCATION

In Namibia, 87.3% of the population aged 15 years and over is considered literate. There is no significant difference in the literacy rates of males and females. The 2023 census results show that literacy is highest in urban areas (93.8%) and significantly lower in rural areas (79.6%). Literacy is highest among the youth population aged 15-34 years. The Erongo Region has a literacy rate of 95.4% for individuals ages 15 years and over. The higher literacy rate may be linked to the urban and peri-urban nature of parts of the Region where access to education will be improved compared to more rural and isolated regions.

Figure 4-58 indicates the literacy rates in Namibia by region according to the 2023 Population and Housing Census. The Erongo Region recorded a literacy rate of 95.4%, placing it among the highest in the country, and well above the national average of 87.3%. This reflects the region's urbanised character and concentration of education infrastructure.

FIGURE 4-58 LITERACY RATE BY REGION



Source: NSA, 2024

School attendance in for the population aged 6 years and over in Namibia and Erongo is detailed in Table 4-16. School attendance in Erongo is better than in Namibia on average with 4% of the population in the region having never attended school compared to 9.7% nationally. Given that the population of Erongo is slightly older than the national average it is expected that a smaller proportion of the population are currently attending school and a larger proportion have left education compared to national averages.

TABLE 4-16 EDUCATION ATTENDANCE, 2023

Education Level	% Attendance for Namibia	% Attendance for Erongo
Never attended	9.7%	4%
Pre-primary	2.1%	1.8%
Primary and secondary	31.2%	24.1%
Tertiary	5.3%	5.1%
Adult Education	0.3%	0.1%
Left education	50%	63.4%
Unknown	1.4%	1.5%

Source: NSA, 2024

Of the population aged 6 to 24 years, the enrolment rate in education is 76.5% in Namibia. School enrolment is slightly higher in urban areas (78.4%) than in rural areas (74.6%). The Erongo Region has a slightly lower enrolment rate than the national average at 74.2%. The Kunene Region has the lowest enrolment rate at 54.3%. School attendance in Namibia is mandatory for persons aged 6 to 17 years. There are generally good enrolment rates for children aged 6-14 years (peaking at 94.5% for 11 year olds). However, from 15 years of age, enrolment appears to drop significantly, with 82.2% of 17 year olds and 70.9% of 18 years olds still in school. Only 23.8% of 24 year olds are enrolled in education, highlighting the small number of individuals that are attaining a tertiary education.

The majority of the population aged 15 years and over in Namibia have completed primary school as their highest level of educational attainment as shown in Table 4-17. Only 11.8% of those aged 15 and over have completed a tertiary level education. Marginally more females have completed tertiary education (12.2%) than males (11.4%) (NSA, 2024).

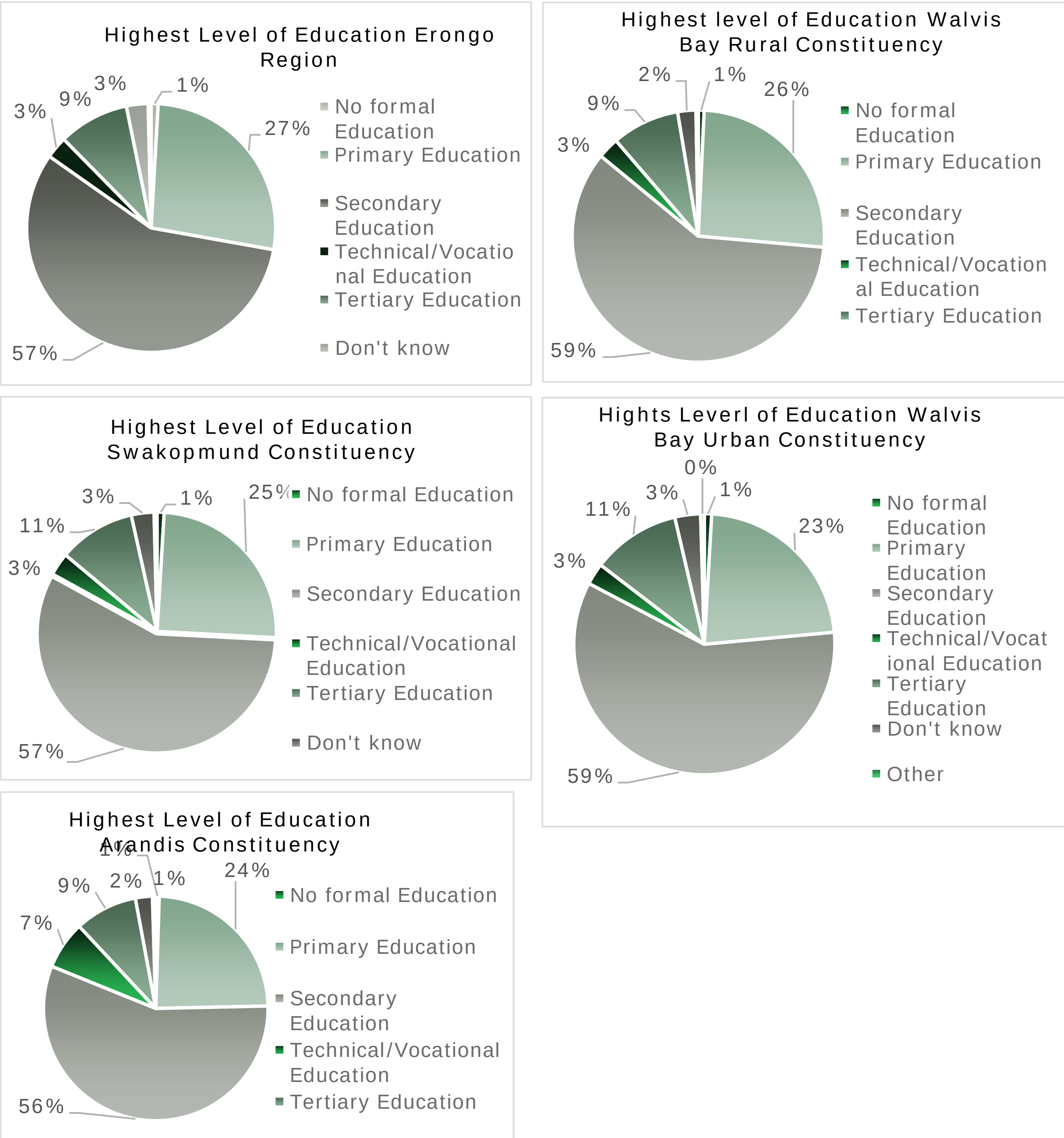
TABLE 4-17 EDUCATION ATTAINMENT IN NAMIBIA

Education Level	Namibia
No formal education	1.2%
Incomplete primary education	15.1%
Primary education	44.7%
Secondary education	24.8%
Tertiary education	11.8%

Source: NSA, 2024

The highest level of educational attainment of the population aged 15 years and over within the Erongo Region and its constituencies is detailed in Figure 4-59 below. Educational attainment does not vary significantly between Erongo and Walvis Bay. Within the region, Walvis Bay and Swakopmund show slightly higher levels of secondary and tertiary attainment than the regional average, reflecting their urbanised nature and the presence of private and technical training institutions. In contrast, Arandis (including Henties Bay) shows somewhat lower levels of tertiary attainment, with education levels skewed more toward secondary school completion. This highlights differences in education access and outcomes within the coastal constituencies.

FIGURE 4-59 HIGHEST LEVEL OF EDUCATION POPULATION OVER THE AGE OF 15, 2023



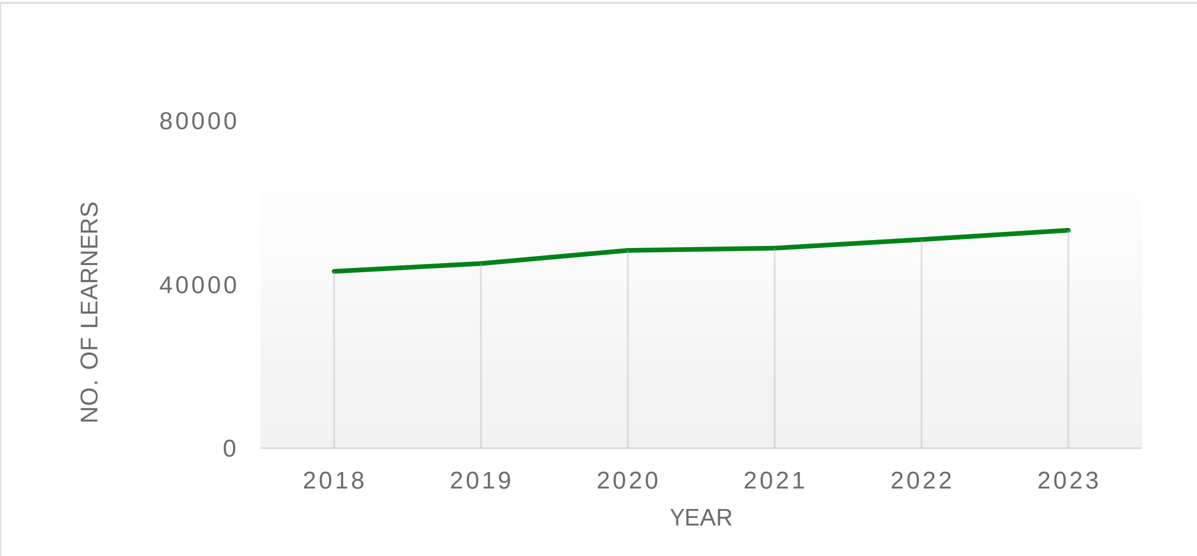
Source: NSA, 2025

The Namibian government has improved access to education through increasing the proportion of the national budget spent on this sector. Between 2012 to 2019 expenditure on the development of educational infrastructure rose substantially. Construction of new schools has improved access for children. In 2010 48.6% of children had access to their nearest primary school that was within one km of their homes. However, access to schools in rural areas is still a challenge with many children having to travel significant distances to reach their schools. Access to pre-primary education also remains limited in the country. The learner to teacher ratio in 2016 in Namibia was 1:25.5. This represented a slight increase from 2012 (1:25.1). The ratio ranges quite significantly between regions. For example, in 2016 the ratio in the Zambezi Region was 1:22.8 while in the Kavango East Region it was 1:31.7. It is estimated that at least 9% of schools in 2016 had a suboptimal learner to teacher ratio (UNICEF, 2017).

According to the Ministry of Education's Education Management Information System (EMIS) 2023 report, the Erongo Region had 18 secondary schools, 17 combined schools, and 49 primary schools. Twenty of these schools are situated in Walvis Bay, underscoring the town's role as the region's largest educational hub (Ministry of Education, 2023).

Figure 4-60 demonstrates a steady increase in the number of learners in Erongo, from 43,213 in 2018 to 53,258 in 2023. The number of children per school increased from about 576 learners per school in 2018 to about 619 in 2023, substantially higher than the national average of 390 learners per school. The learner-to-teacher ratio in Erongo also increased, from 24.8 in 2018 to 26.8 in 2023, indicating growing pressure on education infrastructure (Ministry of Education, 2023).

FIGURE 4-60 GROWTH IN NUMBER OF LEARNERS IN THE ERONGO REGION, 2018–2023



Source: Ministry of Education, 2023

4.5.9 HEALTH

Namibia recognises that health is a fundamental human right and is committed to achieving health for all Namibians. The main health and well-being issues for Namibia are child and maternal mortality, Human Immunodeficiency Virus (HIV), malaria- and Turberculosus (TB)-related deaths, Non-Communicable Diseases (NCDs), and road accident deaths (The Nambia Ministry of Health and Social Services (MoHSS) and ICF International, 2014).

As specified in the United Nations General Assembly Special Session (UNGASS) on HIV and Acquired Immune Deficiency Syndrome (AIDS), young people in the 15-24 age range is an important group to monitor with regard to reductions in HIV incidence at the population level (UN General Assembly, 2001, as cited in (The Nambia Ministry of Health and Social Services (MoHSS) and ICF International, 2014) .

In 2013, testing of women and men aged between 15 and 24 revealed an HIV positive infection rate of 4.1% in the Erongo Region and 2.8% in the ǁKharas Region (The Nambia Ministry of Health and Social Services (MoHSS) and ICF International, 2014).

The HIV incidence per 1,000 people (all ages) has decreased from 3.31 in 2018 to 2.81 in 2020. The female and male incidence rates were 3.96 and 2.66 in 2018, respectively which declined to 3.70 and 2.25 in 2020 (NPC, 2021). The total number of HIV infections in the 15-49 age category was 7 190 in 2018 and reduced to 6 353 in 2020 (NPC, 2021).

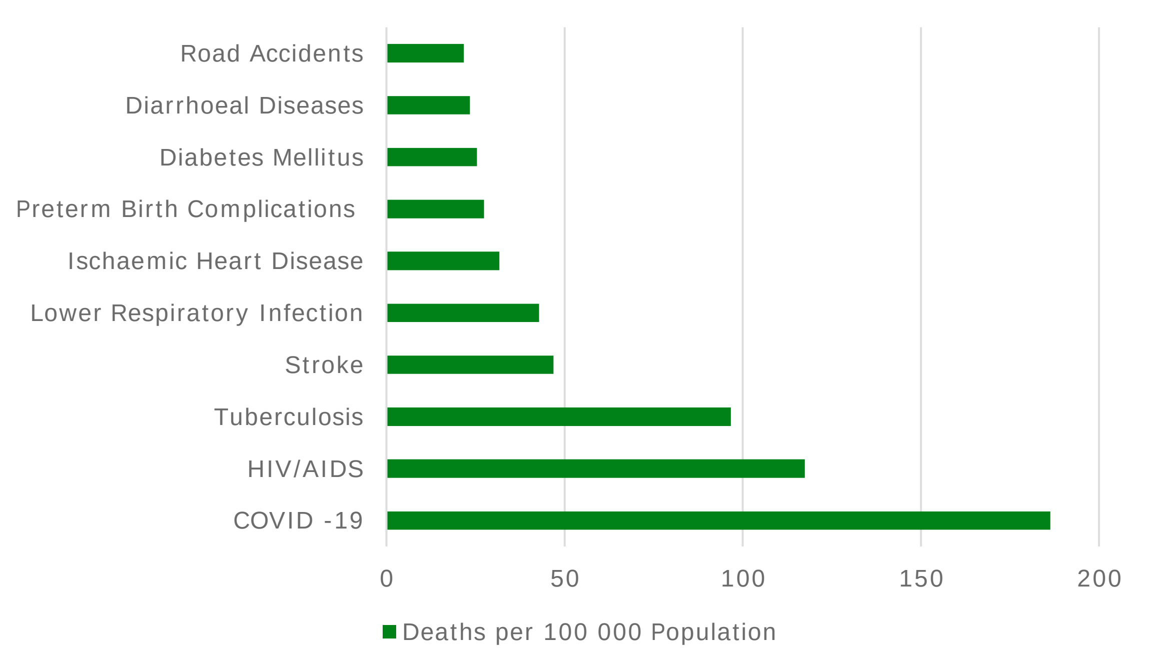
According to the World Health Organization (WHO), life expectancy at birth was 60.4 years in 2021 for Namibia. Life expectancy is higher for females (63.4 years) compared to males (57.3 years). The average life expectancy at birth for Namibia is lower than the average for Africa (63.6 years). Life expectancy in the country has been improving rising from 53 years in 2000. However, this improvement is occurring at a slower rate than the African region as a whole.

The leading cause of death in Namibia in 2021 was COVID-19 as shown in Figure 4-61. A population with a high incidence of HIV also has additional health issues associated with compromised immune systems. For instance, there were 468 tuberculosis infections per 100,000 population in 2023 across Namibia. This infection rate has worsened since 2022.

Malaria is also present in certain regions in the country, particularly in the north and north east regions such as Omaheke. In 2022, there were 8.29 malaria infections per 1,000 population at risk. This infection rate has improved since 2021. The under-five mortality rate is 37.88 per 1,000 live births, improving since 2021 and is below the regional average for sub-Saharan Africa (71 per 1000 live births). The Erongo Region is considered malaria free.

Road traffic accidents had a mortality rate of 22 per 100,000 population in 2021. Maternal mortality was 215 per 100,000 live births in 2020. This has improved significantly since 2012 when there was a maternal mortality ratio of 362 (World Health Organization, 2024).

FIGURE 4-61 LEADING CAUSES OF DEATH NAMIBIA, 2021



Source: NSA, 2024

The majority of Namibians make use of public health services (82%), with the remaining 18% accessing private healthcare through medical insurance schemes. Access to healthcare is considered good, with 76% of the population on average living within 10 km of a healthcare facility.

The Ministry of Health and Social Services is responsible for providing public health services. Healthcare is provided in a four tier system that includes primary healthcare sites (e.g. clinics), district hospitals, intermediate hospitals, and referral hospitals. Clinics generally are staffed by nurses and pharmacy technicians and assistance. Patients that require medical attention from doctors are referred to larger primary healthcare centres that are staffed by doctors, nurses and pharmacists. If a patient requires more specialist care, they are referred to district hospitals. Not all district hospitals have every specialist on staff; therefore, patients may be referred to intermediate hospitals if they require additional care. The most medically complex cases are all referred to the Windhoek General Hospital.

There are 844 private healthcare facilities in Namibia that employ 72% of all the doctors in the country and just under 50% of all the nurses.

In rural areas, on average, each primary healthcare facility serves a population of 5,780 people while each district hospital serves 58,825 people. This has resulted in overcrowding and long wait times. In response, many people travel significant distances to attend clinics and hospitals in areas far from their homes that are perceived to be less crowded and provide better services. The public health system in Namibia is facing challenges from a shortage of qualified professionals as well as high staff turnover. This is not helped by the fact that many medically trained people choose to work within the private health system where salaries are higher, and workloads tend to be more manageable (Christians, 2020).

The public healthcare system in the Erongo Region is facing similar challenges to those seen nationally. The demand for healthcare services in the region is growing as the population is aging. Staff shortages limit the provision of adequate services and specialist treatment. It was noted that clinics and health centres are particularly overcrowded in Walvis Bay and Swakopmund due to rural-urban migration. Physical infrastructure is not equipped to meet the demands of the growing population. Old and unreliable ambulances and other patient transport vehicles used by the healthcare services also limit the accessibility of rural and isolated populations to reach services (Uirab, 2024).

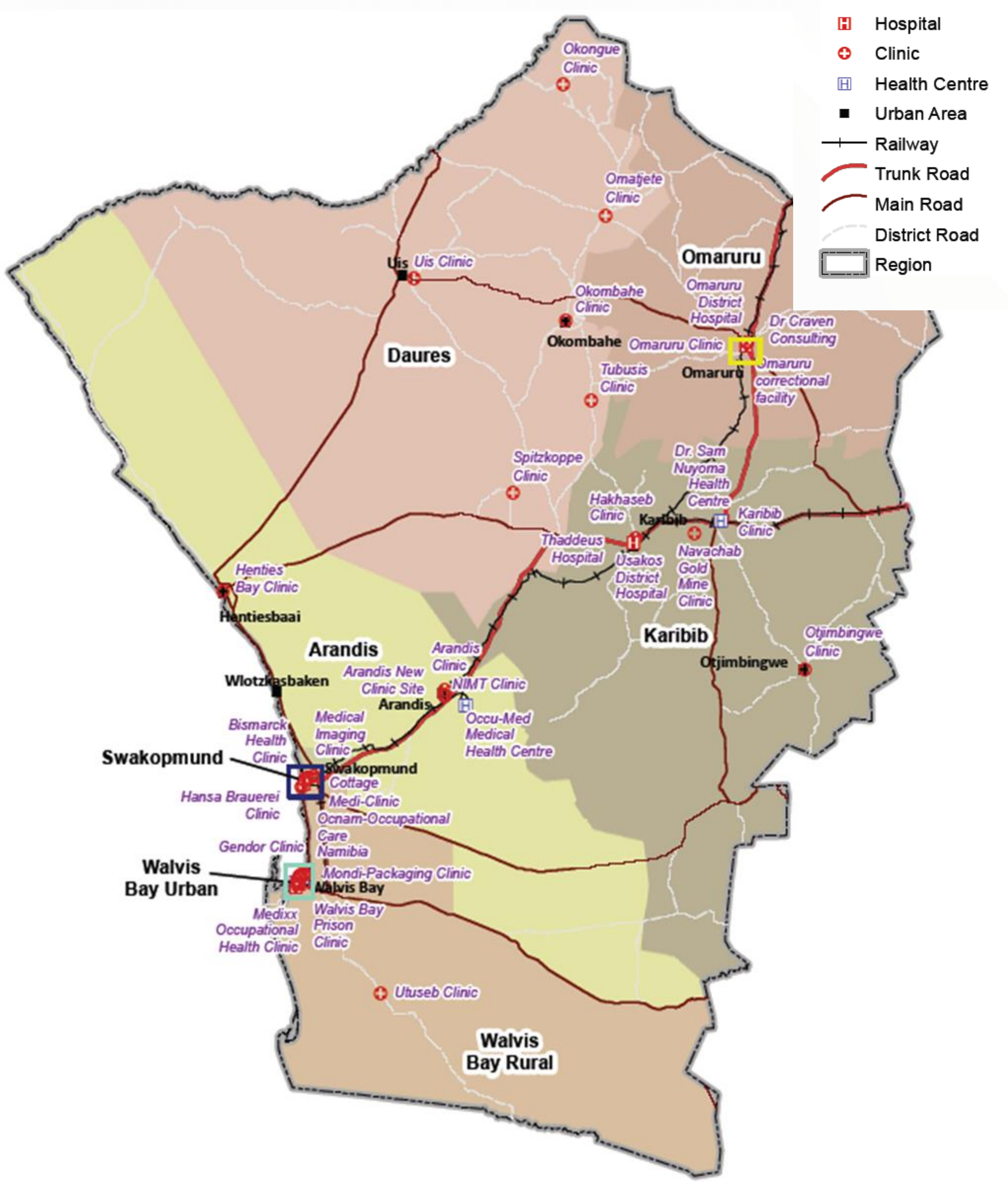
Figure 4-62 and Table 4-18 shows the distribution of health services in the Erongo Region and clearly illustrate the dominance of the towns of Swakopmund and Walvis Bay with respect to access to health services. The region had seven hospitals, four health centres and 44 clinics in 2023. It had a total of 55 health facilities in 2023, up from 49 in 2023.

TABLE 4-18 HEALTH FACILITIES BY REGION AND CONSTITUENCY, 2023

Area / Constituency	Health Facilities	Health Facilities	Clinics	Health Centres	Hospitals
Namibia	1,120 est.	1,150 est.	1,050+	44	34
Erongo Region	49	55	44	4	7
Walvis Bay Urban	17	20	16	2	2
Swakopmund	11	10	9	0	1
Walvis Bay Rural	1	2	2	0	0
Henties Bay	3	3	2	0	1
Arandis	4	5	4	1	0

Source: NSA, 2023

FIGURE 4-62 DISTRIBUTION OF HEALTH FACILITIES IN THE ERONGO REGION



Source: NSA, 2023

4.5.10 INFRASTRUCTURE AND SERVICES

4.5.10.1 ENERGY

The dominant source of energy used for cooking and lighting is mains electricity, reported by 46.9% of households in Namibia during the 2023 census. Lighting that uses a connection to the public electricity grid is more common in urban areas (69.2%) than rural areas (19.9%). In rural areas, it is more common for households to use battery lamps or torches for lighting (53%) or solar energy (17.8%). In the Erongo Region, 77.7% of households use grid electricity for lighting, followed by 10.9% that use battery lamps or torches.

Electricity from the national grid is not the most common source of energy used for cooking in Namibia. Wood / firewood is used by 50.1% of households as their primary source of energy for cooking. Grid electricity was used by 34.1% of households. In urban areas, households are more likely to cook using grid electricity (55%) compared to rural households (8.8%). Gas is used by 21.8% of urban households whereas 84.6% of rural households used wood / firewood for cooking.

In the Erongo Region, grid electricity is used by 72.9% of households for cooking. Followed by 13.3% that use wood / firewood, and 12.9% that use gas. Furthermore, 77.7% of households in Erongo use mains electricity for lighting. Access to grid electricity is more common in urban or semi-urban areas of the region. In rural areas of the Erongo Region, a grid connection is much less common. For example, only 41% of households in the Daures Constituency had access to electricity from the grid for lighting, with many of these households using solar power or battery powered lamps for lighting. Additionally, these rural households often used wood as an energy source for cooking (NSA, 2024). The primary electricity provider in Namibia is the Namibia Power Corporation (NamPower) which is a state owned utility company. NamPower is responsible for electricity generation, transmission and distribution throughout the country. There are some Regional Electricity Distributors (RED) that play a role in local distribution from the NamPower grid (NamPower, n.d.). Erongo Red is a commercialised electricity company operational within the Erongo Region. The distributor was formed from a merger of the electricity distribution services that had previously been operational in towns, municipalities and constituencies (in particular Walvis Bay, Swakopmund, Henties Bay, Omaruru, Karibib, Usakos and Arandis). This merger was done in conjunction with the Erongo regional Council and NamPower. The company purchases electricity from NamPower and then distributes it locally to customers (Erongo RED, n.d.).

Within the project AoI, electrification is nearly universal in the main towns: 99.1% of households in Walvis Bay Urban and 98.7% in Swakopmund. Arandis (including Henties Bay) reported 92.3%, while in Walvis Bay Rural the share was lower at 82.4%, reflecting more scattered settlement structures (NSA, 2025).

4.5.10.2 WATER AND SANITATION

Access to safe drinking water is a key indicator of development. Drinking water is considered safe if it is derived from piped water (inside or outside tap), public fountains, protected wells, bottled water, and protected boreholes (with tank covers). Around 91.4% of households in Namibia have access to safe drinking water. This proportion is higher in urban areas (98%) than rural areas (83.5%). The majority of households in the country get their drinking water from an inside tap connected to a public piped water supply (41.7%). Unprotected boreholes were used by 2.3% of households, rivers/dams/streams by 3%, canals by 0.4% and unprotected wells by 1.5%.

In the Erongo Region, 97.6% of households have access to safe drinking water. The majority of households have access to piped water in their homes (59.1%), piped water in outside taps (14.7%) or public fountains (14.2%). Unsafe drinking water sources are used by a small minority of households: unprotected borehole (1.1%), river/dam/stream (0.6%), unprotected well (0.1%). Overall, 73.7% of households in Walvis Bay Urban have access to piped water in their homes, while 14% have access to piped water from a tap / fountain outside of their homes. In Walvis Bay Rural, 65.9% of households have piped water in their homes and 23.4% of households make use of an outside tap. Piped water was available in 69.2% of households in Swakopmund, 61.5% in Arandis (incl. Henties Bay).

Access to adequate sanitation is relatively poor in Namibia. The majority of households have no toilet facilities and partake in open defecation (40%). Only 33.8% of households have access to a private flushing toilet that is connected to a public sewerage system. Access to private toilets is more common in urban households (54.4%) while only 8.9% of rural households have access to this form of sanitation. Open defection is the most common form of sanitation used in rural households (63.8%). In Arandis (including Henties Bay), 62.3% of households reported flush toilets connected to the sewer, while Walvis Bay Rural recorded 54.9%. Households without any toilet facility were rare in Walvis Bay Urban (0.1%) but higher in Walvis Bay Rural (7.6%) and Arandis / Henties Bay (6.8%) (NSA, 2025).

Access to adequate sanitation has been slowly improving in Namibia, with a reduction in the percentage of households having no toilet facilities from 48.6% in 2011 to 40% in 2023.

Households in the Erongo Region have better access to adequate sanitation compared to the national averages. Overall, 68.8% of households in the region have access to a private flushing toilet connected to a public sewerage network, with only 9.7% of households engaging in open defecation. This is a marginal improvement from 10.6% of households in 2011. In Walvis Bay Urban, 89.7% of households have a private flush toilet connected to a main sewer. Access in Walvis Bay Rural (84.7%) and Swakopmund (85.5%) is similar (NSA, 2024). The primary water provider in Namibia is NamWater. This is a state owned utility company that supplies bulk water to urban municipalities and rural communities (NamWater, n.d.).

4.5.10.3 WASTE MANAGEMENT

Most households in Namibia dispose of their waste through regular collection (36.9%) or burning (24.2%) and dumping outside in a field/bush (23.1%). Regular waste collection is not common in rural areas (4.4%). However, in urban areas this is the dominant form of waste management (63.7%). For rural households, burning waste is the most common (41.8%).

In the Erongo Region, regular waste collections are used by 78.4% of households for the disposal of their waste. This is the highest rate of regular waste collections across all regions of Namibia. Only 8.1% of households in the region burn their waste, and 2.7% dump their waste outside, 8.1% burn their waste, and 4.1% deposit their waste in a rubbish pit.

Walvis Bay Urban recorded 98.2%, Swakopmund 96.2%, Arandis (incl. Henties Bay) 84.6%, and Walvis Bay Rural 71.5% (NSA, 2025). According to the Erongo Regional Profile (NSA, 2022), Walvis Bay and Swakopmund municipalities operate formal landfill and transfer facilities, while Henties Bay and Arandis rely on smaller disposal sites with more limited coverage.

4.5.10.4 TELECOMMUNICATIONS

Access to telecommunications varies widely in Namibia with a clear urban rural divide. Most Namibians have access to mobile phones with 98% of the population aged over 15 having coverage. However, access to fixed line telephones, televisions, internet and broadband is still limited in some areas. In 2023, 28.3% of the population ages 3 years and above in Namibia has access to the internet and 52.2% had their own mobile phone. In the Erongo Region, 47.8% of the population aged 3 years and older had access to the internet in 2023 and 67.3% had their own mobile phone. Access to telecommunications in Erongo is improved compared to the national average. There have also been significant improvements since the previous census. For example, in 2011 only 15.5% of the population aged 3 years and over in Erongo had access to the internet (NSA, 2024). The largest telecommunications provider in the country is Mobile Telecommunications Company (MTC) Namibia. MTC also provides internet services. Other providers include Telecom Namibia and Paratus.

4.5.10.5 TRANSPORT INFRASTRUCTURE

Namibia has a relatively well established road network, however, the quality of roads is not always good. The majority of towns and settlements can be reached via the road network that consists of district, main, and trunk roads. The road network totals a distance of around 48,117 km. Of this 4,500 km are tarred roads. The remining roads tend to be gravel or dirt roads. Namibia has a series of tarred national highways that link key towns with neighbouring countries. For instance, the Port of Wlavis Bay is connected visa the Trans-Caprivi Highway and the Trans-Kalahari Highway to Botswana, and the Democratic Republic of the Congo and then on to other countries such as Zambia, Zimbabwe and South Africa.

Namibia has 16 licensed airfields across the country, but main air travel is via the Hosea Kutako International Airport in Windhoek. The airport offers regional flights to major sub-Saharan cities such as Cape Town, Johannesburg, Gaborone, Luanda, and Harare. There are also a small number of long haul international flights (Namibia Investment Centre, 2025).

- Ports

The port of Walvis Bay is the largest port in Namibia. A smaller secondary port is located in Lüderitz. Both ports are operated by the Namibian Ports Authority (NPA). Walvis Bay port has a deep-water harbour that has a depth of 12.8 m and can accommodate vessels up to 2,400 tonnes in 13 commercial berths. A new container terminal was completed in 2019 that has an additional quay with a depth of 16 m. Walvis Bay receives around 899 vessels per year and handle around 8 million tonnes of cargo. Cargo that travels through the port includes imports, exports and transhipments as well as bulk and break-bulk volumes of numerous commodities. The port also has a passenger berth for accommodating cruise and passenger vessels as well as ship repair facilities (Namport, 2025).

4.5.10.6 SUMMARY OF ACCESS TO BASIC SERVICES

Access to basic services at a regional and regional level is provided in Table 4-19.

TABLE 4-19 ACCESS TO BASIC SERVICES — ERONGO REGION AND SELECTED CONSTITUENCIES (2023)

Type of Basic Service	Percentage of Households			
	Erongo Region	Walvis Bay Urban	Swakopmund	Arandis
Source of Energy for Cooking				
Electricity from Mains	72.90%	97.30%	96.80%	90.50%
Gas	12.90%	2.00%	1.50%	4.00%
Wood/Firewood	13.30%	0.40%	1.20%	5.20%
Source of Energy for Lighting				
Electricity from Mains	77.70%	99.20%	98.70%	92.30%
Solar Energy	6.50%	0.10%	0.30%	3.10%
Battery/Torch/Cell phone	10.90%	0.30%	0.50%	2.60%
Source of Drinking Water				
Piped water inside dwelling	59.10%	73.70%	69.20%	61.50%
Piped water outside dwelling	14.70%	14.00%	15.10%	18.60%
Public piped water	14.20%	4.60%	5.00%	11.70%
Boreholes/covered tanks	1.10%	0.00%	0.20%	2.00%
Type of Sanitation				
Flush toilet to sewer	68.80%	89.70%	85.50%	62.30%
Flush toilet to septic tank	2.20%	0.70%	1.20%	2.80%
Public flush to sewer	5.40%	8.00%	6.10%	9.20%
No toilet facility	9.70%	0.10%	2.40%	6.80%
Waste Disposal				
Regularly collected	78.40%	98.20%	96.20%	84.60%
Irregularly collected	2.60%	0.90%	1.50%	3.20%
Burning	8.10%	0.00%	0.30%	2.00%
Dump in field/bush	2.80%	0.00%	0.10%	1.50%

Sources: NSA, 2025

Walvis Bay and Swakopmund provide the broadest range of public and private services (see Table 4-20) in the Erongo Region, reflecting their size and economic importance. Walvis Bay hosts the country's main seaport and is a national logistics hub, supporting a wide array of services including education, health, government, finance, retail, and recreation. Swakopmund functions as the regional capital and Namibia's premier coastal tourism destination, with extensive accommodation, food services, tourism and recreation facilities.

Henties Bay, though smaller, provides essential local services (see Table 4-20) residents and seasonal visitors. Its facilities include basic education, health services, accommodation, retail, and municipal offices, proportionate to its population size and seasonal economy.

The number of services and facilities in Walvis Bay, Swakopmund, and Henties Bay are detailed in Table 4-20 below.

TABLE 4-20 PROFILE OF PRIVATE AND PUBLIC SERVICES AND FACILITIES

Type of Facility / Service	Number of Facilities / Services		
	Walvis Bay	Swakopmund	Henties Bay
Accommodation & Food	32	45	15
Cemetery	2	2	1
Education	22	20	4
Finance (banks, ATMs)	12	10	2
Government Ministries	11	9	2
Health Facilities	5	6	2
Tourism & Recreation	40	55	12
Retail (shops, markets)	7	9	3

Source: Source: OpenStreetMap, Erongo Regional Council & GRN Ministerial Data, 2023

4.5.11 HOUSING AND LIVING CONDITIONS

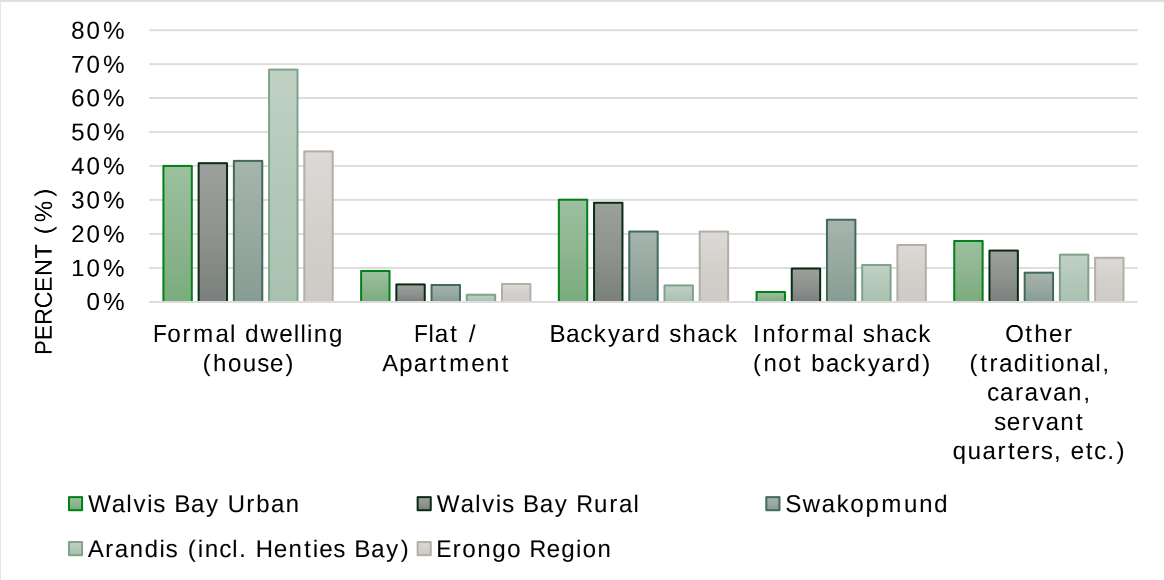
in 2023, 60.1% of households in the Erongo Region resided in formal dwellings, compared to the national average of 57.3% (NSA, 2024). Formal dwellings include detached and semi-detached houses, flats and apartments, cluster houses, and townhouses. Figure 4-63 shows the type of dwelling occupied by households in the Erongo Region.

A higher proportion of households in Erongo live in formal housing compared with the national picture, yet the region also records a larger share of informal housing. In 2023, 37.4% of households in Erongo lived in informal dwellings, compared with 28.7% nationally (NSA, 2024). This underlines that while the region's housing stock is more formalised than average, the scale of in-migration into the coastal towns has contributed to the continued expansion of informal settlements and backyard squatting.

The coastal constituencies reflect these dynamics in different ways. In Walvis Bay Urban, only 40.4% of households occupy formal dwellings, while 29.7% live in informal shacks and 20.7% in backyard structures (NSA, 2025). Walvis Bay Rural shows slightly stronger formal coverage, with 48.0% in formal dwellings, 22.0% in shacks, and 8.0% in backyard units. Swakopmund

Urban has the highest share of formal dwellings (54.8%), though more than a third of households (34.1%) live in informal shacks. Arandis Constituency, which includes Henties Bay, reported 52.0% of households in formal dwellings, 24.0% in shacks, and 10.5% in backyard structures (NSA, 2025).

FIGURE 4-63 HOUSING TYPES IN ERONGO AND COASTAL CONSTITUENCIES, 2023



Source: NSA, 2025

Taken together, these results show that Walvis Bay Urban records the lowest share of formal housing, while Swakopmund Urban has the highest. Walvis Bay Rural and Arandis Constituency (including Henties Bay) fall in between, but all constituencies continue to show significant levels of informal and backyard housing. This reflects the pressure of migration-driven urbanisation and highlights the challenges of providing adequate, affordable housing in Erongo's growing coastal towns.

4.5.12 COMMUNITY COHESION, SAFETY AND SECURITY

In the Erongo Region, the top five most prevalent crimes include housebreaking, robberies, assault, domestic violence, and drug offences. According to the Police Commander for Erongo, contributing factors to crime include poverty, unemployment, and alcohol and drug misuse. Drug related offences have been a point of concern for local law enforcement. Between January and July 2023, 151 people were arrested on drug offences. Between January and July 2024, a further 134 people were arrested for drug offences in Erongo (Andre, 2024). Overall, crime rates have increased by 5% in the region between 2023 and 2024. Between January and July 2024, a total of 5,332 crimes were reported. This is an increase from 5,070 the previous year. An influx of jobseekers was also cited as contributing to the increase in crime (Namibian Broadcasting Corporation, 2024).

Gender-based violence (GBV), domestic violence, and rape are some of the most common offences reported in Namibia. The prevalence of GBV can be attributed to societal acceptance of certain types of violence against women and girls. There is a challenge that there is significant underreporting of GBV and related offences in rural areas. Despite comprehensive gender equality legislation and strong guidance from the state in regards to gender equity, patriarchal socio-cultural norms still prevail in many parts of the country leading to high rates of GBV. In the year ending September 2020 police in Namibia had recorded 6,000 GBV cases nationally with the highest rates observed in the Khomas Region (region with the largest population). These crimes include 896 rapes and 74 gender-based murders (United Kingdom Kome Office, 2021).

4.5.13 RECREATION AND TOURISM

Recreation and tourism within the Erongo Region are intrinsically linked to nature, including desert landscapes, mountains, the Dorob National Park, Kuiseb River, unique flora and fauna, Ramsar bird sites, coastal zones, dunes, game reserves, and communal conservancies. Eco-tourism and adventure sports activities are a key attraction for the region (Erongo Regional Council, 2015).

The Erongo Region is considered one of Namibia's key tourism destinations with tourism contributing to foreign currency generation, infrastructure development, employment and livelihoods. The tourism industry in the region has shown signs of growth post-COVID. In the first quarter of 2024 the region recorded a 60% increase in room occupancy rates in tourist accommodation. During 2022 there were 381 new tourism business registered in Erongo. This included accommodations providers and tour operators.

Walvis Bay in particular has become a hub for cruise ship tourism due to the presence of the passenger berth and cruise terminal in the Port of Walvis Bay. By the ned of 2024, 65 cruise liners had already pre-booked arrivals at Walvis Bay for 2025 and 2026. Walvis Bay has also become a hub for marine tourism activities such as boat tours (Rengura, 2024).

4.5.14 CULTURAL HERITAGE

4.5.14.1 TANGIBLE CULTURAL HERITAGE

Namibia has a history of maritime trade and resource exploitation, as seen through the many shipwrecks that have been identified along its coast. Shipwrecks that have been within the territorial waters or contiguous zone of Namibia for 35 years or more are considered historic shipwrecks and are considered historic monuments (Government of Namibia, 2004).

The majority of shipwrecks are not recorded, so although there are no known shipwrecks within the licensing area this does not confirm the absence of maritime archaeology within the area.

4.5.14.2 INTANGIBLE CULTURAL HERITAGE

Traditional line fishing is common along the Namibian coast, although it does not operate within the licensing area.

Many of the cultures within Namibia have beliefs related to natural elements and features (SLR, 2022). However, there has been limited evidence of spiritual beliefs connected to the ocean and the coast, with the exception of the San group. The San were forcibly relocated inland from the coast by colonial and apartheid governments and can no longer practice rituals associated with the ocean. These rituals still exist within living memory but have been disconnected from their place of performance.

4.6 SUMMARY OF KEY SENSITIVITIES

4.6.1 PHYSICAL AND BIOLOGICAL KEY SENSITIVITIES

Due to the high diversity of habitats and marine biota along the coast of central Namibia (several of which are of conservation concern), significant biodiversity importance is attributed to many areas inshore of PEL 82. The sensitivity and significance of some of the physical and ecological features on the shelf and shelf edge are summarised below:

- There is a double shelf break off Walvis Bay, with the outer break beginning at depths of ~400 m and therefore in the eastern portion of PEL 82.
- Sediments in the license area block are dominated by sandy muds with muddy sands and sand occurring in the eastern portion.
- PEL 82 overlaps with low percentage occurrence of the known phosphate deposits.
- The PEL 82 license area is located in an area of strong south-easterly winds, with minimal seasonality in the wind pattern.
- Catabatic, or easterly ‘berg’ winds can transport substantial volumes of sediment up to 150 km offshore.
- The license area lies offshore of a perennial upwelling cell centred around Walvis Bay.
- The nearshore region around Walvis Bay also experiences periodic, large-scale low oxygen events and sulphur eruptions following decay of expansive algal blooms, both of which can have catastrophic effects on marine communities of the inner shelf area.
- PEL 82 is located in the offshore Central Namib and Namib Biozones, which extend beyond the shelf break onto the continental slope and into abyssal depths.
- Pelagic communities in the license area comprise plankton, pelagic invertebrates and fish, and their main predators, marine mammals (seals, dolphins and whales), seabirds and turtles, many of which are recognised as being sensitive to anthropogenic disturbance. The north-eastern half of PEL 82 falls within a pelagic habitat considered ‘Endangered’, with the remainder rated as ‘Least Threatened’.
- There is overlap of the license area with spawning grounds of monkfish (northeastern corner) and orange roughy (southeastern corner)..
- The inshore waters of the central Namibian coastline are home to a number of bony fish and cartilagenous fish, many of which are popular angling species and/or are considered Endangered’, ‘Near Threatened’ or ‘Vulnerable’.
- The fish most likely to be encountered on the shelf, beyond the shelf break and in the offshore waters of PEL 82 are the large migratory pelagic species (tunas, billfish and sharks) many of which are considered threatened by the International Union for the Conservation of Nature (IUCN), primarily due to overfishing.
- Leatherback and Loggerhead turtles have been encountered in the offshore waters of the license area; Leatherback Turtles are listed as ‘Vulnerable’ worldwide by the IUCN and Loggerhead turtles are globally listed as ‘Vulnerable’.
- The cetacean fauna of central Namibia comprises up to 33 species of whales and dolphins. The species most likely to be encountered in the project area are the humpback whale, sperm whale and pilot whale.

- Humpback whale is likely to be the most frequently encountered baleen whale in PEL 82, ranging from the coast out beyond the shelf, with year-round presence but numbers peaking in June – July (northern migration) and a smaller peak with the southern breeding migration around September – October but with regular encounters until February associated with subsequent feeding in the Benguela ecosystem.
- Two populations of bottlenose dolphins occur within Nambian waters, of which the small population that inhabits the very near shore coastal waters between Lüderitz and Cape Cross, is considered a conservation concern (Elwen et al. 2019).
- The Cape fur seal occurs at various coastal breeding sites inshore of PEL 82. The colony closest to the license area block is at Cape Cross. The seal population is considered to be healthy and stable in size although there has been a northward shift in the distribution of the breeding population. PEL 82 lies well offshore of the foraging ranges of seals from these colonies.
- The benthic fauna of the outer shelf and continental slope (beyond ~450 m depth) are very poorly known due to limited opportunities for sampling as well as the lack of access to Remote Operated Vehicles (ROVs).
- PEL 82 mostly overlaps with benthic habitat considered of ‘Least Concern’, however, those along the 500 m depth contour in the eastern portion of PEL 82 have been assigned a threat status of ‘Vulnerable’, with those further inshore to the 100 m depth contour considered ‘Endangered’.
- As many as 110 species of bony and cartilaginous fish have been identified in the demersal communities on the continental shelf of the southern African West Coast, however, little is known of the demersal communities beyond the shelf break.
- 11 species of seabirds are known to breed along the Namibian coast of which the Cape Gannet is considered ‘Critically Endangered’ and the African Penguin, Bank Cormorant and Cape Cormorant are considered ‘Endangered’ on the Namibian red-list. These species all forage close to shore and encounters with drilling operations in PEL 82 are highly unlikely.
- Other seabird species present off Namibia’s coast comprise at least nine species of albatrosses, petrels or giant-petrels of which the Tristan Albatross is considered ‘Critically Endangered’ and the Atlantic yellow-nosed and Black-browed Albatross are considered ‘Endangered’ on the Namibian red-list. PEL 82 overlaps with the distribution of incubating Atlantic Yellow-Nosed Albatrosses from Gough Island and Black-browed Albatross from Bird Island (South Georgia). Encounters with these pelagic seabirds are thus possible.
- While PEL 82 does not overlap with the impact management or conservation zones of the adjacent EBSAs (Walvis Ridge and Namib Flyway), the license area block does overlap (37.4%) with ESAs.
- Six coastal IBAs lie inshore of the license area block; of which, two (Walvis Bay Wetland and Sandwich Harbour) are designated RAMSAR sites.
- PEL 82 overlaps with the proposed Southeast 22 and Southeast 23 Marine IBAs to protect Atlantic Yellow-nosed Albatross and White-chinned Petrel.

4.6.2 SOCIAL KEY SENSITIVITIES

This section provides a summary of the key social sensitivities in the project area that will need to be managed. These sensitivities are further evaluated in the impact assessment chapter.

Employment within the Erongo Region is dominated by the Agriculture, Manufacturing, and Retail Trade sectors. As a result, the local population may not be able to benefit extensively from employment generated by the project as they will not have the necessary expertise in the oil and gas or construction sectors and may not have the educational attainment necessary to secure skilled positions. The project may need to source a large proportion of labour from other regions within Namibia or from abroad to meet the workforce requirements for mobilisation and exploration.

Given the low population density in the Erongo Region, there may also be a limited pool of local contractors that will be capable of entering the supply chain of the project which may minimise local economic benefits of the project.

Artisanal fishers are present within the Erongo Region, including communities from ethnic minority groups such as the Topnaar. Artisanal fishers are particularly vulnerable to changes and already face uncertain livelihoods due to exploitation, marginalization, rising operational costs, and the consequences of overfishing in the commercial sector. Previously unidentified marine archaeology is sensitive to direct impacts by the project that may partially or wholly remove them. The project will need to use side scan sonar and bathymetric data to identify possible marine archaeology in the licensing area. If any marine archaeology is identified, the project will need to carefully manage and mitigate the impacts upon the archaeology through an impact assessment.

Other users of the offshore marine areas include the commercial fishing industry and oil and gas license area holders. As the license area lies within the main trawling lanes and traffic routes into and out of Walvis Bay, both coastal shipping and fishing craft may be encountered.

Various subsea telecommunications cables traverse across the Namibian EEZ, of which two come ashore at Swakopmund. These cables, however all lie south and outside of PEL 82.

5. STAKEHOLDER ENGAGEMENT

This section provides a summary of the engagement undertaken during the scoping phase of the project and planned for the upcoming ESIA phase. Regular, meaningful and culturally appropriate engagement and consultation will be central to the success of this project.

In this regard, a Stakeholder Engagement Plan (SEP) has been developed and appended to this ESIA (Appendix B) to guide the engagement process throughout the project lifecycle (i.e. during mobilisation, exploration and demobilisation). The SEP also incorporates a grievance mechanism (GM), building on Chevron's existing grievance mechanism, which will be used to address external stakeholder grievances pertaining to the project and its associated activities. The SEP is a 'live' document and will be updated as the project progresses.

The stakeholder engagement process described herein and in the SEP has been designed to comply with relevant national legislative requirements, as well as to align Chevron's internal policies and procedures. Overall, it demonstrates Chevron's commitment to good practice in stakeholder engagement.

5.1 OBJECTIVES OF STAKEHOLDER ENGAGEMENT

A stakeholder is defined as any individual or group potentially affected by a project, interested in a project or who can themselves affect the project. The main objectives of stakeholder consultation / engagement are as follows:

- Identify all those affected by or who can affect the project to strive to include them in the engagement process.
- Understand the views of stakeholders and make sure that they adequately understand the positive and negative impacts of the potential project.
- Inform stakeholders throughout the ESIA process, including local benefits and partner opportunities.
- Build relationships and trust through supporting open dialogue and engagement with stakeholders. Establish transparency in activities being undertaking and build trust with stakeholders.
- Engage with all stakeholders, including vulnerable and marginalised groups, by having an inclusive approach to consultation and participation. This may include the use of differential measures to maximise effective participation of vulnerable stakeholders.
- Manage expectations and concerns by providing a mechanism for stakeholders to engage with the project about their concerns and expectations and provide a mechanism for receiving, documenting and addressing comments received.

5.2 LEGAL FRAMEWORK

5.2.1 NATIONAL REGULATIONS

Stakeholder engagement related to the ESIA process in Namibia is primarily guided by the stipulations set out in the Environmental Management Act (EMA) 7 of 2007 and associated regulations such as the Environmental Impact Assessment Regulations. The EMA sets out requirements for public consultation based on the rights of the public to be informed as early as possible of any development project which may impact them, be included in decision making regarding project design, and be empowered to provide comment on potential development projects. Additionally, the Act specifies in Section 36 that a public hearing may be carried out as part of the environmental impact assessment process prior to a final decision being made by the Environmental Commissioner regarding an application, if it is deemed necessary by the Commissioner (Environmental Management Act 7 of 2004).

Sections 21-24 of the EIA Regulations provides further details on the public consultation process required (Environmental Impact Assessment Regulations, 2012):

- A project must give notice of the public consultation process using site notices, written communication to neighbours and authorities as well as potentially interested and affected parties, and advertisements once per week for two consecutive weeks in at least two widely circulated newspapers;
- Public notices / communication should include details of the application / project to which the consultation is associated, the nature and location of the project, details of where further information on the application / project can be obtained and how to communicate with the project;
- All interested and affected parties must be recorded on a register by the project. Interested and affected parties include all persons who have submitted written comments or attended meetings during the public consultation, all persons who have requested to be added to the register following public consultations, and all organs of state that have jurisdiction in respect to the planned activities of the project;
- All registered interested and affected parties are entitled to provide written comment on the application, including comments on scoping reports, EIA reports, and any amendments to such reports; and
- All comments received from registered interested and/or affected parties must be recorded by the project in the reports that are submitted as part of the application.

5.2.2 CORPORATE POLICIES AND PROCEDURES

The Stakeholder Focus Area (SFA) is one of the six Focus Areas in Chevron's Operational Excellence Management System (OEMS). SFA outlines how we engage stakeholders to foster trust, build relationships, and promote two-way dialogue to manage potential impacts and create business opportunities. The company is committed to working with stakeholders in a socially responsible and ethical manner to ensure respect for human rights. Further commitments include:

- Building and maintaining relationships with all external stakeholders (including governments and communities;
- Identifying and assessing stakeholder issues; and
- Developing and implementing issue management plans, stakeholder engagement plans, and social impact management plans.

The Stakeholder Engagement and Issues Management (SEIM) Process, which operationalises the SFA, is a framework for identifying, assessing, and managing social risks and impact across asset lifecycle. The Process helps the Company to understand and address the concerns of stakeholders with a goal of building trust and fostering positive relationships.

5.3 PRINCIPLES OF STAKEHOLDER ENGAGEMENT

The key principles guiding the project's approach to stakeholder engagement are as follows:

- Transparent- process, objectives and criteria communicated openly to stakeholders;
- Credible: building confidence and trust through honoring commitments and sharing; relevant information in a timely manner
- Respectful: engagements prioritized and conducted in a culturally appropriate manner;
- Collaborate: to work cooperatively with stakeholders to find solutions that meet common interests;
- Responsive: to stakeholder concerns and in disseminating feedback on their inputs;
- Proactive: to act in anticipation of the need for information or potential issues;
- Fair: to conduct all engagements impartially without bias and treat stakeholders fairly, and their issues and concerns are afforded fair consideration;
- Accessible: engagements and information disclosed in a language and form accessible to stakeholders and without cost to them engage in language; and
- Inclusive: engagements that are appropriate for all identified.

5.4 STAKEHOLDER IDENTIFICATION

5.4.1 PROJECT STAKEHOLDER CONTEXT

The relevant stakeholders have been identified based on the nature and context of project activities. The project will entail an offshore hydrocarbon exploration program within PEL 82 in blocks 2112B and 2212A. PEL 82 is located approximately 163 km north-west of Walvis Bay. Walvis Bay will be used a logistics base for the project. Given that the majority of the project activities will be occurring in deepwater and the project is restricted to exploration drilling and testing, the number and type of stakeholders that may be impacted by the project is limited.

The following categories of external stakeholders have been identified as being of interest for the project:

- National, Regional, and Local Authorities;
- Traditional Authorities;
- Affected Communities, including vulnerable groups;
- Civil Society and Community Associations;
- Onshore Business Community;
- Commercial Marine Users; and
- Media.

Table 5-1 lists the stakeholders that have been identified for the project. This list will continue to be developed and refined as the project progresses through its lifecycle.

A stakeholder database has been developed that includes various details for individual stakeholders such as:

- Stakeholder category;
- Name of the organization;

- Individual name and position in the organization; Contact information- email address, telephone number; and
- Responses received.

This database is a live document and will continue to be updated as and when new stakeholders are identified or stakeholder details change. The database will be maintained by CNEL for the duration of the project.

TABLE 5-1 SUMMARY OF EXTERNAL PROJCT STAKEHOLDERS

Category	Stakeholder	Relationship to Project
Authorities	• Ministry of Industry, Mines and Energy (MIME) • Ministry of Environment and Tourism (MET) • Ministry of Agriculture, Fisheries, Water and Land Reform (MAFWLR) • Ministry Works and Transport (MWT) • Namibia Ports Authority (NamPort) • Erongo Regional Council (ERC) • Municipality of Henties Bay • Municipality of Swakopmund • Municipality of Walvis Bay	• The MIME is responsible for promoting and regulating the development and use of Namibia's mining and hydrocarbon resources. The Ministry issues licenses for petroleum exploration and production. • The Ministry of Environment and Tourism is responsible for issues relating to the environment including the EIA process and will comment on the EIA report. • The Ministry of Agriculture, Fisheries, Water and Land Reform deals with sensitive issues in the marine environment that could be impacted by project activities. • The Ministry of Works and Transport oversees maritime affairs through its Department of Transport. • The Nambian Ports Authority (Namport) a public entity associated with the Ministry of Works and Transport, manages the ports of Walvis Bay and Lüderitz and is responsible for protecting the environment within harbour areas under the National Ports Authority Act. • The Erongo Regional Council is responsible for decentralized governance and is mandated to plan and develop the region in a sustainable manner by establishing, managing and controlling settlement areas focusing on core services. Local Government may also have a role in issuing permits and processing applications associated with the project. They may also have a role in monitoring the implementation of project commitments included in an Environmental and Social Management Plan (ESMP). • Municipal Administrations (which govern cities) are responsible, in general, for: promoting the economic and social development of the Municipality, the quality of life of citizens, basic public services such as education, health, culture, sports, recreation and tourism, water and energy supply, basic sanitation and waste management, as well as the road network, the energy network and public lighting, building maintenance and wastewater management, civic and community education of citizens, social welfare services, parking, traffic and public transport.
Traditional Authorities	Topnaar Traditional Authority	Traditional authorities represent their communities' interests in local decision making.
Potentially affected Communities	Walvis Bay communities close to onshore Area of Influence (AoI)	This category includes households and social support services (i.e. schools, healthcare facilities and places of worship) within the AoI that will potentially be impacted by or interested in the project. Positive benefits associated with employment may be experienced by some in this stakeholder category.
Civil Society, Non-Governmental Organizations and Community Associations	• Community associations (including fishing and tourism) • Civil society groups and NGO's (including conservation, workers,	Local community associations/ organizations and NGO's that engage in and are supportive of livelihood activities ensuring the needs of communities are being met. These groups can collaborate with the project to support the realization of socio-economic benefits and livelihood compensations (where necessary) plans are effective. Furthermore, the groups can influence the project directly or through public opinion. There are a large number of active NGO's in the Erongo Region associated with environmental and biodiversity conservation.

Category	Stakeholder	Relationship to Project
	youth, justice, policing etc.)	
Onshore Businesses and Business Associations	Businesses that are operational within the onshore AoI.	Businesses may experience disruptions to their operations, especially during construction of the project due to changes in road conditions / access, dust, noise etc. Some businesses may benefit in terms of service provisions.
Commercial Marine Users	Commercial fisheries, cargo, passenger transport, oil and gas logistics, and other marine users are in operation near the offshore AoI.	This includes any business engaged in commercial activities in the buffer zones of the offshore and nearshore components of the project who may face temporary disruptions to commercial activities during project construction.
Media	Local newspapers, radio, television, social media.	Local media will be used for the communication of project-related information and has the potential to raise positive or negative awareness about the project. Newspapers will be used to advertise public meetings as part of the public participation process.

5.4.2 VULNERABLE GROUPS

Vulnerable people or groups are those who may be more adversely affected by project impacts by virtue of characteristics such as their gender, gender identity, religion, physical or mental disability, ethnicity, literacy and employment status. Vulnerable individuals and/or groups may include but are not limited to, people living below the poverty line, single-headed households, migrant workers and refugees.

To create an inclusive engagement process, it is important to identify individuals and groups who may find it more difficult to participate and those who may be directly and differentially or disproportionately affected by the project because of their disadvantaged or vulnerable status.

TABLE 5-2 below provides an overview of the groups that may be considered vulnerable in the project area and need to be particularly considered in the engagement plan in order to facilitate access and provide them with the opportunity to engage in informed discussion about the project.

TABLE 5-2 POTENTIALLY VULNERABLE GROUPS

Vulnerable Group	Description of the Group
Single parent households	Single parents may be less able to access stakeholder meetings due to caring responsibilities.
Elderly and retired individuals	Elderly individuals may find it difficult to access meetings about the project and have their voices heard.
Low-income households	These households might face more barriers to expressing any issues they may have with the project.
Physically and/or mentally disabled	Those who have physical and/or mental disabilities may find it difficult to access meetings / information about the project and have their voices heard.

5.5 STAKEHOLDER ANALYSIS

It is not practical, and not necessary, to engage with all stakeholder groups with the same level of intensity all the time. Analysing and prioritising stakeholders is important to determine appropriate engagement methods for different stakeholders. It also helps identify which stakeholders need to be prioritised during latter stages of the ESIA process. It is important to keep in mind that the project development situation is dynamic and that both stakeholders and their interests might change over time, in terms of level of relevance to the project and the need to actively engage at various stages. Stakeholder analysis should, therefore, be revisited throughout the project lifecycle.

For each stakeholder category identified in Section 5.4 above, the following needs to be considered:

1. Level of influence that they may exert over the project:

- High – Stakeholder is highly influential and has significant ability to stop or disrupt the project or cause extensive damage to its reputation.
- Medium – Stakeholder has a moderate influence and considerable capacity to stop or disrupt the project and cause damage to its reputation.

- Low – Stakeholder is considered to have limited influence and little capacity to stop or disrupt the project or cause damage to its reputation.

2. Level of interest that they may have in the project:

- High – Project is of high interest to stakeholder.
- Medium – Project is of moderate interest to the stakeholder.
- Low – Project is of little or negligible interest to the stakeholder.

3. Level of impact that they may experience as a result of the project:

- High – Stakeholder is considered to be highly sensitive to potential project impacts and may experience significant changes in their health, wellbeing and livelihoods as a result of the project.
- Medium – Stakeholder is considered to be moderately sensitive to potential project impacts and may experience some changes in their health, wellbeing and livelihoods as a result of the project.
- Low – Stakeholder is not considered to be sensitive to the potential project impacts and is unlikely to experience any changes in their health, wellbeing and livelihood as a result of the project.

Once the above criteria have been decided for each stakeholder category, the matrix below (Figure 5-1) can be used to determine the engagement approach to be adopted. Varying engagement approaches are necessary, depending on the level of impact and influence that each stakeholder has in regard to the project. Approaches to engagement are further described in TABLE 5-3. The analysis also needs to consider which stakeholder categories may find it more difficult to participate in consultation activities owing to their marginalized or vulnerable status (such as disabled or elderly people).

As the level of influence and importance in the project may change over time, there is a need to review and, where necessary, update this information on a regular basis.

FIGURE 5-1 STAKEHOLDER ANALYSIS MATRIX

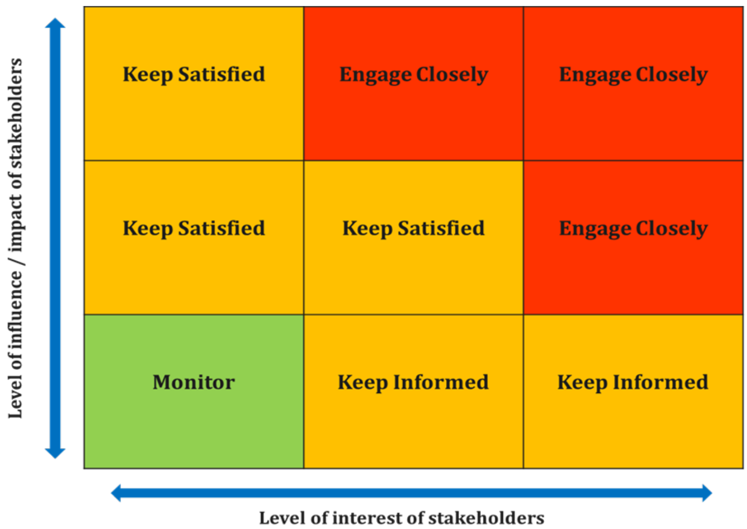


TABLE 5-3 ENGAGEMENT APPROACHES

Approach to Engagement	Frequency and Type of Engagement Activities
Engage closely	Stakeholders are directly engaged throughout the ESIA process. Communication is two-way and is likely to revolve around the conduct of direct, in-person or virtual meetings to discuss the project, facilitate dialogue and ensure that relevant information and feedback from stakeholders is considered in the ESIA process.
Keep satisfied	Stakeholders are directly and indirectly engaged throughout the ESIA process. Communication is predominantly one-way and revolves around the distribution of written information (e.g. information leaflets) via email, post or by hand. Stakeholders are encouraged to respond with written or verbal feedback and comments. Where appropriate, and at the stakeholder's request, there may be more direct contact.
Keep informed	Stakeholders are engaged with indirectly throughout the ESIA process. Communication is one-way and revolves around the distribution of written information (e.g. information leaflets) via email, post or by hand. Stakeholders are free to respond with written or verbal feedback or comments if they wish.
Monitor	There are no deliberate plans to engage with these stakeholders throughout the EISA process. However, their interest in and opinions of the project are monitored (e.g. through the receipt of correspondence and online, including social media, activities) to identify any change in perceptions and the potential need for engagement, as appropriate.

Using the approach and frequency of engagement activities set out in Table 5-4 together with the outcomes of the stakeholder analysis, recommended levels of engagement have been assigned to project stakeholder groups. This approach recognises that stakeholder engagement is multi-faceted, and that the approach to engagement is not uniform across stakeholders.

Priority should be given to stakeholders that are highly influential, including those that are both supportive and unsupportive of the project.

TABLE 5-4 STAKEHOLDER ANALYSIS RESULTS

Stakeholder	Impact Level	Influence Level	Interest Level	Engagement Approach
Ministry of Industries, Mines and Energy	Medium	High	High	Engage Closely
Ministry of Environment and Tourism	Medium	High	High	Engage Closely
Ministry of Agriculture, Fisheries, Water and Land Reform	Medium	High	High	Engage Closely
Ministry Works and Transport	Low	Medium	Medium	Keep Satisfied

Stakeholder	Impact Level	Influence Level	Interest Level	Engagement Approach
Namibia Ports Authority	High	Medium	Medium	Keep Satisfied
Erongo Regional Council	Low	Medium	High	Engage Closely
Municipality of Henties Bay	Low	Low	High	Keep informed
Municipality of Swakopmund	Low	Low	High	Keep informed
Municipality of Walvis Bay	Medium	Medium	High	Engage Closely
Topnaar Traditional Authority	Low	Low	High	Keep Informed
Potentially Affected Communities	Low	Low	High	Keep Informed
Civil Society and Community Associations	Low	Medium	Medium	Keep Satisfied
Onshore Businesses and Associations	Low	Low	Medium	Keep Informed
Commercial Marine Users	High	Medium	High	Engage Closely
Media	Low	Low	Low	Monitor

5.6 STAKEHOLDER DISSEMINATION TOOLS

This section describes the information dissemination tools that can be used during the implementation of the SEP.

Communicating information and engaging with stakeholders in a manner that is accessible is key to the success of an engagement program. Various communication methods will be used to facilitate engagement and disseminate information during the Project. The level and purpose of engagement will determine the methods and channels.

Project stakeholders' literacy levels and education levels may vary, and careful consideration must be given to the target audience when preparing engagement materials. Table 5-5 below outlines tools and methods for engagement and information dissemination and guidelines for preparing engagement materials.

TABLE 5-5 TOOLS AND METHODS FOR ENGAGEMENT

Communication Channel	Objective	Target Stakeholders	Additional Guidance
One on one formal meetings	To disseminate Project information, respect	Government ministries,	Prior to formal meetings CNEL should communicate with local

Communication Channel	Objective	Target Stakeholders	Additional Guidance
(in-person/ online)	cultural protocol, build stakeholder relationships, understand concerns, and reinforce two-way dialogue.	local authorities, port authorities, fishing associations	authorities/ associations to inform them of the proposed meeting and the meeting objectives. They can play a key part in relaying the details of the meeting to the relevant stakeholders as necessary. However, CNEL should also communicate meeting details using additional methods to strive to make all relevant stakeholders aware.
Public meetings	To disseminate Project information to large groups at one time, build stakeholder relationships, and understand high-level concerns and reinforce two-way dialogue.	Communities	At least two weeks' notice should be given to stakeholders ahead of a community meeting. Consideration should be given to accessibility of the meeting venues and it may be necessary to arrange transportation for individuals and groups, such as elderly or disabled people. Display posters / newspaper adverts for a public meeting must be developed using simple language and as much visual representation as possible. Public meetings are useful as a starting point for engagement, but may exclude the expression of certain viewpoints, particularly those held by vulnerable groups or others who might be unwilling to express their perspectives in such a formal setting. Therefore, depending on the objective of the meeting, smaller follow-up Focus Group Discussions (FGDs) may be required.
Focus Group Discussions (FGDs)	To disseminate Project information to small stakeholder groups, often with a common interest, build stakeholder relationships, understand concerns, and develop management measures / livelihood restoration measures.	Communities, special interest groups (e.g. fishing association/ cooperative members)	Focus group discussions can also be an effective mechanism through which to engage vulnerable groups. Prior to holding focus group discussions, consideration should be given to language requirements, whether a representative from the technical team is required to provide input and answer questions, whether a female representative is required to engage women groups. At least two week's notice should be given to stakeholders ahead of a focus group discussion.
Letters, Email, Website updates	To disseminate Project information, make announcements, provide Project updates, the engagement programme and	Government ministries, local authorities, port authorities, fishing	Communications must be prepared using simple, non-technical language, include maps where appropriate, include the contact details for relevant Project personnel, and information on the grievance mechanism.

Communication Channel	Objective	Target Stakeholders	Additional Guidance
	schedule, construction schedule, contact details for CNEL, and information on the grievance mechanism.	associations, civil society, local media	
Non-technical summaries / project update flyers	To disseminate Project information, make announcements, provide Project updates, the engagement program, mobilization and drilling schedule, contact details for the Project personnel and information on the grievance mechanism.	All stakeholders.	Summary documents and information flyers should be prepared using simple, non-technical language, and include maps and graphical representations. Summaries / flyers should always include the contact details for relevant project personnel and information on the grievance mechanism.
Media (newspaper)	To make project announcements and inform stakeholders of upcoming meetings.	All stakeholders	CNEL should coordinate press releases in consultation with relevant authorities.

5.6.1 SPECIAL MEASURES FOR ENGAGING VULNERABLE GROUPS

For stakeholder engagement to be both inclusive and effective, special attention must be given to enabling vulnerable groups to receive information, be able to raise concerns and have those concerns addressed. The following strategies are recommended:

Culturally Appropriate and Accessible Meeting Locations

To overcome barriers related to distance and travel, in-person meetings should be held within or near the communities themselves. Preferred venues could include local town halls, community centres, or other accessible public spaces.

Inclusive Planning and Representation

Engagement planning should involve representatives from vulnerable groups to support the adequate consideration of their perspectives and needs. This may include organising separate group discussions (e.g. for the elderly) or using facilitators who are trusted by and familiar with these groups. The timing of meetings should reflect when individuals are available to attend, considering both employment and duties in the home.

Flexible and Adaptive Approaches

Recognising that vulnerable groups may face unique constraints (e.g., mobility, caregiving responsibilities, or social stigma), engagement methods should be flexible. This could include the use of audio and visual materials for those who speak a variety of languages.

5.7 SUMMARY OF STAKEHOLDER ENGAGEMENT TO DATE

5.7.1 SCOPING PHASE STAKEHOLDER ENGAGEMENT

The scoping phase stakeholder engagement aimed at facilitating disclosure of the latest project details, the Draft Scoping Report (including Non-Technical Summary) and obtaining information to identify the expectations of interested and potentially affected parties in relation to the project.

Stakeholder engagement during the scoping phase included engagements in municipal areas where onshore components of the project are to be located (Walvis Bay). This process included formal engagement with:

- Community members living in close proximity to potential project site;
- Municipal / regional planning and implementation authorities including the appropriate line ministries; and
- The business community who use the resource or are dependent on the resource that may be impacted by the project.

Prior to the engagements, a Background Information Document (BID) was prepared (English, Afrikaans and Oshivambo) for distribution with invitations to the meetings. All stakeholders identified within the project stakeholder database were invited to attend a meeting and were supplied with the BID as well as access (via a website link) to the Draft Scoping Report and Non-Technical Summary. The meeting date, venues, and basic project information were published in advertisements in two newspapers that are widely circulated in the local area. These advertisements ran for two consecutive weeks prior to the meetings. Hard copies of the full Scoping Report were made available to the public at the following venues: Walvis Bay town hall and Town council office.

A public meeting was held on 12 June 2025 in Walvis Bay to ensure easy access to the meeting within the areas where people live and work. A total of 28 people attended this meeting. A PowerPoint presentation was prepared for use in the meeting to facilitate information sharing and discussion regarding the Project and the ESIA process. Posters were also used at the meeting that provided information on the Project, the ESIA process, and potential impacts identified during scoping. The meeting was led by Urban Dynamics and representatives from ERM and CNEL were also present. The Project team was introduced to the stakeholders. CNEL provided an overview of the company and Project and ERM explained the ESIA process and preliminary findings from the scoping phase. Comments and suggestions raised by stakeholders were recorded and included in the meeting minutes and in the updated Scoping Report. Evidence of the meetings included signed registers and photographs.

Key concerns and questions raised, and responses given are summarized in Table 5-5. These concerns and questions have been incorporated into the ESIA approach.

On 3 July 2025 a dedicated online meeting was also held during the scoping phase to engage with a representative from the Ministry of Fisheries and Marine Resources (MFMR) who could not attend the public meeting. MFMR is included within the Ministry of Agriculture, Fisheries, Water and Land Reform. The meeting was facilitated by Urban Dynamics on behalf of CNEL. Representatives from CNEL and ERM were also present. During the meeting, Project team was introduced and CNEL provided an overview of the company and the Project. ERM provided an overview of the ESIA process and the potential environmental and social impacts that have been identified as part of scoping. The questions raised and responses given during this online meeting are summarised in Table 5-6.

5.7.1.1 KEY ISSUES RAISED BY STAKEHOLDERS

The table below provides a summary of the comments received during the two engagements conducted as part of the scoping phase of the Project as well as the responses provided.

TABLE 5-6 SUMMARY OF QUESTIONS RAISED DURING THE SCOPING PHASE PUBLIC MEETING

Question / Concern	Response
Community Member: What are the procedures that the youth should follow in order to take part in this industry, and what job opportunities are available? This was not explained in your presentation.	CNEL: At this stage, we are still in the exploration phase, which unfortunately does not come with many direct employment opportunities yet. However, there are potential opportunities within support services. We encourage young people to find out what skills are required by local companies that might be contracted to support the project. For entrepreneurs and business owners, it's also a good idea to explore how to become a supplier or service provider to third-party contractors working with us. Information about available opportunities is often only displayed at the sub-contractors' notice boards in Walvis Bay. It's important for community members to actively visit these notice boards to check for updates and opportunities. Additionally, if you are looking to upskill, you should first research what skills are needed by the companies working on the project or within the wider industry, both locally and internationally. That way, you can focus your training efforts in areas that are in actual demand. Additionally, we work closely with Petrofund, which offers scholarships for students who want to study in fields related to the oil and gas industry. We also recommend attending events such as the Oil and Gas Youth Summit planned for 25 – 26 July, where more information will be shared about future opportunities and how to get involved. There is a cost to it but also opportunities to volunteer to gain access to the event.
Community Member: I want to know, where does local content actually start? We often feel left out once the project begins. Where are these opportunities advertised, and how can we access them?	CNEL: Opportunities for local participation are typically advertised directly by the sub-contractors or third-party contractors who work on the project. These are usually made available through notices posted at their offices or notice boards. It is therefore important for local businesses and interested individuals to actively monitor these spaces and engage with the sub-contractors directly to find out about available opportunities.
Community Member: How is local content defined? Does it include companies that are locally registered even if the owners are not Namibian? How exactly is it defined?	CNEL: Namibia has several official instruments guiding local content, including the Local Content Policy and the Petroleum and Energy Act. These documents provide the specifications on what qualifies as local content. For example, the local content policy defines a Namibian company as one that has at least 51% local ownership Chevron maintains a database of local companies that have formally expressed their interest in providing services, and third-party contractors are able to consider the companies listed on that database. Chevron also has an open-door policy, allowing any interested local company to approach us and present their profiles and capabilities
NGO: Regarding marine life, how will the drilling, machinery, and chemicals used in this project affect marine ecosystems and the communities living along the coast?	CNEL: Chevron will use a non- aqueous drilling fluid (NADF) system, also known as drilling muds, that is biodegradable and has lower toxicity and bioaccumulation potential. ERM is currently undertaking a full ESIA, which includes identifying sensitive marine areas, modelling potential impacts and recommending appropriate mitigation measures.

Question / Concern	Response
	A mitigation example includes Chevron delaying the start of a previous seismic project in another block to be outside of the June to November whale migration season. We will continue studying the potential impacts to ensure they are avoided where possible or reduced to the lowest practical level. While PEL 82 is located offshore approximately 257 km northwest of Walvis Bay, we recognise the importance of protecting marine ecosystems throughout the project area.
Media: PEL 82, was acquired by Chevron, does it mean they own the Walvis- basin area. Is Gemsbok prospect the license area?	CNEL: No, Chevron holds exploration rights over two specific blocks within PEL 82, specifically blocks 2112B and 2212A, which are part of the Walvis Basin. These blocks were previously part of the Galp portfolio and include a relatively small portion of the basin. 'Gemsbok prospect' refers to a specific prospect well within the license area; each well within the area has its own name.
Media: Based on the ESIA process diagram, you indicated we are currently in the scoping phase. Will a full Environmental and Social Impact Assessment (ESIA) be required, and is that why we are here now at the scoping phase (the second step)?	CNEL: Yes, a full ESIA is required. Urban Dynamics: We are busy with the scoping phase currently.
Media: We have an Oil Industry Contractor (OIC) list, and there are three local companies that provide offshore oil and marine services. Will Chevron use one of these existing providers, or will a new company be brought in to do this work?	CNEL: We are likely to use one of the existing local companies, but final decision has not yet been made at this stage. The actual work is some time away and new players may enter the market before then. It will be assessed closer to the time.
Community Member: We have noticed that when these new industries begin operations, they often don't engage directly with schools, where the future workforce is being prepared. These are new industries for our country, and we need to make sure that our children are given the right information and guidance early on, so that when they finish school, they can pursue courses and careers aligned with the demands of these industries. Please make an effort to engage with schools and provide them with clear information about	CNEL: Thank you for your contribution. Chevron is aware of the serious challenges faced by communities in Namibia, including the lack of access to water, food insecurity, and unemployment. This is why we are part of NAMPOA (Namibian Petroleum Operators Association), where petroleum industry players come together to work on addressing these social challenges in a coordinated way. We don't believe in just providing short-term solutions; we want to focus on building skills and creating meaningful, long-term opportunities for people. While we are still in the early exploration phase, which means job opportunities are currently limited, we know that there will be a need for various skills as the project develops. These may include general workers, engineers, support staff, and specialised skills like welding and potentially even underwater work. We acknowledge that preparation needs to start now, and your recommendation about engaging directly with schools to build awareness and interest in these opportunities is valuable. We will take

Question / Concern	Response
potential job opportunities and the skills or technical expertise required by the industry.	this suggestion forward and ensure it is considered as we continue planning our community engagement and skills development initiatives.
Community Member: What qualification do you need to get involved in Oil industry?	CNEL: It's important to research the skills required by the various companies involved in the industry and seek employment through them. If you already have a qualification, you can attend specific courses to upskill yourself for offshore work. Community Member: emphasised the importance of up skilling for young people to access opportunities in this industry. She shared her personal example of how she has prepared herself for potential offshore or oil and gas related work by obtaining: A Welding qualification; Work experience in welding; Health and Safety certificates; Medical fitness examinations required for offshore work; A valid passport to be able to travel to South Africa for specialised offshore training courses; and An up-to-date CV detailing her qualifications, skills, and work experience. CNEL: We are one of the presenting sponsors of the Youth in Oil and Gas Summit here in Walvis Bay being held in July. We encourage you to find more information on their social media platforms.
Community Member: Where is Chevron's office in Walvis Bay so that we can visit and get first-hand information about available opportunities? Events like conferences on oil and gas—how can we attend those if we're unemployed and don't have the means to participate?	CNEL: We will discuss this with the organizers of the upcoming Youth Summit in July, to explore what opportunities can be made available for more youth to get involved — including as volunteers.
Community Member: I think it is better for Chevron to do their own short listing and not the third-party contractors.	CNEL: Noted

TABLE 5-7 SUMMARY OF QUESTIONS RAISED DURING MFMR MEETING DURING THE SCOPING PHASE ENGAGEMENTS

Question/Concern	Response
UD: invited MFMR representative to provide insights based on her experience in similar projects.	MFMR: noted a trend of declining attendance at project meetings, possibly due to changes in public behaviour following COVID-19. She suggested that focus group meetings might be more effective for stakeholder engagement. She also mentioned that invites to meetings sometimes get lost in the process. MFMR pointed out that while she receives some project information through Ministry of Environment, Forestry and Tourism (MEFT) sub-committees, she often does not receive supplementary invitations or background documents directly. She recommended that hard copies be sent to the Executive Director's Office and soft copies directly to her. This approach will allow her to review data, consolidate feedback with colleagues, and prepare combined reports efficiently.
MFMR: raised a concern that the map presented during the session did not clearly indicate whether the boundary of PEL 82 overlaps with or lies near any Ecologically or Biologically Significant Marine Areas (EBSAs), particularly in relation to known sensitive zones along the Namibian coast. MFMR requested that this be clarified to better assess any potential interaction between the license area and environmentally sensitive marine habitats, such as whale migration routes or productive feeding areas.	ERM: acknowledged the concern and confirmed that the project team will review and improve the mapping. A more detailed and clearly labelled map will be included in the Scoping Report to accurately show the relationship between the PEL 82 boundary and nearby EBSA areas.
ERM: asked what more could be done by consultants to effectively reach and engage industry stakeholders, particularly those in the fisheries sector, during the public consultation process. ERM acknowledged that UD, as the consultant responsible for public engagement, has complied with the requirements of the Namibian environmental impact assessment (EIA) Regulations — including placing newspaper notices, sending stakeholder emails, and displaying physical notices. However, she noted that despite these efforts, industry stakeholders are often under- represented and requested input from the Ministry on how consultation processes could be strengthened to ensure these key	MFMR: acknowledged that the consulting team complied with the public consultation requirements outlined in the Environmental Management Act and associated regulations. MFMR noted that participation in general public meetings for offshore projects is often limited, particularly among sector stakeholders such as the fishing industry. This is largely due to the meetings' focus on socio-economic benefits—such as employment opportunities—rather than technical matters relevant to industry groups. MFMR encouraged that consultants adopt additional engagement methods to strengthen participation and recommended the following: • Conduct focused group discussions with key industry stakeholders. • Engage clustered stakeholder groups, including vulnerable communities, cooperatives, and fishing associations. • Explore tailored engagement approaches beyond general community meetings. MFMR also pointed out the need for the Ministry to update its stakeholder database, particularly

Question/Concern	Response
	for cooperatives and fishing associations, to reflect recent leadership changes.
UD: asked MFMR to share insights based on her experience within the Ministry regarding whether any environmental issues or concerns have been observed after Environmental Clearance Certificates (ECCs) have been issued for offshore exploration projects.	MFMR: indicated that, generally, the Ministry did not receive significant complaints about negative impacts from offshore exploration activities and typically grants consent for ECCs, provided that the required notification timelines for starting and completing activities are respected. MFMR further explained that the fishing industry seldom have objections but that stakeholders involved in aquaculture activities, are often more sensitive towards potential impacts on their industry. A specific incident was discussed regarding the death of dolphins near Lüderitz, which attracted public concern on social media. MFMR confirmed that although offshore activities were ongoing at the time, these operations were not located near the affected area, and an investigation found no direct link between the activities and the dolphin deaths. MFMR emphasized the importance of early engagement with the Ministry, especially for projects near EBSAs. While the EBSA framework is not legally binding, it supports improved coastal and marine management through recommended zoning. MFMR also noted that compared to Namibia, South Africa applies stricter environmental scrutiny and tends to receive more objections to similar offshore projects.

5.8 STAKEHOLDER ENGAGEMENT PLAN

5.9 ESIA PHASE STAKEHOLDER ENGAGEMENT

As part of the application process for the Environmental Clearance Certificate, public meetings will be held by CNEL and Urban Dynamics to inform the public about the project status and the preliminary findings of the ESIA. A public meeting has been scheduled for 9th October 2025. The meeting date, venues, and basic project information are currently being published in advertisements in two newspapers that are widely circulated in the local area. These advertisements are running for two consecutive weeks prior to the meetings.

Feedback from stakeholders will then be incorporated into the Final ESIA Report prior to submission to the Environmental Commissioner.

The following are some of the important messages that will be communicated to stakeholders when the ESIA Report is publicly disclosed:

- Background of the project;
- Project description and location;
- Project activities;
- Potential benefits and negative impacts posed by the project;
- Potential measures to manage and mitigate negative impacts and to enhance positive ones;
- Process that will be followed to continue engaging with stakeholders;
- Recording issues and concerns related to the project; and
- Grievance Mechanism.

Once the ESIA report is submitted to the Environmental Commissioner, the Commissioner may take appropriate actions to assist with the review. This may include consultation with relevant institutions and authority structures, public consultations, and/or a public hearing per the provisions of the Environmental Management Act 7 of 2007. The Environmental Commissioner will inform the Project of decisions made to undertake further public consultation. CNEL will support with the process where required.

5.10 FUTURE STAKEHOLDER ENGAGEMENT ACTIVITIES

5.10.1 PRE-MOBILIZATION PHASE ENGAGEMENT

Following the issuing of the Environmental Clearance Certificate, the project will move into the pre-mobilization phase during which project planning will continue. Engagement to keep stakeholders updated on project activities and managing stakeholder expectations will take place during this Phase. Stakeholder engagement activities may include:

- Provide project updates to stakeholders when required;
- Maintain expectations about job opportunities and project benefits;
- Receive, respond to and monitor grievances received;
- Maintain stakeholder database, stakeholder engagement log and grievance log;
- Revise stakeholder mapping to accommodate changes in the project and social dynamics; and

- Review and assess stakeholder participation in order to revise, if necessary, the frequency, means and format of engagement to meet accessibility and participation requirements of all stakeholders.

Project Updates

It is important that stakeholders continue to have a good understanding of the project activities. Engagement meetings will, therefore, be undertaken during the pre-mobilization phase as needed. All planned formal and informal engagements should be used as an opportunity to identify and register any new stakeholders and to gather their feedback and concerns.

CNEL will therefore continue to provide updates to stakeholders regarding the progression of planning for mobilization commencement, as well as any other pertinent information to be disclosed.

The meetings will play an important role in communicating relevant project information (such as start dates for drilling campaigns) with communities and other stakeholders as well as disseminate information on employment, local content and the grievance management.

5.10.2 MOBILIZATION, DRILLING AND TESTING PHASE ENGAGEMENT

Keeping stakeholders updated on project activities, marine exclusion zones, employment / procurement opportunities, managing stakeholder expectations and responding to grievances will take place during these phases. Activities include:

- Provide project updates to stakeholders when required;
- Receive, respond to and monitor grievances received;
- Maintain stakeholder database, stakeholder engagement log and grievance log;
- Revise stakeholder mapping to accommodate changes in the project and social dynamics; and
- Review and assess stakeholder participation in order to revise, if necessary, the frequency, means and format of engagement to meet accessibility and participation requirements of all stakeholders.

Project Updates

CNEL will implement proactive and structured engagement with affected stakeholders. Engagement should take place frequently (as and when required based on project activities). Targeted engagement with specific stakeholder groups will be required, for instance, when exclusion zones are to be enforced or removed.

Engagement will be focused on informing and updating community members and stakeholders about the Project mobilization, drilling, and testing activities and schedule, including anticipated delays or changes, and procurement and employment opportunities, as well as the potential impacts that can be expected to occur along with the measures planned to mitigate these.

These engagements may include:

- Targeted face-to-face information disclosure meetings with environmental permitting authorities and other key regulatory authorities such as local government, and the Namibian Ports Authority if required; and
- Community meetings for updates and information sharing on topics of concern such as disruptions to fishing activities and other marine traffic.

Information dissemination tools will continue to be used to support the above activities. For example, notice boards and email updates are an accessible way for communicating changes to stakeholders concerning Project design, progress on meeting social and environmental management commitments, details of upcoming Project activities and or changes to schedule. The project website will also be updated on a regular basis.

Monitor Contractors

Unmanaged or poorly handled engagement with communities by contractors can present a risk to the Project. It may result in inconsistent or contradictory messages or conflicting commitments from the contractor and Project representatives, which can give rise to unmet expectations.

CNEL will liaise with and monitor contractors too so that any interactions taking place between contractor workforce and stakeholders are consistent with the standards, core principles and procedures for undertaking, recording and documenting stakeholder engagement.

Stakeholder Database and Engagement Log

In order to ensure all stakeholders affected by project construction are identified and engaged, CNEL will regularly update the stakeholder database, stakeholder engagement log and SEP, and assess and revaluate risks associated with stakeholders , as necessary, based on information gathered through regular engagements and grievance management.

Any new stakeholders that may have developed an interest in the Project should be monitored, and strategies developed for engaging them. CNEL will have designated responsible personnel tracking information on new stakeholders or changing stakeholder issues / risks, which arise through their stakeholder interactions.

Review and Respond to Grievances

Unresolved stakeholder grievances can quickly escalate and lead to unforeseen work stoppages and delays. It will, therefore, be important during the mobilization, drilling, and testing phases to respond quickly and effectively to grievances, and regularly engage with stakeholders to anticipate where stakeholder issues or concerns may arise before they do.

Designated responsible personnel will log and respond to all grievances and resolve locally those that can be managed in the immediate term and report and escalate more complex issues to the Project management, as appropriate.

5.10.3 DEMOBILIZATION PHASE ENGAGEMENT

Upon completion of drilling and testing activities the Project will be demobilized. Stakeholder engagement will be scaled back at this phase and will focus on targeted stakeholders that will likely be impacted. The program of engagement will be further refined near to the start of demobilization. Activities may include:

- Stakeholder engagements related to demobilization;

- Provide project updates if there is a change or any specific demobilization activities occurring;
- Receive, respond to and monitor grievances received;
- Maintain stakeholder database, stakeholder engagement log and grievance log; and
- Revise stakeholder mapping to accommodate changes in the Project and social dynamics.

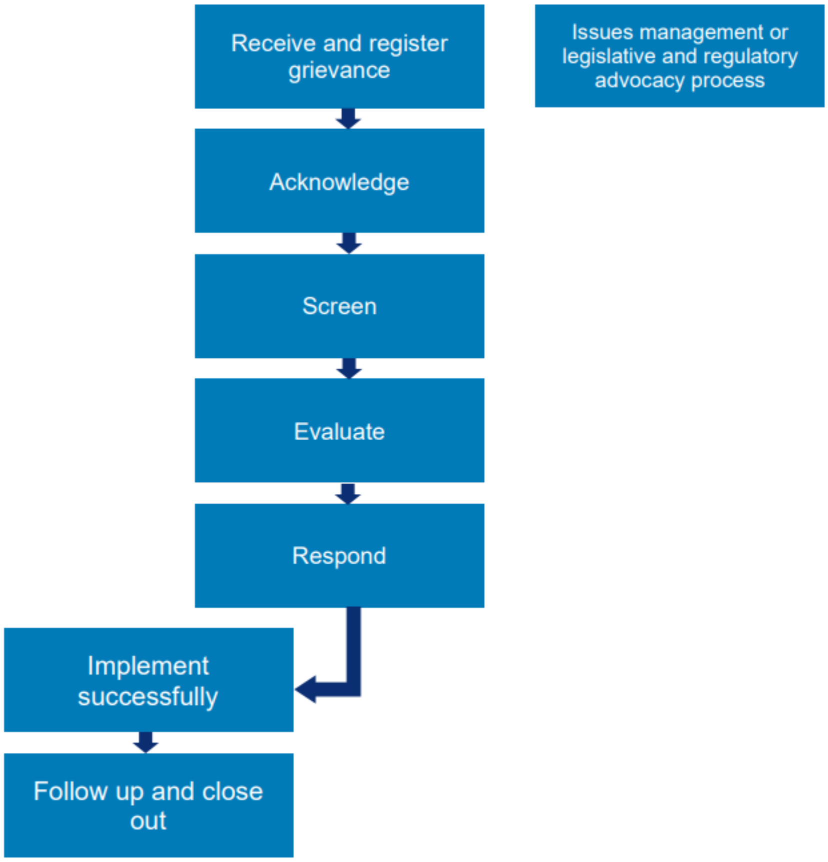
5.11 CNEL GRIEVANCE MECHANISM

Grievances are complaints or comments (or questions/suggestions) concerning the way in which a project is being implemented.

Grievances can encompass minor concerns as well as serious or long-term issues. They might be felt and expressed by a variety of parties including individuals, groups, communities, entities, or other parties affected or interested in the social or environmental impacts of the project. It is essential to have a robust and credible mechanism to systematically handle and resolve any complaints that might arise in order that they do not escalate and present a risk to operations or the reputation of the company (nationally or internationally). If well-handled, an effective GM can help foster positive relationships and build trust with stakeholders.

CNEL has established a grievance mechanism procedure (2025) to define the process to managing stakeholder concerns and complaints in alignment with the Chevron Operational Excellence Stakeholder Engagement and Issues Management Process and the Chevron Human Rights Policy. CNEL's existing 2025 grievance mechanism (GM) will be applicable to the project and the same grievance mechanism process described in the GM and summarized in Figure 5-2, will be followed.

FIGURE 5-2 CNEL GRIEVANCE MECHANISM PROCESS



Source: CNEL, 2025

Corporate Affairs, under the oversight of the Namibia Country Manager, will administer the GM by providing resources to handle correspondence, coordinate internal resolutions, manage a log, and report (both internally and externally).

The recommended timeline for the different steps in the GM execution are:

- Register grievances within 48 hours of receiving the grievance.
- Acknowledge grievances within 72 hours of receiving the complaint including the
- invalid/out of scope grievances.
- Screen and assign level within 96 hours. Closure and response to the grievance will ideally be:
  - Level 1: provide pre-approved standard response within 1 week along with acknowledgement.
  - Level 2: evaluate and address grievance within 4 weeks of receiving grievances.
  - Level 3: identify the gap within the existing management processes and/or procedures. Work with the relevant teams to close the gaps in existing procedure for repeated, multiple, widespread complaints within 60 days.
- Any grievance that remains outstanding after 60 days will be elevated and monitored irrespective of the project/operations/area that might have been the origin for the grievance.

- If the grievance takes more than 30 days, the complainant will be provided weekly update on the progress and approximate time, it may take to address it.
- Any grievance that is elevated to legal system, will be handled by the law function and taken out of the grievance register.

5.11.1 RECEIVING A GRIEVANCE

Stakeholders can submit grievances through several methods, including:

- In-person, through letters or in the designated location or regular postal service or electronically.
- Physical grievance dropbox location:
  - Office located at the shorebase
- Electronic:
  - Through e-mail address monitored by Corporate Affairs advisor.
- Traditional means of collecting grievance:
- Letter that can be sent to the Chevron office in Windhoek
- Face-to-face in any external stakeholder meetings (please note generic comments will not be considered a grievance, but a specific issue or grievance raised in these meetings will be handled as a grievance and addressed accordingly)

The locations of the physical grievance boxes will be subject to a quarterly review initially, and will be supplemented by additional locations, if necessary.

Corporate Affairs is responsible for ensuring that any personnel and contractors that could potentially receive claims will be knowledgeable about the grievance mechanism process and ready to accept feedback. Corporate Affairs will stress that there will be no costs or retribution associated with lodging grievances.

5.11.2 PUBLICIZING THE PROCEDURE

The grievance mechanism procedure will be publicized and communicated in a manner appropriate to the scope and nature of the project, and in a manner appropriate to the audience (i.e., method of delivery, language, etc.). CNEL will publicize and communicate the process to those most likely to use/administer it: local communities, authorities, and contractors. Notification will include:

- A summary of the procedure and how it can/should be used;
- Details of the process, such as who is responsible for receiving and responding to grievances, and any external parties that can receive grievances from communities;
- What type of response can be expected and when stakeholders can expect a response
- Safeguards in place to maintain confidentiality.

CNEL's Grievance Mechanism does not replace existing Namibia legal processes, or CNEL administrative processes already in use. In addition, the GM does not impede access to other judicial or administrative remedies that might be available under domestic law or through existing arbitration procedures, or substitute for feedback mechanisms provided through collective agreements.

CNEL Corporate Affairs, under the oversight of the Namibia Country Manager, will administer the GM by providing resources to handle correspondence, coordinate internal resolutions, manage a log, and report (both internally and externally).

CNEL's Grievance Mechanism will be appended to the full SEP which will be appended to the ESIA.

5.11.3 REGISTERING AND ACKNOWLEDGING A GRIEVANCE

Grievances will be logged in the Grievance Register within two days of receiving the grievance. A member of the CNEL team will be assigned to each grievance when they are logged and will be responsible for:

- Defining and implementing resolution actions.
- Investigating the grievance.
- Consulting relevant departments or persons within the organization.
- Making sure resolution actions are completed.
- Tracking progress of individual grievances.
- Aggregating and forwarding feedback to Complainants.
- Documenting resolution actions.
- Gaining necessary approvals from, and reporting to, management.

While no response is necessary for anonymous grievances, these will be logged and reported with other grievances to facilitate continuous improvement.

The Corporate Affairs advisor will formally acknowledge a grievance within five working days of the submission of the grievance, informing the Complainant that CNEL's objective is to respond within twenty working days. Written feedback is preferred so that a record of correspondence is retained and recorded.

If grievance is considered out-of-scope for the grievance mechanism (see section 4.2.3 on screening), the Corporate Affairs advisor should draft a response for signature by the Country Manager explaining why it is out-of-scope and providing any guidance of where to go to get the issue addressed (if possible). In cases where another entity (e.g. the government or a contractor) should be responsible for handling the grievance, CA will share the grievance with the appropriate government stakeholder (unless the grievance could result in potential reprisal) and inform the Complainant that the grievance has been shared with the appropriate body/person.

5.11.4 SCREENING A GRIEVANCE

Each grievance will be screened from Level 1 to 3, per definitions provided in , to determine the appropriate response. "Routine" issues will be managed through the grievance mechanism. "Potentially Significant" grievances will be flagged and managed via the Issues Management/Legislative and Regulatory Advocacy Process.

Category	Grievance Description	Type	Approach
Pre-screening	A grievance is a "valid" inquiry when it is asserted in good faith and something Chevron wishes to address. This level also includes grievances that are out-of-scope	Valid or out-of-scope	Progress to further screening
Level 1	A grievance for which there is already a management-approved response.	Routine	Inform appropriate management and then utilize approved answers to handle response.
Level 2	Grievances characterized by being a one-time situation, local in nature, and that will not impact Chevron's reputation.	Routine	Define response plan and craft draft response for management and Law approval.
Level 3	Repeated, widespread, or high-profile grievances that may result in a negative impact on Chevron's business activities or reputation. Level 3 feedback may indicate a gap in a management plan or procedure, or that a serious breach in policy or law may have occurred. Level 3 grievances would also include safety or human rights issues, physical or economic displacement and resettlement, and matters that may present legal issues.	Potentially significant	Prioritize Issues Management/ Legislative and Regulatory Advocacy Process (specifically the Enterprise Topic List), engage appropriate internal stakeholders and define appropriate management strategy. This process has within it requirements to consult with Law.

5.11.5 EVALUATE AND RESPOND TO A GRIEVANCE

The Corporate Affairs advisor will lead the grievance evaluation, which could include collecting relevant documents, making site visits, consulting appropriate internal staff, contacting external stakeholders, and other activities. Evaluation findings will be used to document decision making process and inform proposed remedy.

Before responding to the Complainant, Corporate Affairs will complete the following:

- Level 1 Grievances – Corporate Affairs informs the country manager and then utilizes recently approved answers to respond to Complainant. Response requires approval from the country manager.
- Level 2 Grievances – Corporate Affairs in collaboration with the project define a plan for grievance response and crafts the draft response for country manager approval.
- Level 3 Grievances:
    - The Corporate Affairs advisor works directly with the country manager and other departments to define plan for grievance response, then drafts a response.

- o In the case of sensitive grievances, CNEL may engage an external organization or third party (e.g., NGOs) in a joint investigation or allow for the participation of a Community Action Council, or other community structure, to demonstrate transparency in the process being taken to resolve the issue. Level 3 grievance responses need to be approved by the General Manager, CA, Africa, Eastern Mediterranean and Middle East.

Once the response has been approved, the Corporate Affairs advisor will take final, approved language and respond formally using appropriate communication means in the appropriate languages.

Corporate Affairs advisor is responsible for ensuring all information on the grievance is documented and actions tracked in the Grievance Register.

5.11.6 CLOSE OUT A GRIEVANCE

If the Complainant accepts the proposed resolution, the agreed actions are implemented. The Corporate Affairs advisor is responsible for assigning action parties, actions, and deadlines to implement the resolution. These are recorded in the Grievance Register with any supporting documentation. If necessary, monitoring arrangements will be put in place to verify implementation.

After resolution, the grievance should be formally closed out. This includes requesting the Complainant sign a completion form to document satisfaction with resolution actions, documenting actions taken, and closing out in the Grievance Register.

A Grievance Recording Form template and Grievance Register template are included in the appendices of the CNEL Grievance Mechanism Procedure

6. ESIA APPROACH AND METHODOLOGY

This chapter outlines the methodology for assessing the environmental and socio-economic impacts of both planned and unplanned activities associated with the potential project.

6.1 ESIA TEAM

Table 6-1 presents the project team and specialists appointed as part of the ESIA process. The CV for the EAP is attached as Appendix A.

TABLE 6-1 ESIA PROJECT TEAM AND SPECIALISTS

Name	Organisation	Position
ESIA Project Team		
Stephanie Gopaul	ERM	Partner In Charge
Vicky Louw	ERM	Project Coordinator and ESIA compiler
Joane Foucher	ERM	Project Manager
Specialist Team		
Dr. Victoria Griffiths	ERM	Social Performance Specialist
Rachel Gray	ERM	Stakeholder Engagement Support
George Chatzigiannidis	ERM	Noise Specialist
Michael Fichera	ERM	Discharge Modelling Specialist
Novania Reddy	ERM	Climate Change and GHG Specialist
Maitshoko Tumane	ERM	Air Quality Specialist
Heidri Bindemann-Nel	UD	Local Environmental Expert and Socio-Economic Study lead
Ernst Arthur Simon	UD	Local Stakeholder Engagement Specialist and Facilitator and Socio-Economic Study support
Tresia Amwaalwa	UD	Stakeholder Engagement Support
Collin Shapaka	UD	Stakeholder Engagement Support
Andrea Pulfrich	Pisces	Marine Biodiversity Specialist
Sarah Wilkinson	CapMarine	Fisheries Specialist

6.2 IMPACT ASSESSMENT METHODOLOGY

During the scoping phase, an initial analysis was carried out to identify the ways in which the project could interact with environmental and socio-economic resources or receptors, both positively and negatively. This process highlighted which potential impacts were likely to be significant, allowing the specialist studies in the detailed ESIA Report to focus on these key issues. Each potential impact identified is assessed using a methodology adapted from Chevron and ERM approaches, ensuring alignment with regulatory requirements.

6.2.1 IMPACT IDENTIFICATION AND CHARACTERISATION

An 'impact' is any change to a resource or receptor caused by the presence of a project component or by a project-related activity. Impacts can be negative or positive. Impacts are described in terms of their characteristics, including the impact type and their spatial and temporal features (namely extent, duration, reversibility and scale). Terms used in the characterisation of impacts within this study are described in Table 6-2.

TABLE 6-2 IMPACT CHARACTERISTICS

Characteristic	Definition	Term
Type	A descriptor indicating the relationship of the impact to the project (in terms of cause and effect).	Direct - Impacts that result from a direct interaction between the project and a resource/receptor (e.g. between occupation of the seabed and the habitats which are affected). Indirect - Impacts that follow on from the direct interactions between the project and its environment as a result of subsequent interactions within the environment (e.g. viability of a species population resulting from loss of part of a habitat as a result of the project occupying the seabed). Induced - Impacts that result from other activities (which are not part of the project) that happen as a consequence of the project. Cumulative - Impacts that arise as a result of an impact and effect from the project interacting with those from another activity (including those from concurrent or planned future third-party activities) to create an additional impact and effect.
Duration and Reversibility	Duration - The time period over which a resource / receptor is affected. Reversibility - The degree to which an impact can be undone or recovered from. This includes consideration of the natural resilience of the affected resource or receptor, the availability of restoration measures and the timeframe required for recovery.	Temporary - impacts are of short duration and intermittent or occasional. Localized and fully reversible within a short timeframe. Short term - impacts last for 6 months or less. Localized, low intensity and fully reversible. Medium term - impacts last more than 6 months and up to 3years. Regional in extent, moderate intensity and reversible with intervention. Long term -Impacts last more than three years and less than ten years. May affect ecosystem or community function. Reversible but may require significant effort. Permanent - impacts cause a lasting change beyond 10 years. High intensity and scale. Irreversible or only partially reversible.
Probability/ Likelihood	The chance or frequency with which an impact may occur.	Rare - The impact is rare or unheard of. Remote - The impact has occurred once or twice in the industry. Unlikely - Reasonable to expect the impact will not occur . Seldom - Exceptional conditions may allow impact to occur. Occasional - Conditions may allow the impact to occur. Likely - The impact is expected to occur.

Characteristic	Definition	Term
Extent	The reach of the impact (i.e. physical distance an impact will extend to)	On-site - impacts that are limited to the project site. Local - impacts that are limited to the project site and adjacent areas. Regional - impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries, habitat type/ecosystems, i.e., extend to areas outside the project site. National - impacts that affect nationally important environmental resources or affect an area that is nationally important/ or have macro-economic consequences. Trans-boundary/International - impacts that affect internationally important resources such as areas protected by international conventions or impact areas beyond the national boundary of the country in which the project is based.
Scale	Quantitative measure of the impact	The size of the impact (e.g., area damaged or impacted, the fraction of a resource that is lost or affected, etc.). This characteristic has no fixed designations as it is intended to be a numerical value.
Irreplaceable loss of resources	The degree to which the impact may cause permanent loss of unique or sensitive resources.	Evaluate the uniqueness and sensitivity of affected resources. Identify if the impact could lead to permanent loss of critical habitats, cultural heritage, or ecosystem services.

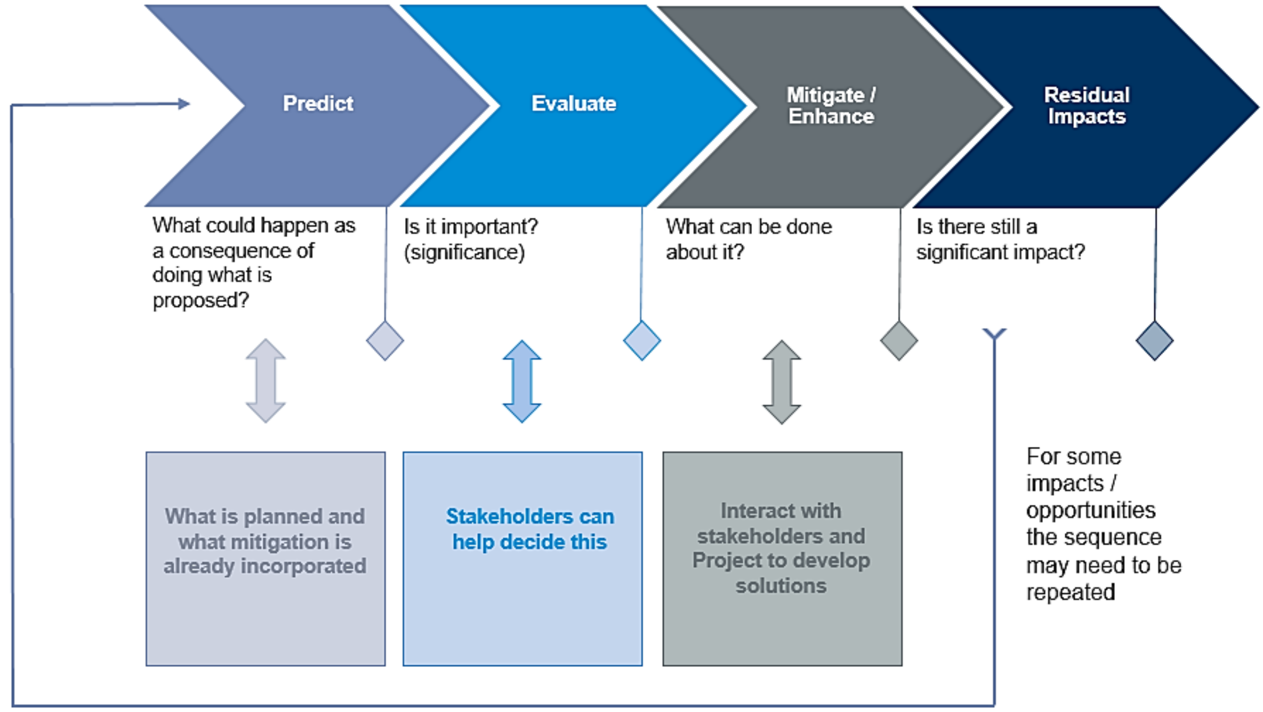
Source: Adapted from ERM, 2012

When categorising an impact, it is important to note that this process will consider any control measures that are already part of the project design. Additional mitigation measures aimed at further reducing the significance of impacts will also be proposed where necessary or appropriate.

6.2.2 POTENTIAL IMPACT PREDICTION

The assessment of potential impacts followed an iterative process considering four questions, as illustrated in Figure 6-1. For any potential impact rated as Minor or greater in significance, the project team performed an iterative process of reviewing the potential impacts using the mitigation hierarchy framework. Where significant residual impacts remained, additional mitigation measures were considered. Residual impacts were then re-assessed and refined until reduced to the lowest practicable level for the potential project.

FIGURE 6-1 IMPACT PREDICTION AND EVALUATION PROCESS



Source: ERM, 2012

6.2.3 DETERMINING MAGNITUDE

This study describes what could happen by predicting the magnitude of the potential impacts and quantifying these to the extent practicable. The term 'magnitude' is used as shorthand to encompass all the dimensions of the predicted impact including:

- The nature of the change (what is affected and how).
- Its size, scale, or intensity.
- Its geographical extent and distribution.
- Its duration, frequency, reversibility; and
- Where relevant, the probability of the impact occurring as a result of accidental or unplanned events.

Magnitude therefore describes the actual change that is predicted to occur in the resource or receptor.

An overall grading of the magnitude of potential impacts is provided, considering all the various dimensions to determine whether a potential impacts is of Negligible, Small, Medium or Large Magnitude. Each potential impact is evaluated on a case-by-case basis and the rationale for each determination is described.

The magnitude designations themselves are universally consistent. However, this scale is defined according to the type of potential impact and is dependent on associated circumstances. For example, for readily quantifiable impacts, numerical values can be used whilst for other topics a more qualitative classification may be necessary. Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes are regarded as having no impact and characterised as having a negligible magnitude. In the case of a positive potential impact, no magnitude designation has been assigned as it is considered sufficient for the purpose of the impact assessment to indicate that the project is expected to result in a positive impact.

The following table summarizes magnitude designations across the different receptors:

TABLE 6-3 DEFINITION OF MAGNITUDE ACROSS DIFFERENT RECEPTORS

Magnitude	Biophysical	Socio-economic
Negligible	No measurable change; within natural variation. No observable alteration in ecosystem structure or function. Localized, short-term, fully reversible.	No perceptible effect on well-being or access to resources. No change in income, employment, or access. Localized, short-term, fully reversible.
Small	Localized, short-term, minor changes in ecosystem components. Small-scale, low intensity. Limited to project area. Reversible within months.	Local, rare, short-term effects on few individuals. Minor disruption in access or services. Reversible within months.
Medium	Regional, measurable, recoverable changes in ecosystem structure or function. Moderate scale and intensity. Reversible within 1–3 years.	Evident change affecting many people or areas. Medium duration and scale. Reversible with intervention.
Large	Widespread, long-term, potentially irreversible changes. High intensity and scale. Affects ecosystem integrity. May not be reversible.	Dominates baseline conditions. It affects majority of the population. Long-term or large-scale. Reversibility uncertain.
Positive	Not assigned; noted as beneficial where applicable.	Not assigned unless robust data is available to support benefit.

Source: Adapted from ERM, 2012

6.2.4 DETERMINING RECEPTOR SENSITIVITY

The specific scale of sensitivity/vulnerability/importance for a receptor depends on the receptor assessed, but in general, it may be defined in terms of its quality, value, rarity, or importance. The ability of a receptor to adapt to change, tolerate and/or recover from potential impacts is key in adding expert judgment and assessing its overall sensitivity to the impact under consideration.

The value of a resource is assessed by considering its quality and its importance as represented, e.g., by its local, regional, national or international designation, its importance to the local or wider community or its economic value.

The assessment of receptors' sensitivity (e.g., a faunal community or an industry such as fishing or shipping) considers their expected response to the change and their capacity to adapt to and manage the effects of the impact.

The scale of sensitivity/vulnerability/importance of the environmental and social receptors that will be impacted by a planned event will be classed as 'low', 'medium', or 'high', as described in Table 6-4. The severity of the potential impact on environmental and social receptors that will be impacted by an unplanned planned event will be classed as 'low', 'medium', or 'high', as described in Table 6-4.

TABLE 6-4 RECEPTOR-SENSITIVITY/ VULNERABILITY DEFINITIONS

Receptor Type	Low Sensitivity Some tolerance to accommodate the effect or can recover/adapt. Low risk of irreplaceable loss of resources.	Medium Sensitivity Low capacity to accommodate the effect and limited ability to recover/adapt. Moderate risk of irreplaceable loss of resources.	High Sensitivity Very low capacity to accommodate the effect and low ability to recover/adapt. High risk of irreplaceable loss of unique or sensitive resources.
Communities	Cohesive, resilient, strong infrastructure and governance	Moderate cohesion, some infrastructure/governance gaps	Fragmented, vulnerable, lacking infrastructure or governance
Ecosystems	Stable, diverse, resilient to environmental changes	Some stress or degradation, moderate resilience	Highly degraded, low biodiversity, sensitive to further disturbance

Source: Adapted from ERM, 2012

6.2.5 EVALUATION OF SIGNIFICANCE

The next step in the assessment is to evaluate the magnitude of impacts and explain their importance to society and the environment. This is to enable decision makers and stakeholders to understand how much weight should be given to the issue in deciding on their view of a project. This is referred to as Evaluation of Significance.

For the purposes of this report, the following definition is used:

'An impact is significant if, in isolation or in combination with other impacts, it should, in the judgment of the team undertaking the assessment, be reported in the ESIA so that it can be taken into account in decision making on whether the project should proceed and if so under what conditions.' (ERM, 2013).

This recognises that evaluation requires an exercise of judgment and that judgments may vary between parties in the process. The evaluation of impacts that is presented in this study is based on the professional judgment and experience of the team undertaking the assessment. The team undertaking the assessment is informed by reference to the national legal standards, international regulations, government policies, CNEL policies/ standards/ guidelines and applicable industry practices.

Where standards are not available or provide insufficient information on their own to allow a grading of significance, the significance has been evaluated considering the magnitude of the impact and the value or sensitivity of the affected resource or receptor. Magnitude is defined across the various dimensions described in the previous sub-section (refer to Section 6.2.3). The value of a resource is judged considering its quality and its importance as represented, for example, by its local, regional, national, or international designations; its importance to the local or wider community; or its economic value. The assessment of receptor sensitivity, for example a faunal community or an industry (e.g. fishing, shipping), takes into account their anticipated response to the change and their ability to adapt to and manage the effects of the impact (refer to Section 6.2.4).

6.2.5.1 PLANNED AND UNPLANNNED EVENTS

For both planned and unplanned events, magnitude and sensitivity/vulnerability/importance are considered together to evaluate whether a potential impact is significant and, if so, to determine its degree of significance.

For planned events, magnitude considers the nature, size, geographical extent, duration, frequency and reversibility of the potential impact occurring.

For unplanned events, magnitude (often referred to as consequence) considers the probability, extent, duration, intensity and the severity of the impact on environmental and social receptors, particularly in the context of accidental or unforeseen events. The principle is illustrated in Figure 6-2.

FIGURE 6-2 EVALUATION OF SIGNIFICANCE (PLANNED AND UNPLANNED EVENTS)

Evaluation of Significance		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	Medium	High
Magnitude of Impact	Negligible	Incidental	Incidental	Incidental
	Small	Minor	Minor	Moderate
	Medium	Moderate	Major	Severe
	Large	Major	Severe	Catastrophic

Source: Adapted from ERM, 2012

The matrix applies universally to all resources/receptors and all impacts to these resources/receptors, as the resource/receptor-specific considerations are factored into the assignment of magnitude and sensitivity/vulnerability/importance designations. Table 6-5 provides context for the various impact significance ratings.

TABLE 6-5 DEFINITIONS OF ENVIRONMENTAL AND SOCIAL SIGNIFICANCE (CONSEQUENCE) CRITERIA AND ASSOCIATED IMPACT SIGNIFICANCE RATING

Impact Significance	Potential Environmental Impact Definition	Potential Social Impact Definition
Incidental	Negligible disturbance or impact and/or the impact is reversible within a very short period of time (e.g. days to months).	Incidental impact that is indistinguishable from existing and/or pre-project conditions.
Minor	Impact occurs at a local scale (e.g. within, or in the vicinity of a disturbance footprint or operational area) or affects a minor part of a species habitat or population but the impact is recoverable in the short term (e.g. 3 months to 2 years).	Minor, inconvenient social impacts that lasts less than one year and/or are reversible.
Moderate	Impact occurs at a local scale or affects a minor part of a species habitat or population but the impact is recoverable in the long-term (e.g. two	Moderate, localised or short-term (e.g. 1 to 3 years), recoverable social impact. Community stakeholders are likely able to adapt with relative ease.

Impact Significance	Potential Environmental Impact Definition	Potential Social Impact Definition
	to ten years), or impact affects a wide area (e.g. significantly greater than disturbance footprint), or affects a significant proportion of a habitat or population (e.g. >10%) but the impact is recoverable in the short-term (e.g. 3 months to 2 years).	
Major	Impact occurs at a local scale or affects a minor part of a species habitat or population and the impact is persistent (e.g. >10 years for recovery or never expected to fully recover), or impact affects a wide area (e.g. significantly greater than disturbance footprint), or affects a significant proportion of a habitat or population (e.g. >10%) but where the impact is recoverable in the long-term (e.g. 2 to 10 years).	Major, local-to-regional (sub-national) or medium-term (e.g. 3 to 6 years) recoverable social impact. Community stakeholders may be able to adapt with some targeted support or assistance.
Severe	Impact affects a wide area (e.g. significantly greater than disturbance footprint), or affects a significant proportion of a species habitat or population (e.g. >10%) and the impact is persistent (e.g. >10 years or never expected to fully recover), or impact affects a very large area (e.g. an entire region and/or the majority or all of a habitat type or population and/or results in loss of ecosystem function) and lasts long-term (e.g. 2 to 10 years).	Severe, local-to-national or long-term (up to 10 years) non-recoverable social impacts. Community stakeholders, social services or infrastructure may not be able to adapt without sustained targeted support or assistance.
Catastrophic	Impact affects a very large area (e.g., an entire region and/or the majority or all of a species habitat type or population and/or results in loss of ecosystem function) and is persistent (e.g., >10 years for recovery or never expected to fully recover).	Nonrecoverable social impacts lasting longer than 10 years and community stakeholders may not be able to adapt without significant intervention. Total loss of (substantial or significant) community property, cultural asset or natural resources (e.g., ecosystems services) without the ability to replace.

Source: Chevron, 2024

6.2.5.2 MITIGATION

The impact assessment process ensures that project decisions are informed by their potential effects on the environment and society. A critical step in this process is the identification and integration of mitigation measures into the design and planning of the potential project.

Mitigation efforts focus on identifying where potential impacts of Minor or greater significance may occur and working with the project team to apply the Protective by Design approach using the mitigation hierarchy framework. This ensures that impacts are avoided or reduced as far as reasonably practicable.

When a significant impact is identified, mitigation measures are defined following a structured hierarchy, as outlined in Box 6-1. The priority is to first avoid or reduce the impact at its source. If residual effects remain, additional measures such as abatement, restoration, or compensation are considered to further reduce the significance of the impact.

BOX 6-1 MITIGATION HIERARCHY

Avoid at Source; Reduce at Source: avoiding or reducing at source through the design of the project i.e. avoiding by siting or re-routing activity away from sensitive areas or reducing by restricting the working area or changing the time of the activity.
Abate on Site: add something to the design to abate the impact i.e. pollution control equipment.
Abate at Receptor: if an impact cannot be abated on-site then control measures can be implemented off-site i.e. traffic measures.
Repair or Remedy: some impacts involve unavoidable damage to a resource (i.e. material storage areas) and these impacts require repair, restoration and reinstatement measures.
Compensate in Kind; Compensate through Other Means where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate i.e. financial compensation for degrading agricultural land and impacting crop yields.

Source: ERM, 2012

6.2.5.3 POTENTIAL RESIDUAL IMPACTS

In some cases, it may only be possible to reduce the potential impact to a certain degree through mitigation (i.e., there is an impact remaining even after mitigation). These potential impacts are therefore residual in the sense that they remain after mitigation measures have been applied to the intended activity.

Where an impact could not be completely avoided, the potential residual impact has been reassessed and the possibility for further mitigation considered. All residual significant impacts are described in this study with commentary on why further mitigation is not feasible. Additional mitigation measures do not need to be declared for impacts rated as Incidental and Minor significance.

6.2.5.4 CUMULATIVE IMPACTS

A cumulative impact is one that arises from a result of an impact from the project interacting with an impact from another activity to create an additional impact.

How the impacts and effects are assessed is strongly influenced by the status of the other activities (e.g. already in existence, approved or proposed) and how much data is available to characterise the magnitude of their impacts.

The approach to assessing cumulative impacts is to screen potential interactions with other projects on the basis of:

- Projects that are already in existence and are operating or in progress;
- Projects that are approved but not yet operating or in progress; and
- Projects that are a realistic proposition but are not yet installed or under construction.

7. ASSESSMENT OF PLANNED ACTIVITIES

This chapter evaluates the potential environmental (physical and biological), social and cultural impacts associated with the mobilisation, exploration and demobilisation of the potential project.

7.1 IDENTIFICATION AND SCREENING OF KEY POTENTIAL IMPACTS

During the scoping phase of the ESIA process, the ESIA team systematically identified key potential environmental and social impacts arising from both planned and unplanned project activities, as well as their interactions with environmental and social resources and receptors that require further analysis. These findings were subsequently refined during the ESIA phase.

The project team evaluated potentially significant impacts using the impact assessment methodology outlined in Section 6. Mitigation measures have been developed and integrated into this report to prevent or minimise negative effects while promoting positive outcomes. A summary of these mitigation measures is provided in this chapter, with further details available in the Environmental and Social Management Plan (ESMP) in Section 11.

The significance of each potential impact has been assessed both prior to and following the implementation of the recommended mitigation or enhancement measures. Impacts deemed Not Significant are summarized in Table 7-1 and excluded from detailed assessment. Table 7-2 presents the potential impacts selected for additional evaluation during the ESIA phase, identifying the issues that warrant further analysis within this report.

TABLE 7-1 POTENTIAL IMPACTS SCOPED OUT OF ESIA ASSESSMENT

Aspect	Issue	Activities	Results
Planned Events			
Air Emissions	Degradation of air quality	• Vessels and helicopter atmospheric emissions • Power generation on the drillship during drilling • Bunkering	Potential air quality impacts from vessel and exploration activities are expected to be temporary and localized. Given the offshore location, well-mixed airshed and distance from shore, no significant regional or health impacts are anticipated. Therefore, this potential impact is not considered significant and will not be assessed further.
Ecosystem disturbance	Disturbance to marine fauna and seabirds due to light	• Operation and presence of support vessels, helicopters from onshore support base • Mobilisation, presence, operation and demobilisation of Drillship/MODU and support vessels • Drilling • Well testing for appraisal wells	Artificial lighting from offshore project vessels may attract marine fauna and seabirds, but the risk is minimal due to the project's distance from the shore (>80 km), limited duration and restricted lighting use. The likelihood of marine turtles being present is also low, as the area lacks nearby nesting beaches. Overall, the potential impact is considered not significant and will not be assessed further.
	Seawater quality degradation /contamination and impacts on marine fauna	Wastewater discharges from the drillship, supply and support vessels	Operational discharges from the drillship and support vessels may affect local water quality and marine fauna. However, all discharges will comply with MARPOL 73/78 Annexes I, IV and V, which regulate oil, sewage and garbage disposal at sea. As a result, the potential impact is considered not significant and will not be assessed further.
	Increased hard substrata on the seabed	• Placement of wellhead on the seabed. • Discharge of residual cement during riserless stage. • Abandonment of wellhead on seabed.	The potential impact of increased hard infrastructure on the seabed is highly localised and has a neutral impact on benthic biodiversity. Therefore, the impact was not considered significant and will not be assessed further
	Disturbance of seabed geology	• Drilling	The potential impact of drilling of the geology will be very localised to the drilling location and where the drill bit will penetrate the seabed geology. Therefore, the impact was not considered significant and will not be assessed further.

Aspect	Issue	Activities	Results
Wastewater Management	Degradation to sea water quality	• Disposal of excess WBF at surface • Well testing for appraisal wells • Vessel discharge of oily water • Discharge of sanitary effluents (black and grey water) • Disposal of food waste • Ballast water from support and supply vessels (potentially international)	Water quality impacts are expected to be localized and temporary. All discharges will comply with MARPOL 73/78 standards. CNEL will implement a Waste Management Plan and follow best environmental practices, including minimizing WBF volumes and managing well testing fluids. The potential impact is deemed insignificant and will not be further assessed.
Community	Community, Health, Safety & Security	Interactions of foreign/ migrant workers with local residents	The project will employ personnel throughout its duration; however, due to the specialised nature of offshore operations, most drillship staff will be expatriates. These workers are expected to transit briefly through Walvis Bay or Lüderitz. Shore base operations will primarily involve existing employees of local logistics companies. Given the short-term nature of the project and the limited number of personnel involved, the potential for significant interaction with local communities is minimal. Therefore, this potential impact is considered insignificant and will not be assessed further.
		Noise from helicopters	Helicopter transfers for crew changes will occur over the ports of Walvis Bay or Lüderitz. Flight paths will avoid residential areas, minimizing potential noise disturbance. As a result, this potential impact is considered not significant and will not be assessed further.
	Visual	Drillship	The drillship will be located more than 72 km offshore and therefore is very unlikely to be seen from the shore. Therefore, this potential impact was considered not significant and will not be assessed further.
	Traffic and transportation	• Drillship/MODU presence at Site (offshore) including exclusion zone, wellhead and riser • Labour, equipment and services supply • Road traffic • Equipment and services supply • Onshore crew change	The offshore project activities are not anticipated to increase traffic significantly as the project will add five more vessels for the duration of the project (1 to 5 years). While the safety exclusion zone may be perceived to impact traffic and transportation, the project area in relation to the navigation routes is substantially larger and therefore the impact will be not significant. The volume of road traffic expected to be generated by the onshore project activities is expected to be minimal therefore this potential impact will not be assessed further in the ESIA Report.
	Tourism & recreation	• Operation and presence of supply and support vessels,	The onshore and offshore elements of the project are not expected to negatively impact on tourism and recreation, particularly in the vicinity of the

Aspect	Issue	Activities	Results
		helicopters from onshore support base	port, therefore, this potential impact will not be assessed further in the ESIA Report.
Waste Management	Increase in non-hazardous and hazardous wastes disposal	Disposal of non-hazardous and hazardous wastes generated by the project activities at onshore disposal sites	The project will result in an increase in both non- hazardous (eg: kitchen waste and scrap metals) and hazardous (eg engine lubricants and filters) waste generated in the area. Wastes will be transported by vessels to the onshore in Walvis Bay prior to off-site disposal. Solid non-hazardous waste will be disposed of at a suitably licensed waste facility. Hazardous wastes will be treated/ disposed of at a licensed waste treatment/ disposal facility. Therefore, this potential impact was considered not significant and will not be assessed further.
Natural Resource Use	Fresh water supply	Provision of drinking water for the crew on all vessels	The MODU will produce water and where required bottled water may be provided. Therefore, this potential impact was considered not significant and will not be assessed further.
Stakeholder	Increased pressure on local utilities and infrastructure	Disposal of shore base generated waste	Waste generated at the shore base will be managed and disposed of at a hazardous waste treatment facility established by CNEL, located adjacent to the city's municipal infrastructure. The volumes of waste generated and requiring onshore management will be relatively small therefore this potential impact is scoped out of further assessment.
Unplanned Events			
Ecosystem Disturbance	Introduction of alien invasive species	Ballast from support and supply vessels (potentially international)	De- and re-ballasting of project vessels will only be undertaken in adherence to International Maritime Organisation (IMO) guidelines governing discharge of ballast waters at sea. The IMO states that vessels using ballast water exchange should, whenever possible, conduct such exchange at least 200 nm from the nearest land and in water of at least 200 m depth. Where this is not feasible, the exchange should be as far from the nearest land as possible and in all cases a minimum of 50 nm from the nearest land and preferably in water at least 200 m in depth. Based on the implementation of these measures the potential impact is considered insignificant and will not be further assessed.
	Sediment disturbance	Dropped Objects	The accidental and irretrievable loss of equipment to the seabed could potentially disturb and damage seabed habitats and crush any epifauna and infauna within the equipment footprint. Considering the available area of similar habitat on and off the edge of the continental shelf in the

Aspect	Issue	Activities	Results
			Namib and Central Namib ecozone, this disturbance of, and reduction in, benthic biodiversity can be considered of negligible intensity, highly localised and limited to the footprint of the lost equipment (On-site). Any impacts would persist temporarily only, as lost equipment will be retrieved or if irretrievable and left in place on the seabed would offer hard substratum for colonisation by sessile benthic organisms in an area of otherwise unconsolidated sediments or will likely sink into the sediments and be buried over time. The impact for equipment lost would be fully reversible if retrieved with losses being unlikely. The potential impact is thus considered to be of INCIDENTAL significance without mitigation. The impact significance is not further evaluated in this ESIA Report.
	Sediment disturbance	Dropped Objects	Accidental loss of equipment on the seabed may cause minor, highly localized habitat disturbance and temporary reduction in benthic biodiversity. Since similar habitats are widespread, these potential impacts are negligible and confined to the equipment's footprint. Lost equipment will either be retrieved or, if left, can serve as a substrate for marine life or become buried over time. The potential impact is reversible with retrieval, unlikely to cause losses and not considered significant; therefore, further evaluation is not included in this ESIA Report.
	Degradation of seawater quality	Small instantaneous chemical and oil spills	All project vessels are required to implement a Shipboard Oil Pollution Emergency Plan (SOPEP). Small chemical and oil spills that occur onboard will be addressed promptly in accordance with SOPEP and the ESMP) As a result, small spills are not considered likely to have significant impact and will not be further assessed.
	Potential injury of marine fauna	Collisions with marine fauna	Seabird collisions at offshore installations are rare, and local seabirds and marine mammals generally adapt to the presence of these structures within days, making their overall impact not significant. Similarly, increased predation on fish and squid drawn to installation lights is not considered

Aspect	Issue	Activities	Results
			significant, so this potential impact is not further evaluated in this ESIA Report.
Community	Community and Occupational Health and Safety	Dropped Objects	Dropped objects from project vessels present potential health and safety risks. These risks are addressed through adherence to industry health and safety standards, established control measures, and compliance with CNELS's H&S Standards. Mitigation and prevention strategies for such incidents are incorporated into the ESMP for this project to reduce risk. The impact significance is not further evaluated in this ESIA Report.

TABLE 7-2 POTENTIAL IMPACTS SCOPED IN FOR ASSESSMENT

Aspect	Issue	Activities	Results
Planned Events			
Ecosystem Disturbance	Seawater and sediment quality degradation /contamination and impacts on marine fauna	• Disposal of cuttings to the seafloor and overboard during drilling	Cuttings discharged both at the seabed (prior to riser installation) and below the sea surface during risered drilling (closed loop system) may generate a sediment plume that could disturb nearby marine habitats, benthic communities and marine fauna. This potential impact will be assessed further in the ESIA Report, including a discussion on the treatment and base fluid content of these muds and cuttings prior to disposal.
		• Drilling	The potential impact of drilling on the seabed is expected to be highly localised and short-term. During the initial phase (top hole drilling), only limited physical disturbance is anticipated, primarily from the discharge of cuttings and excess cement. In subsequent phases, the dispersion of cuttings (both from the vessel and at the seabed) will be modelled. These results will be included in the ESIA Report, along with an evaluation of potential impacts on benthic fauna.
		• Disposal of excess cement	Already mixed excess cement will be disposed of overboard. Contaminant concentrations in seawater would be expected to return to background levels rapidly, with the assistance of currents and the mixing capacity of the water body (the assimilative capacity of water would be expected to minimise any

Aspect	Issue	Activities	Results
			impacts) and therefore have limited impacts on marine fauna. However, these potential impacts will be assessed in the ESIA Report.
	Disturbance of marine fauna	• Drillship and vessels noise due to dynamic positioning and moving • Noise from drilling activities (including well logging) • Vertical Seismic Profiling	Underwater noise from drilling (including well logging), VSP and vessel operations may disturb marine fauna and habitats, especially noise-sensitive species. These potential impacts, including vibrations, will be assessed in the ESIA report.
Community and Stakeholders	Fishing and Navigation	• Riser/ BOP - Structure Removal • Drillship/MODU presence at Site (offshore) including exclusion zone, wellhead and riser	The activities associated with the exploratory drilling program will require the establishment of temporary safety exclusion zones around the drilling unit, which may be perceived negatively by fishing communities and could affect navigation routes. These potential impacts will be evaluated in the ESIA Report.
Stakeholders	Global Climate Change	• Mobilisation, operation, presence and demobilisation of vessels • Well testing and appraisal • Helicopter support • Labour equipment and service • Onshore equipment supply • Onshore crew change	GHG emissions during the drilling program are temporary and not considered potentially significant. However, considering CNEL's project standard (refer to Section 2.4.5) and increased public awareness of the risk associated with global climate change which could raise concerns from stakeholders, the GHG emissions and climate change study will be assessed and included in the ESIA Report (refer to Section 7.2.2).
Unplanned / Accidental Events			
Ecosystem Disturbance	Disturbance of fisheries and marine fauna	Well loss of containment event	The risk of a well loss of containment event for the project can be minimised by applying the Chevron WellSafe Standard protocols and verification plan. The risk and potential impact of a well loss of containment event will result in marine pollution and disturbance of sensitive receptors and marine and potentially coastal habitats. It will also impact fisheries, the health and safety of the workforce and result in decreased air quality in the region of the well loss of containment event. The significance of the potential impact of a well loss of containment event will therefore be assessed further in the ESIA Report.
	Community		A well loss of containment event may lead to strained relations with marine and onshore stakeholders, depending on the locality of the incident. Economic impacts could be significant, involving hydrocarbon spills, resource deployment

Aspect	Issue	Activities	Results
			for containment and cleanup and damage to vessels and the drilling unit. Potential economic and social disruption will be assessed further in the ESIA Report.
Community	Community health and safety	Vessel collisions	Vessel collisions could lead to health and safety risks and the mitigation and prevention of these incidents needs to be included in the ESMP. The significance of this potential impact will therefore be assessed further in the ESIA Report.
		Helicopter incidents	The ESMP for this project will include measures to minimise helicopter incidents during crew transfers. The significance of this potential impact will therefore be assessed further in the ESIA Report.

7.2 PLANNED OPERATIONS: KEY ENVIRONMENTAL IMPACTS

The following sections present the evaluation of the potential environmental impacts from the planned activities that were identified during scoping and stakeholder engagement as potentially significant.

7.2.1 SUMMARY OF MODELLING RESULTS

This section summarises the findings of the various modelling studies which inform the impact assessment for planned events. The modelling studies are provided in Appendix D and Appendix F.

7.2.1.1 DRILL CUTTINGS DEPOSITION MODELLING STUDY

A Drill Cuttings Deposition Modelling Study was undertaken by ERM (2025b) to assess the spatial extent and environmental fate of discharged cuttings and muds (Appendix D). The study assumed a drilling duration of 16 days, with a one-day pause between each section to allow suspended solids to settle. Simulations extended to 21 days to account for post-discharge dispersion.

ERM (2025b) conducted a modelling study to assess the spatial extent and environmental fate of drill cuttings and muds discharged during offshore drilling operations (refer to Appendix D). The study focused on two locations: the Gemsbok Well in Block 2112B and a potential second well in Block 2212A, in water depth ranging from 900 m to 1,500 m. Seasonal scenarios were modelled for March, June, September and December 2023.

The modelling accessed:

- Total Suspended Solids (TSS) concentrations in the water column
- Seabed accumulation of cuttings, WBM and NADF minerals and NABF
- Hydrocarbon concentrations on the seabed

Across all scenarios, TSS concentrations near the seabed exceeded the 35 mg/L threshold set by MARPOL Resolution MEPC.159(55) and the International Finance Corporation (IFC, 2007). Surface water concentrations remained below this threshold.

To assess potential burial impacts, depositional thickness was compared against two conservative thresholds:

- 6.3 mm for instantaneous deposition (Smit *et al.*, 2006, 2008)
- 5 cm/month for gradual deposition (Ellis & Heim, 1985; MarLIN, 2023)

Depositional thickness exceeded both thresholds at both well locations. The Gemsbok Well showed smaller impact areas, with deposition exceeding 6.3 mm generally within a 50 m radius, while the second potential well showed deposition within a 500 m radius (refer to Table 7-3).

TABLE 7-3 SUMMARY OF CUTTINGS DEPOSITION RESULTS FOR THE GEMSBOK WELL AND THE POTENTIAL SECOND WELL LOCATION

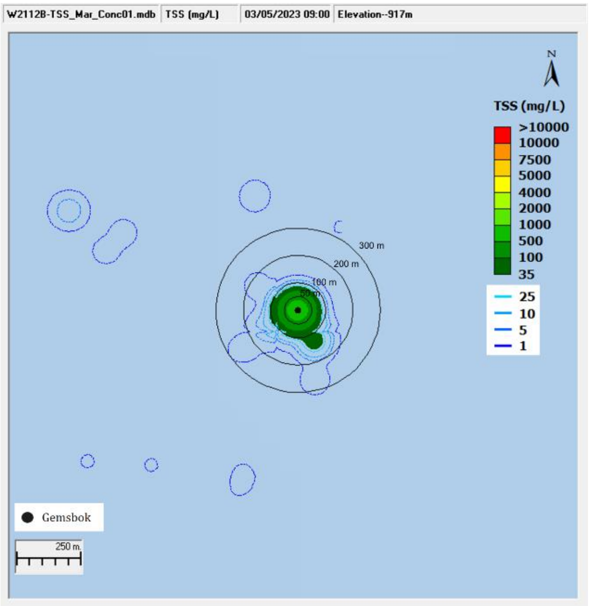
Well	Month	Area (m^2) with Thickness> 5 cm threshold	Area (m^2) with Thickness> 6.3 mm threshold
Gemsbok Well (in Block 2112B)	March	4,157	15,869
	June	4,943	33,948
	September	2,574	6,424
	December	2,189	4,451
Potential second well location (in Block 2212A)	March	8,780	364,244
	June	13,212	219,030
	September	15,002	228,540
	December	15,814	243,553

Source ERM, 2025b

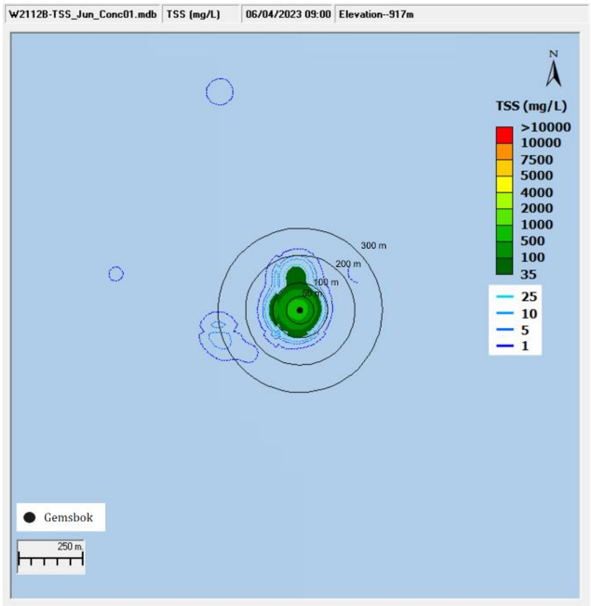
Figures Figure 7-1 and Figure 7-2 illustrate the maximum seabed areas where TSS concentrations exceeded the 35 mg/L threshold for each seasonal scenario at both well locations. It is noted that the second potential well was initially referred to as “Sable”.

FIGURE 7-1 MAXIMUM AREA OF TSS ABOVE THRESHOLD NEAR SEABED IN MARCH, JUNE, SEPTEMBER AND DECEMBER FOR THE GEMSBOK WELL

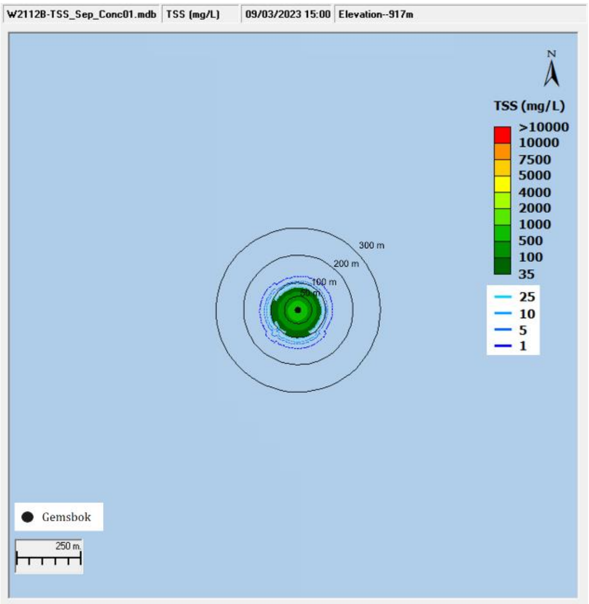
March



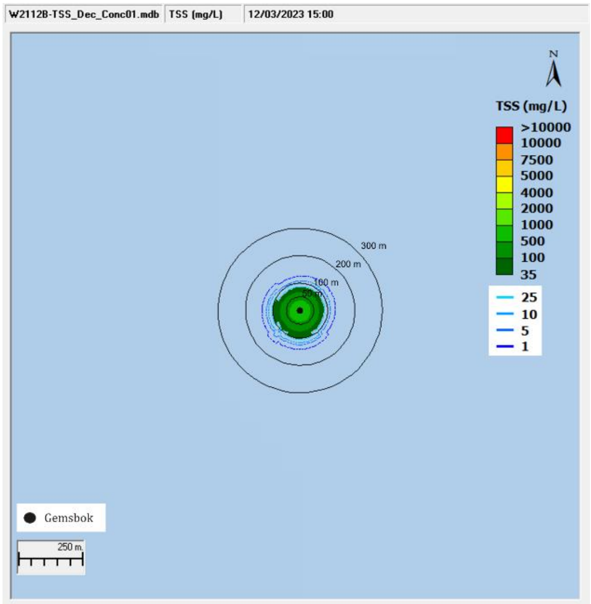
June



September



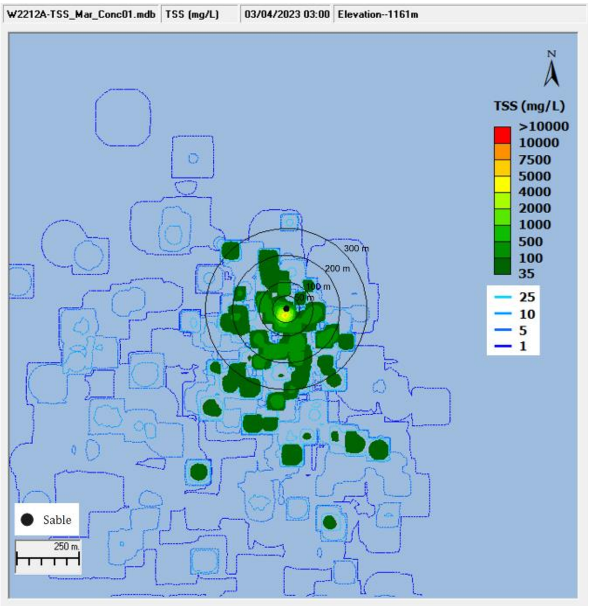
December



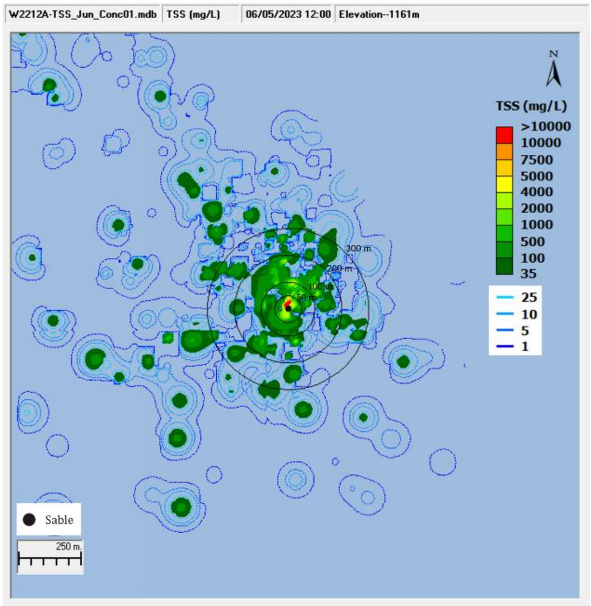
Source ERM, 2025b

FIGURE 7-2 MAXIMUM AREA OF TSS ABOVE THRESHOLD NEAR SEABED IN MARCH, JUNE, SEPTEMBER AND DECEMBER FOR THE POTENTIAL SECOND WELL LOCATION

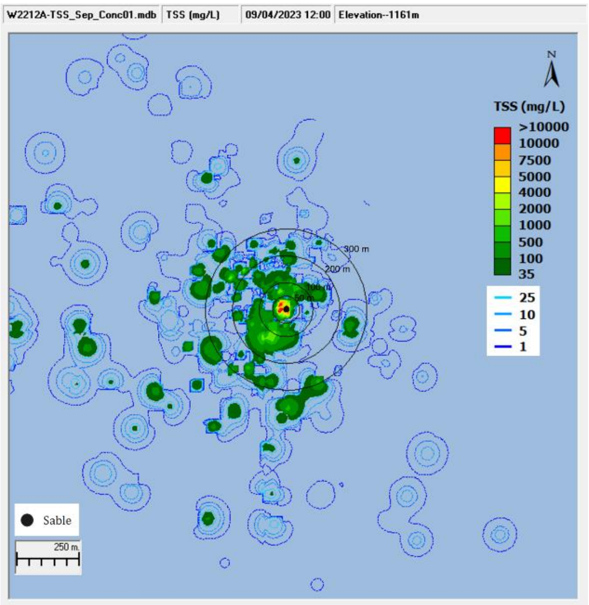
March



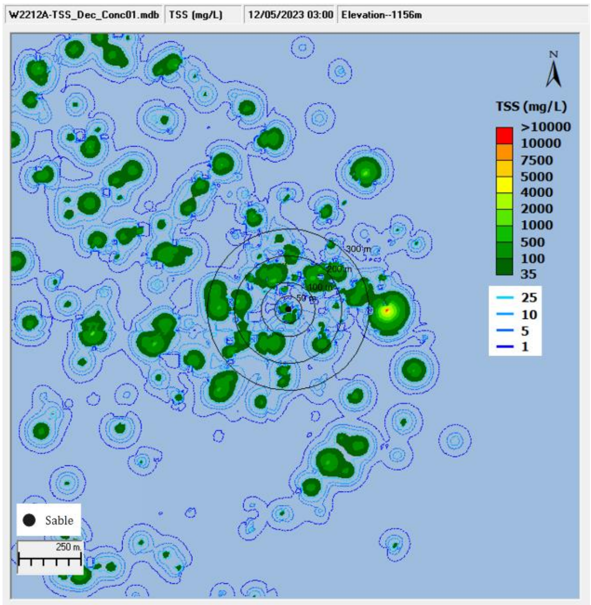
June



September



December



Source ERM, 2025b

Hydrocarbon deposition from NABF was also evaluated. Although the 10 g/m² concentration threshold applied is not regulatory, it was used to delineate potential accumulation zones. The ecological significance of these concentrations remains uncertain and may warrant further investigation. Table 7-4 presents the seasonal variation in areas where hydrocarbon concentrations exceeded the 10 g/m² threshold. At the Gemsbok Well, the impacted area ranged from 0.619 km² in December to a peak of 6.860 km² in June. In comparison, the second well location exhibited a broader and more consistent impact, with affected areas ranging from 2.943 km^2 in December to 7.201 km^2 in June. These results demonstrate seasonal variability and suggest that the second well location may be subject to wider hydrocarbon dispersion, potentially due to differing oceanographic conditions.

TABLE 7-4 SUMMARY OF NABF CONCENTRATION RESULTS FOR THE GEMSBOK WELL AND THE POTENTIAL SECOND WELL LOCATION

Well	Month	Area (km^2) with NABF Concentration > 10 g/m^2
Gemsbok Well (in Block 2112B)	March	3.950
	June	6.860
	September	5.560
	December	0.619
Potential second well location (in Block 2212A)	March	5.128
	June	7.201
	September	2.965
	December	2.943

Source ERM, 2025b

7.2.1.2 UNDERWATER NOISE MODELLING

An Underwater Noise Modelling Study was conducted by ERM (2025c) to assess sound propagation and potential acoustic impacts from drilling and VSP activities at the Gemsbok well (Block 2112B) and a second potential well (Block 2212A) in PEL 82. The study aimed to model underwater acoustic propagation resulting from drilling and VSP operations, evaluate potential effects on marine mammals, fish and sea turtles and delineate potential impact zones associated with auditory injury, temporary threshold shifts (TTS) and behavioural disturbances. Noise impact criteria were established by reviewing the most current guidelines and scientific literature, addressing both physiological and behavioural responses in marine mammals, fish and sea turtles (refer to Appendix F).

Noise sources considered included drillship propellers and thrusters, riser drag, supply vessels and drilling operations. VSP, although unlikely to be undertaken, was included as a conservative scenario.

Detailed modelling predictions using ERM's proprietary Marine Mammal Noise Exposure Tool (MMNET), incorporating site-specific bathymetry, seabed characteristics and sound speed profiles were undertaken for noise emissions non-impulsive (drilling unit and support vessels) signals and from impulsive VSP. The potential zones of noise impact were estimated for different marine faunal species based on comparisons between established noise impact criteria for potential physiological and behavioural impacts (for marine mammals, turtles, fish and eggs and larvae[9]) and the modelled received noise levels. Sound transmission loss modelling was undertaken for two source locations within PEL 82 and the following scenarios:

- Single VSP pulse;

[9] The noise criteria for fish are presented in Tables 3.3 and 3.4 in the Noise Modelling Report.

- Exposure to 50 VSP pulses over two hours;
- Cumulative exposure to 250 VSP pulses over 12 hours; and,
- Continuous non-impulsive noise - 24 hr exposure.

Source levels reached:

- 202 dB re 1 µPa RMS for drillship and support vessels;
- 242 dB re 1 µPa peak for VSP airgun arrays.

Thresholds were based on NOAA (2024), Southall et al. (2019), Popper et al. (2014) and Finneran et al. (2017).

Two modelling approaches were used:

- Drilling: SELcum calculated for animals swimming away from the source at 5.4 km/h, using AcTUP algorithms (RAMGEO and Bellhop) up to a distance of 50 km from the drilling location (taking into account swim speed) and then it remains stationary at this point for the rest of the 24-hour assessment period.
- VSP: SELcum calculated for stationary animals under 50-pulse (2-hour) and 250-pulse (12-hour) scenarios.

Key Findings:

Marine Mammals

The predicted potential impact zones for auditory injury (AUD INJ) and TTS from drilling noise are within 100 m of the source for all marine mammal hearing groups. Potential behavioural disturbance related to drilling may extend as far as 9.6 km from the Gemsbok well and up to 11 km from the second potential well, particularly in deeper waters.

For VSP, potential behavioural impact zones for low-frequency cetaceans may reach up to 400 m under a 250-pulse scenario and up to 200 m under a 50-pulse scenario at both wells. For other hearing groups, potential behavioural impact zones stay within 100 m of the source. Under the general 160 dB re 1 µPa RMS criterion for all marine mammals, potential behavioural impact zones are estimated to extend up to 300 m from the Gemsbok well and up to 400 m from the second well.

Fish and Sea Turtles

Among fish species sensitive to sound, especially those with swim bladders used in hearing, non-impulsive sources such as drilling units and support vessels are expected to create recoverable injury zones within 100 m and TTS zones within 400 m of the source. Fish may exhibit behavioural responses at distances of up to 1 km.

For impulsive noise (VSP), potential impact zones for fish are mainly influenced by cumulative exposure to multiple VSP pulses, with potential impairment zones (TTS) remaining within 100 m and behavioural disturbances reaching about 400 m for both types of fish.

For sea turtles, predicted zones for potential auditory injury and TTS consistently remain within 100 m of both wells for both VSP and drilling activities. Potential behavioural impact zones for sea turtles are also confined to 100 m, although responses may still occur.

7.2.2 POTENTIAL IMPACT OF GHG EMISSIONS TO THE ATMOSPHERE

Impact Description

The potential offshore exploration activities will result in GHG emissions, primarily during the mobilisation, drilling (exploration and appraisal) and demobilisation phases. These emissions will arise from the following sources:

- Transit and operation of the drillship and support vessels.
- Helicopter transport for crew rotations.
- Emergency flaring during appraisal drilling.
- Operation of survey vessels during pre-drilling surveys.

These activities will release CO_2, CH_4 and nitrous oxide (N_2O), contributing to Namibia's national GHG inventory and the global atmospheric GHG load. The Global warming potential (GWP) values expected for the potential project are presented in Section 3.6.1 and this is a measure of how much heat a given mass of greenhouse gas traps in the atmosphere and therefore it is used as an estimate of its relative contribution to global warming. It is a relative scale which compares the gas in question to the heat trapped by a similar mass of CO_2 (whose GWP is by convention equal to 1). The GWP of a set of gases is calculated over a specific time interval, that must be stated whenever a GWP is quoted or else the value is meaningless. Commonly, a time horizon of 100 years is used by regulators. The GWP values expected for each of the gases emitted as a result of the potential activities has been calculated using the 100-year time horizon GWP factors published in the IPCC fifth Assessment Report (AR5) to align with Namibia's NDC.

Impact Assessment

Assuming a maximum of four wells drilled per year, the project's annual GHG emissions are estimated at 44,208 tCO_2e.

Namibia's national GHG emissions were estimated at 24.12 million tonnes of CO_2 equivalent ($MtCO_2e$) in 2022, including emissions from forestry and land use change (ClimateWatch, 2025). Under the second update of the First NDC, Namibia commits to reducing 11.9 $MtCO_2e$ by 2030.

The CNEL project's estimated contribution to annual national GHG emissions, calculated on a worst-case basis, ie. assuming four wells are drilled per year is:

- Below 0.2% of the annual national GHG emissions under the business-as-usual scenario.
- Below 0.4% of the annual national GHG emissions under the Namibia's NDC reduction target.

Based on the CNEL ESIA methodology, the magnitude of this potential impact is considered <u>small</u>, due to its limited contribution to national inventory and the short duration of the project activities.

As stated in the second update of the First NDC, the latest assessment from Namibia's fourth national communication indicated the high vulnerability of the agriculture, water resources, coastal zone, health, biodiversity, ecosystems, fisheries and tourism sectors. Considering the project's limited scope and short-term activities, it is unlikely that it will have any significant impact on climate change effects for project-affected local communities and natural ecosystems. Offshore ecosystems are expected to be stable and resilient, with low sensitivity to indirect climate impacts from this short-term activity. Overall, the receptors are assessed as having a medium sensitivity.

The overall potential impact has been assessed as minor and given that the control measures detailed below are already implemented in this project, the residual impact also remains minor (refer to Table 7-5).

Mitigation Measures

The following measures will be implemented to reduce emissions:

- Comply with MARPOL 73/78 Annex VI regulations regarding the reduction of SOx, NOx, ODS, VOC and emissions from shipboard incineration.
- All diesel motors and generators will undergo routine inspections and receive adequate maintenance to minimise soot and unburnt diesel released to the atmosphere.
- Leak detection and repair programmes will be implemented for valves, flanges, fittings, seals, etc.
- Use of a low sulphur fuel for project vessels, if available.
- Prohibition of waste incineration within port limits.
- Regular maintenance of engines to optimise performance and reduce emissions.
- Implementation of leak detection and repair programmes.

TABLE 7-5 POTENTIAL IMPACT OF GHG ATMOSPHERIC EMISSIONS

Criteria	Without Mitigation	With Mitigation
Type	Direct	Direct
Extent	Global	Global
Duration	Short-term	Short-term
Magnitude	Small	Small
Probability	Likely	Likely
Reversibility	Partially Reversible	Partially Reversible
Sensitivity	Medium	Medium
Confidence	High	High
Significance	Minor	Minor

7.2.3 POTENTIAL MARINE ECOLOGY IMPACTS

This section provides a summary of the potential impacts assessed in the Marine Ecology specialist study provided in Appendix H.

So far, offshore petroleum exploration in Namibia's Exclusive Economic Zone has had minimal effect on marine benthic communities, with only 35 exploration wells, 7 appraisal wells (KUDU gas area), and 10 research wells drilled to date. However, comprehensive knowledge of the region’s deep sea benthic environment is limited. Studies from areas with long-term oil and gas production (such as the USA, Mexico, and North Sea) suggest potential impacts that could arise from future offshore activities in Namibia. The following sections discuss and assess relevant environmental aspects and potential impacts.

7.2.3.1 POTENTIAL IMPACT OF SMOTHERING AND DISTURBANCE OF BENTHIC FAUNA ON UNCONSOLIDATED SEDIMENT

Impact Description

Several project activities have the potential to smother or disturb benthic fauna, including:

- Seabed disturbance from drilling.
- Discharge of drill cuttings and drilling mud.
- Sediment dislodgement during ROV operations.
- Release of residual cement onto the seabed.
- Placement of infrastructure on the seabed after well abandonment.

These activities can result in physical smothering, habitat alteration, reduced oxygen levels and disruptions to ecological functions. The effects are most significant in consolidated sediment areas. Although these deep-water communities tend to be less diverse, they remain sensitive to burial or changes in sediment quality.

To mitigate potential impacts on benthic fauna, the project will implement several management measures outlined in the ESMP, including:

- Conducting pre-drilling ROV surveys to ensure wells are placed away from known sensitive or vulnerable hardground habitats, aiming to select level areas for spudding and wellhead installation.
- Using WBM where possible or switching to a low-toxicity Group III NADF as necessary, with an “offshore treatment and disposal” approach that reduces oil content in cuttings to less than 6.9% before discharge.
- Discharging risered cuttings through a caisson at depths greater than 10 m to limit dispersion in surface currents.

As detailed in Section 7.1, the potential impact from residual cement and wellhead abandonment is assessed as neutral and is therefore not considered further.

Drilling is planned within the offshore marine environment of PEL 82, 72 km to 300 km from the Namibian coast, in the Namib sub-photic and continental slope biozones. Most of the license area is considered Least Concern; however, habitats along the 500 m bathymetric contour are classified as Vulnerable and areas near the 100 m contour are deemed Endangered (Holness et al., 2014). These zones may experience the effects of the Namibian OMZ, where benthic communities are usually dominated by tolerant species such as the spionid polychaete *Paraprionospio pinnata* and exhibit low diversity and biomass.

The benthic biota inhabiting unconsolidated sediments of the of the outer shelf and continental slope (beyond ~450 m depth) are very poorly known but at the depths of the potential well drilling are expected to be relatively ubiquitous, varying only with sediment grain size, organic carbon content of the sediments and/or near-bottom oxygen concentrations. These benthic communities usually comprise fast-growing species able to rapidly recruit into areas that have suffered natural environmental disturbance. the benthos of deep-water hard substrata are typically vulnerable to disturbance due to their long generation times.

As described in Section 7.2.1.1, discharge modelling by ERM (2025b) indicates that sediment deposition may exceed both the 6.3 mm threshold for immediate smothering and the 5 cm/month threshold for gradual burial. At the Gemsbok Well (917 m deep), sediment thicker than 6.3 mm was mostly found within 50 m of the well, whereas at the second well (1,166 m deep), the affected area extended up to 500 m. TSS near the seabed exceeded the 35 mg/L threshold set by MARPOL and IFC guidelines for all seasons, though surface concentrations remained below this limit. Hydrocarbon deposition from NADF ranged from 0.619 km² to 6.860 km² at the Gemsbok site and from 2.943 km² to 7.201 km² at the second well.

Seabed Disturbance from Drilling Impact Assessment

The well design uses a 36-inch (91 cm) bore diameter at spudding, disturbing about 0.66 m² of seabed per well through sediment displacement. The drilling footprint for ten wells amounts to 6.57 m². Additionally, the installation of casings, wellheads and blowout preventers (BOP) occupies approximately 78.54 m² per site, resulting in a total area of 785.40 m² for all wells. However, the number of total wells is not confirmed and if more than one well is drilled they will be drilled several kilometres apart. Benthic organisms in these areas may be crushed or displaced, especially those with limited mobility. However, the effects on local biodiversity are expected to be minimal, as similar habitats are common in the vicinity.

Most unconsolidated sediment habitats within the license area are classified as Least Concern, except for smaller Vulnerable and Endangered sections along certain contours. Overall, the disturbance is considered negligible in magnitude and is confined to the immediate well site. Any reduction in biodiversity is likely to be short-term, as successional communities are expected to recolonise the area.

Given the limited affected area, negligible magnitude and observed resilience of benthic communities, ecosystem sensitivity is classified as medium. The disturbances are localized, brief and reversible. Before mitigation, the potential impact is categorized as incidental Table 7-6 This potential impact is considered As low as reasonably practicable (ALARP), with no additional mitigation measures available to further reduce the effect.

Discharge of Drill Cuttings and Mud to the Seabed Impact Assessment

ERM’s (2025b) modelling (refer to Section 7.2.1) shows that drill cuttings and WBMs released during spudding and risered drilling can smother or alter benthic habitats, predominantly within 50–500 m of well sites. Top-hole discharges create mounds that may bury invertebrates, while dispersed cuttings modify sediment and community structure. ERM’s modelling found that deposition exceeding 6.3 mm was mostly limited to 50 m at the Gemsbok Well but reached as far as 500 m at a second site due to stronger currents; impacts remain localised and of small magnitude.

Key ecological impacts include:

- Smothering of sessile fauna.
- Changes to sediment properties.
- Oxygen depletion from biodegradation.

Mortality increases with greater depth, speed and frequency of sedimentation, especially when grain size differs from the local environment. Recovery depends more on food supply and sediment composition than burial depth. Sensitivity varies by species, with mucous-tube dwellers, labial palp feeders, epifaunal suspension feeders, boring and deep-burrowing siphonate species particularly vulnerable, whereas meiofauna are less affected.

Benthic and demersal spawners could be impacted, though major spawning areas are inshore; PEL 82 slightly overlaps with hake, monk and orange roughy distributions. Deep-water corals are highly sensitive, facing smothering and reduced viability. International guidelines recommend habitat surveys and monitoring for their protection.

Recovery rates depend on depth: shallow sites recolonise quickly, but deep systems may take up to 10 years (Jones et al., 2012), with functional recovery in 2–5 years. Mortality peaks where deposits exceed 30 mm, but some benthic fauna can migrate upwards. Cement discharge is not expected to contribute beyond affected zones.

Sensitivity is rated medium for benthic infauna and high if deep-water corals are present. With mitigation, potential impacts are reversible and are reduced from moderate pre-mitigation to minor post-mitigation significance (Table 7-6).

Sediment Dislodging from ROV Operations

During pre-drilling surveys, an ROV is used to capture video footage of the seabed at the potential well location. Standard operating procedures require that the ROV does not contact or rest on the seabed; however, its thrusters may resuspend soft or silty sediments when operating near the seabed. This temporary suspension can cause short-term disturbance to seabed communities and a localised increase in turbidity, which is assessed as having a negligible magnitude. With similar habitats nearby, sensitivity is rated as low and the overall potential impact is classified as incidental before and after mitigation (Table 7-6).

Mitigation and Monitoring

- Establish clear operational procedures for ROVs to ensure they do not land or rest on the seabed during standard operations
- Conduct pre-drilling ROV surveys to identify any sensitive benthic habitats and species.
- Pre-drilling site surveys should be carefully designed to ensure that drilling locations are positioned at least 500 meters away from any vulnerable habitats (e.g., hard grounds), sensitive species (e.g., cold-water corals, sponges), or significant structural features.
- Maintain a minimum distance of 500 m from sensitive features during drilling; adjust well location as needed.
- Limit excess cement slurry during riserless drilling operations.
- Employ high-efficiency solids control equipment to reduce liquid content in cuttings, maximise reuse and recycling of drilling mud, limit fluid change-outs and minimise residual spent mud.
- Optimise reuse and recycling of used WBM and NADF across different wells and sections.
- Regularly maintain the onboard solids control system.
- Arrange for unused cement remaining onboard the drilling unit to be shipped to shore for reuse, storage, or disposal.
- Carry out post-drilling ROV surveys to locate and recover any dropped equipment or excess cement.

Monitoring

- Where practical, monitor sediment deposition and hydrocarbon concentrations.
- Where practical, monitor sediment deposition and hydrocarbon concentrations.
- Monitor cement returns with an ROV and stop cement pumping if significant discharges are detected on the seafloor.
- Monitor (using ROV) hole wash out to reduce discharge of fluids, as far as possible.

7.2.3.2 POTENTIAL IMPACT OF SMOTHERING AND DISTURBANCE OF BENTHIC FAUNA ON HARD SUBSTRATE

Impact Description

The effects of drilling on benthic fauna found on hard substrates are comparable to those observed on unconsolidated sediments (refer to Section 7.2.3.1), but generally more pronounced due to the relative scarcity and sensitivity of these organisms. Wells will be located in unconsolidated sediments to avoid known hard grounds, as identified through ROV surveys and existing data. Modelling suggests that cuttings may disperse up to 500 m from each well, potentially impacting unmapped hard-ground communities considered vulnerable. While most drill waste is not expected to affect sensitive areas, overlap with such communities could lead to slow recovery because of their long generation times. In summary, potential impacts are typically avoided, when possible, remain localised, may persist for extended periods and are assessed as <u>small</u> in magnitude.

Up to 10 wells may be drilled several kilometres apart, with each impact footprint limited to 50–500 m from the well, so ratings apply across the campaign.

Impact Assessment

The main difference for benthic fauna on hard substrate versus unconsolidated sediments (refer to Section 7.2.3.1) is that pre-drilling ROV surveys can identify these habitats, allowing wells to be relocated and reducing potential impacts to Minor for drill cuttings and Incidental for physical disturbance (refer to Table 7-7). Extending surveys to a 500 m radius further lowers impact risk but does not eliminate it.

Mitigation and Monitoring

- Conduct careful design of pre-drilling site surveys to collect sufficient information on seabed habitats, including mapping of sensitive and potentially vulnerable habitats within 500 m of a proposed well site., aiming to select level areas for spudding and well head installation.
- If sensitive habitats (such as hard grounds), sensitive species (e.g., cold-water corals, sponges), or significant structural features are detected, adjust the well position to beyond 500 m, or implement technologies, procedures, and monitoring to reduce risks and assess potential damage.
- Establish clear operational procedures for ROVs to avoid seabed contact.
- Limit the area physically affected by infrastructure to the minimum required.
- Discharge risered cuttings through a caisson at depths >10 m to limit surface dispersion.
- Monitor sediment deposition and hydrocarbon concentrations where practical.
- Employ high-efficiency solids control equipment to reduce liquid content in cuttings and maximize mud reuse.

- Regularly maintain onboard solids control systems.
- Limit excess cement slurry during riserless drilling.
- Ship unused cement onboard to shore for reuse, storage, or disposal.
- Minimise fluid discharge wherever possible.
- Post- Operation
- Conduct post-drilling ROV surveys to locate and recover dropped equipment or excess cement.
- Register and distribute the location of abandoned wellheads via “Notice to Mariners” and “Notice to Fishers”.

Monitoring

- Where practical, monitor sediment deposition and hydrocarbon concentrations.
- Monitor cement returns with an ROV and stop cement pumping if significant discharges are detected on the seafloor.
- Monitor (using ROV) hole wash out to reduce discharge of fluids, as far as possible.

TABLE 7-6 POTENTIAL IMPACTS OF PHYSICAL DISTURBANCE FROM DRILLING ACTIVITIES ON SEABED SEDIMENTS AND BENTHIC FAUNA IN UNCONSOLIDATED SEDIMENTS

Criteria	Seabed Disturbance from Drilling *Without Mitigation*	Seabed Disturbance from Drilling *With Mitigation*	Discharge of Drill Cuttings and Mud *Without Mitigation*	Discharge of Drill Cuttings and Mud *With Mitigation*	Seabed Disturbance from ROV Operations *Without Mitigation*	Seabed Disturbance from ROV Operations *With Mitigation*
Type	Direct	Direct	Direct	Direct	Direct	Direct
Extent	Local	Local	Local	Local	Local	Local
Duration	Short-term	Short-term	Medium Term	Medium Term	Short-term	Short-term
Magnitude	Negligible	Negligible	Small	Small	Negligible	Negligible
Probability	Probable	Probable	Probable	Probable	Probable	Probable
Reversibility	Fully Reversible	Fully Reversible	Fully Reversible	Fully Reversible	Fully Reversible	Fully Reversible
Sensitivity	Medium to High	Medium to High	Medium to High	Medium to High	Medium to High	Medium to High
Confidence	High	High	High	High	High	High
Significance	Incidental	Incidental	Moderate	Minor	Incidental	Incidental

TABLE 7-7 POTENTIAL IMPACTS OF PHYSICAL DISTURBANCE FROM DRILLING ACTIVITIES ON SEABED SEDIMENTS AND BENTHIC FAUNA ON HARD SUBSTRATES

Criteria	Seabed Disturbance from Drilling *Without Mitigation*	Seabed Disturbance from Drilling *With Mitigation*	Discharge of Drill Cuttings and Mud *Without Mitigation*	Discharge of Drill Cuttings and Mud *With Mitigation*	Seabed Disturbance from ROV Operations *Without Mitigation*	Seabed Disturbance from ROV Operations *With Mitigation*
Type	Direct	Direct	Direct	Direct	Direct	Direct
Extent	Local	Local	Local	Local	Local	Local
Duration	Short-term	Short-term	Medium Term	Medium Term	Short-term	Short-term
Magnitude	Negligible	Negligible	Small	Small	Negligible	Negligible
Probability	Occasional	Occasional	Occasional	Occasional	Occasional	Occasional
Reversibility	Fully Reversible	Fully Reversible	Fully Reversible	Fully Reversible	Fully Reversible	Fully Reversible
Sensitivity	Low	Low	Low	Low	Low	Low
Confidence	High	High	High	High	High	High
Significance	Incidental	Incidental	Minor	Incidental	Incidental	Incidental

7.2.3.3 POTENTIAL IMPACT OF TURBIDITY, BIOACCUMULATION, TOXICITY AND HYPOXIC EFFECTS ON BENTHIC FAUNA

Impact Description

Discharges resulting from drilling operations have a significant influence on marine sediment characteristics and water quality. CNEL utilises WBMs and low-toxicity non NADFs, with offshore treatment processes to reduce residual oil content on cuttings prior to discharge. Modelling analyses (refer to Section 7.2.1) indicate that while drilling by-products frequently exceed environmental thresholds near the wells, the area where the deposition of cuttings and muds thickness is greater than 6.3 mm typically remains confined within 50 to 500 m due to localised current patterns.

Hydrocarbon deposition from NADF was assessed using a 10 g/m² threshold, which, although not regulatory, is valuable for demarcating zones of accumulation. Seasonal variability was observed in the modelling results: at the Gemsbok Well, affected areas ranged from 0.619 km² in December to 6.860 km² in June, whereas at the second well, a broader and more consistent potential impact zone was evident, spanning 2.943 km² in December to 7.201 km² in June, likely attributable to differing oceanographic conditions.

Subsurface discharge of cuttings limits their spatial distribution; however, both cuttings and drilling muds are capable of introducing contaminants and persistent chemicals into the environment, impacting sediment composition and overall water quality. These discharges may pose risks of both acute and chronic effects on marine biodiversity and productivity, including bioaccumulation and toxicity concerns.

The initial drilling phase will utilise WBMs for riserless sections, transitioning to NADF for subsequent intervals. Upon installation of the wellhead, BOP and marine riser, a closed-loop system will be established between the well and drilling unit. Spent NADF is collected and recycled on board, with cuttings segregated and stored in sealed skips for compliant onshore disposal at licensed facilities. Treatment of cuttings aboard the drilling unit ensures oil concentrations are reduced to less than 6.9% OOC before offshore discharge.

Drilling activities (including the release of cuttings, residual cement and produced water) contribute to alterations in marine sediment and water chemistry. CNEL employs WBMs, biodegradable NADFs and offshore treatment protocols aimed at minimising oil residues prior to discharge.

Despite the use of subsurface discharge methods to limit wide-scale dispersion, the introduction of persistent pollutants via cuttings and muds remains a concern, with potential consequences for sediment integrity and water quality. Both acute and chronic impacts on marine fauna and ecosystem productivity are possible, with particular risks related to bioaccumulation and toxicity.

The disposal of cuttings either at the wellbore or directly from the drilling unit influences sediment and water quality due to the release of substances from drilling muds. While cuttings themselves are largely inert, the associated muds contain clays, polymers, weighting agents and other chemical additives, all of which may have ecotoxicological implications.

- Chronic accumulation of persistent contaminants within the marine environment
- Acute and chronic effects on ecosystem productivity and biological communities

- Indirect impacts on overall biodiversity

The discharge of residual cement onto the seabed involves the use of chemical additives tailored within cementing programmes to control attributes such as setting time, stability and foam minimisation. Formulations are specific to individual wells, with additive concentrations generally maintained below 10% of the total cement volume. There exists the potential for these additives to leach into the surrounding water column, which could pose toxicity risks to benthic organisms or contribute to bioaccumulation.

During well testing, hydrocarbons separated from water are flared, though discharged treated water may still retain trace hydrocarbon levels, representing potential toxicity risks for marine biota. Incomplete combustion of hydrocarbons can result in unburned material reaching the sea surface, occasionally leading to the formation of visible oil slicks.

Impact Assessment

WBMs are used during riserless drilling to depths of up to 1,558 m, releasing approximately 1,486.6 MT of cuttings and 10,431.41 MT of WBMs per well, discharged about 5 m above the seabed (refer to Table 3-8). While generally inert, these cuttings may contain trace metals or hydrocarbons. Their release increases turbidity, reducing light penetration and potentially affecting filter-feeders, demersal species and phytoplankton. Most metals are bound in immobile mineral forms and resemble natural marine sediments.

Fine particles from WBMs form plumes near the seabed that persist due to weak bottom currents, impacting benthic organisms. Surface plumes disperse more rapidly but may still reduce phytoplankton productivity. Aggregated phytoplankton cells settle faster, transporting carbon to the seafloor and requiring greater energy to resuspend, which can stress benthic fauna.

WBMs disperse broadly, preventing significant mound formation and promoting biodegradation. In contrast, cuttings from NADFs (approximately 1,163.75 MT including 139.0 MT of mineral mass and 139.0 MT of NABF base oil) tend to clump and settle near the wellbore, forming thicker deposits and increasing toxicity risks. Although NADFs are classified as “low toxicity” (Group III NABF: <0.5% aromatics, <0.001% PAHs), their degradation can consume dissolved oxygen, contributing to hypoxia.

Receptors such as filter-feeders and tube-building polychaetes exhibit <u>medium</u> sensitivity to WBMs and NADFs due to increased turbidity and sedimentation. These organisms possess some capacity to recover, although temporary reductions in productivity may occur.

In contrast, deposit-feeding species and sensitive benthic communities face elevated risks from NADFs due to their hydrocarbon content and potential for oxygen depletion. These receptors are considered <u>high</u> sensitivity, particularly within naturally hypoxic environments such as PEL 82.

PEL 82 waters are naturally low in oxygen and benthic communities are adapted to such conditions. Modelling indicates hypoxic zones from cuttings may affect up to 7.201 km^2, with potential impacts lasting over the medium term depending on season and location, depending on season and location. Hydrocarbon deposition exceeding the 10 g/m^2 threshold was observed, suggesting potential accumulation zones that may require further investigation.

Taking into account the use of PLONOR-listed and low-toxicity additives, offshore treatment processes, solids control systems and compliance with discharge standards (e.g., <6.9%

OOC), the overall pollutant load is substantially reduced. Consequently, the risks associated with increased turbidity, bioaccumulation and hypoxia are deemed to be of small magnitude and limited to local areas, with reversibility of hypoxic zones considered likely.

In the case of discharges of cements and WBMs at the wellbore and cuttings below the sea surface and based on the small magnitude and medium sensitivity of filter-feeders and high sensitivity of deposit-feeders, the potential toxicological effects of drilling mud constituents are deemed to be of moderate to minor significance prior to mitigation. This reduces to incidental significance post mitigation for sediment toxicity and reduced oxygen concentration (refer to Table 7-7).

Mitigation and Monitoring

In addition to the mitigation measures for sensitive hard-ground habitats in Section 7.2.3.1, the following must be implemented:

- Conduct careful design of pre-drilling site surveys to collect sufficient information on seabed habitats, including mapping of sensitive and potentially vulnerable habitats within 500 m of a proposed well site., aiming to select level areas for spudding and well head installation.
- If sensitive habitats (such as hard grounds), sensitive species (e.g., cold-water corals, sponges), or significant structural features are detected, adjust the well position to beyond 500 m, or implement technologies, procedures, and monitoring to reduce risks and assess potential damage.
- Limit the area physically affected by infrastructure to the minimum required.
- Use WBM where possible or switch to low-toxicity Group III NADF with offshore treatment to reduce oil content in cuttings (<6.9%) before discharge.
- Discharge risered cuttings through a caisson at depths >10 m to limit surface dispersion.
- Careful selection of drilling fluid additives taking into account their concentration, toxicity, bioavailability and bioaccumulation potential; Use only, PLONOR (Pose Little Or No Risk) chemicals, low-toxicity, low bioaccumulation potential and partially biodegradable additives are used, where practicable. Maintain a full register of Safety Data Sheets (SDSs) for all chemical used, as well as a precise log file of their use and discharge.
- Use NADFs for risered sections and maintain solids control systems to prevent improper discharge.
- If NADFs are used for drilling the risered sections, conduct regular maintenance of the onboard solids control package and avoid inappropriate discharge of NADF cuttings.
- Minimize fluid discharge wherever possible.
- Conduct post-drilling ROV surveys to locate and recover dropped equipment or excess cement.
- Design well test programmes to minimise flaring duration.
- Schedule well testing during daylight hours where feasible.
- Use high-efficiency burners to optimize hydrocarbon combustion and minimise emissions and drop-out.
- Continuously monitor flare performance for malfunctions or drop-out.

Monitoring

- Test drill cuttings daily for retained oil content to check specified discharge standards are maintained (average residual oil on cuttings <6.9%) at the end of the well.
- Test barite for heavy impurities prior to mixing barite on location.
- Test any other discharged fluids for visible oil contamination (static sheen).
- Where practical, monitor sediment deposition and hydrocarbon concentrations.
- Monitor cement returns with an ROV and stop cement pumping if significant discharges are detected on the seafloor.
- Monitor (using ROV) hole wash out to reduce discharge of fluids, as far as possible.

TABLE 7-8 POTENTIAL IMPACT OF TURBIDITY, BIOACCUMULATION, TOXICITY AND HYPOXIC EFFECTS ON BENTHIC FAUNA

Criteria	Without Mitigation	With Mitigation
Type	Direct	Direct
Extent	Local (≤ 7.2 km²)	Local (≤ 7.2 km²)
Duration	Medium-term: recovery is expected within a year	Short-term
Magnitude	Small	Negligible
Probability	High	Medium
Reversibility	Partial	Likely
Sensitivity	Medium (filter-feeders) / High (deposit-feeders)	Medium (filter-feeders) / High (deposit-feeders)
Confidence	High	High
Significance	Moderate to Minor	Incidental

7.2.3.4 POTENTIAL IMPACT OF TURBIDITY, BIOACCUMULATION, TOXICITY AND HYPOXIC EFFECTS ON PELAGIC FAUNA

Impact Description

Cuttings discharges from drilling can temporarily increase turbidity in marine environments, reducing light penetration and potentially affecting phytoplankton photosynthesis and visual predators' foraging. However, these potential impacts are minor, short-lived and localized due to rapid dilution and particle dispersion, with negligible effects on nectonic and planktonic communities. Turbidity is common along the Southern African west coast but less so offshore at PEL 82, which generally experiences clear waters and low productivity. Although benthic and demersal spawners may be affected, major spawning areas are mostly inshore and drilling-related plumes are unlikely to impact sensitive ichthyoplankton, as they disperse away from critical habitats.

Discharges resulting from drilling operations have a significant influence on marine sediment characteristics and water quality. CNEL utilises WBMs and low-toxicity non NADFs, with offshore treatment processes to reduce residual oil content on cuttings prior to discharge. Modelling analyses (refer to Section 7.2.1) indicate that while drilling by-products frequently exceed environmental thresholds near the wells, the area where the deposition of cuttings and muds thickness is greater than 6.3 mm remained predominantly within typically remains confined within 50–500 m due to localised current patterns.

Hydrocarbon deposition from NADF was assessed using a 10 g/m² threshold, which, although not regulatory, is valuable for demarcating zones of accumulation. Seasonal variability was observed in the modelling results: at the Gemsbok Well, affected areas ranged from 0.619 km² in December to 6.860 km² in June, whereas at the second well, a broader and more consistent potential impact zone was evident, spanning 2.943 km² in December to 7.201 km² in June, likely attributable to differing oceanographic conditions.

Impact Assessment

The rapid dilution and extensive dispersion of settling particles lead to impacts that are mainly limited in area and duration; as a result, the overall effect on the water column is assessed to be minor. Large pelagic migratory species are expected to avoid areas affected by localized plumes. Chemicals utilized during risered stages and those bound to cuttings pose limited environmental risks, as the majority of NADF is recycled.

Accurate prediction of the volume of hydrocarbons (to be combusted) and any associated produced water generated during well testing is challenging due to variability in gas composition, flow rates and water content. Burners are engineered to minimise emissions. The estimated quantity of hydrocarbons to be flared per test is approximately 10,000 Sm³/day for 7 days per well, although actual volumes depend on the specific requirements determined post reservoir penetration. During testing, any water from the reservoir may be separated from oily components and treated onboard to minimise hydrocarbons. Any treated water is then either discharged overboard or sent to an onshore facility for further treatment and disposal.

Should produced water be generated during well testing, it will be separated from hydrocarbons and discharged into the sea. The project area, located roughly 72 km from the nearest coastline, substantially reduces exposure risk to coastal receptors; oceanographic conditions further facilitate rapid dispersal away from the site (refer to Section 7.2.1). Any overboard discharge will therefore be of minimal intensity and restricted to the immediate vicinity of drilling units for short durations.

Hydrocarbon 'drop-out' is anticipated to dissipate rapidly in the offshore environment, thereby mitigating potential impacts on sensitive shoreline habitats. Although certain offshore species (including pelagic fish, birds, turtles and cetaceans) may be exposed, the likelihood of significant effects arising from minor changes in water quality is low.

Given the brief exposure periods, restricted distribution and low exposure concentrations, the degree of bioaccumulation or toxicity affecting pelagic fauna is assessed as negligible. Potential toxicological impacts of drilling mud constituents on pelagic fauna are regarded as incidental, both prior to and following mitigation measures.

Mitigation and Monitoring

Refer to mitigation and monitoring measures for sensitive hard-ground habitats in Section 7.2.3.4.

TABLE 7-9 POTENTIAL IMPACT OF TURBIDITY, BIOACCUMULATION, TOXICITY AND HYPOXIC EFFECTS ON PELAGIC FAUNA

Criteria	Without Mitigation	With Mitigation
Type	Direct	Direct
Extent	Local	Local
Duration	Short-term	Very Short-term
Magnitude	Negligible	Negligible
Probability	Likely	Likely
Reversibility	Likely	Fully Reversible
Sensitivity	Low to Medium	Low to Medium
Confidence	High	High
Significance	Incidental	Incidental

7.2.3.5 POTENTIAL BEHAVIOURAL DISTURBANCE OF MARINE FAUNA

Impact Description

The following project phases and activities have the potential to impact marine fauna by causing behavioural changes:

- Underwater noise generated by vessels and drilling operations (non-impulsive) occurs during mobilisation, operational and demobilisation stages. The aggregate noise level from drilling units and four support vessels is approximately 202 dB re 1 µPa @ 1 m RMS. This sound falls within the auditory range of many fish and marine mammals, with possible consequences including physical injury, disruption of communication, or displacement from essential feeding and breeding habitats.
- Underwater noise produced during VSP operations (impulsive), although not currently planned, may reach source levels up to 242 dB re 1 µPa @ 1 m. These pulses, primarily below 0.2 kHz, could notably affect whale species, particularly mysticetes. Two scenarios have been evaluated: 50 VSP pulses occurring over two hours and 250 VSP pulses spread across 12 hours.
- Lighting from vessels and drill units during night-time operations increases ambient light levels, potentially disturbing and disorienting pelagic seabirds, attracting fish and cephalopods and heightening predation risks. Vulnerable groups include those classified as 'Critically Endangered', 'Endangered', 'Vulnerable', or 'Near Threatened'. While Block PEL 82 is situated offshore, migratory and coastal species along vessel transit routes may also be affected.

All whales and dolphins benefit from legal protection under the Namibian Marine Resources Act, which stipulates that vessels must maintain a distance of at least 300 m from any whale. project activities are regulated by the Civil Aviation Act and relevant industry best practices to minimise environmental impact. The appointed drilling contractor will ensure exploration activities conform to good international industry practice and Best Available Techniques (BAT).

Increased noise levels have the potential to affect marine fauna in several ways:

- Causing direct physical effects, such as potential injury to auditory or other organs (including AUD INJ or TTS);
- Masking or interfering with biologically relevant sounds, such as communication, echolocation and signals from predators or prey (indirect effects); and
- Resulting in disturbance that could lead to behavioural changes or displacement from feeding or breeding areas.

Physical injury to marine fauna is addressed separately in Section 7.2.3.6. As detailed in Section 7.1, the potential impact from light was assessed as insignificant and is therefore not considered further.

Underwater noise from vessel and drilling operations (non-impulsive)

The operation and movement of drilling units and support vessels during transit, drilling activity and demobilisation introduce various underwater noises into the surrounding water column, which may contribute to or surpass existing ambient noise levels. For non-impulsive noise, the combined aggregate noise level from drilling units and four support vessels is approximately 202 dB re 1 μPa @ 1 m RMS (refer to Appendix F).

The cumulative effect of increased anthropogenic background noise in marine environments continues to be documented (Koper & Plön 2012). The primary frequencies produced by drilling activities are below 0.2 kHz. Noise generated by vessels and well-drilling generally falls within the auditory range of most fish and marine mammals and can be detected over considerable distances before attenuating below threshold values.

The level of noise received and the potential for disturbance or behavioural change depend on the proximity of marine animals to the source. Underwater noise produced during the project may be perceived by a range of marine fauna, including demersal species near the wellhead as well as those inhabiting the water column and surface pelagic zones.

Regarding continuous sound sources such as drilling, several references address the probable behavioural effects on marine mammals due to sound exposure. Southall et al. (2007) report examples of behavioural responses in low-frequency cetaceans; humpback whales and grey whales exposed to vessel noise and drilling noise playback displayed responses at received sound levels between 110 and 120 dB re 1 μPa (RMS). Based on observed reactions, a criterion of 120 dB re 1 μPa (RMS) was adopted in the underwater noise study (ERM, 2025c) for all low-frequency species concerning behavioural response.

There is limited data available regarding behavioural responses in mid-frequency marine mammals. However, one study found that belugas exposed to playback of drilling sound exhibited marked reactions at noise levels of 110 to 130 dB re 1 μPa (RMS) (Southall et al. 2007) and these findings were used in the underwater noise study (ERM, 2025c) to represent mid-frequency hearing cetaceans.

For high-frequency marine mammals, evidence from both wild and captive animal studies indicates that harbor porpoises are sensitive to diverse human sounds, often at relatively low exposure levels (~90 to 120 dB re 1 μPa). All exposures exceeding 140 dB re 1 μPa led to pronounced and sustained avoidance behaviour in wild harbor porpoises (Southall et al., 2007). Harbor porpoises also commonly avoid moving boats. Southall et al. noted that habituation to sound exposure was seen in some cases but not universally. In particular field settings, strong initial reactions to low noise levels among high-frequency cetaceans diminished rapidly with repeated exposure (Cox et al., 2001), whereas laboratory conditions often showed persistent sensitivity (Kastelein et al., 1997, 2005). Since the drilling vessel remains stationary, habituation could reduce high-frequency marine mammal responses, but sustained avoidance is more likely at around 140 dB re 1 µPa.

The underwater Noise Modelling Study conducted by ERM (2025c) applies the marine mammal behavioural threshold based on the current interim U.S. National Marine Fisheries Service (NMFS) criterion (NMFS 2014), which sets 120 dB re 1 µPa (RMS) as the threshold for disturbance of marine mammals by non-impulsive sound sources. The NMFS criterion aligns with a conservative view of noise levels where behavioural effects were documented in the literature analysed by Southall et al. (2007).

Underwater noise from VSP operations (impulsive)

VSP is a standard method used during well logging that can generate noise levels above ambient conditions. While CNEL does not intend to conduct VSP for the initial well and it is unlikely to occur at subsequent wells, its possible use is considered here. Source levels for the VSP G-Gun array have been measured at 242 dB re 1 µPa at 1 m; RMS 230 dB re 1 µPa at 1 m; and SEL 221 dB re µPa2·s at 1 m, with these levels decreasing rapidly with distance from the source. VSP employs a small airgun array, introducing lower volumes and energy into the marine environment compared to conventional seismic surveys. The airgun array would generally be discharged about five times at 20-second intervals, with this process repeated as necessary for different sections of the well. The pulse frequency for VSP falls below the peak hearing sensitivity range for most odontocetes but overlaps with vocalisation frequencies and hearing sensitivity of many mysticetes (Erbe *et al.* 2017). Humpback and Southern Right whales mainly communicate above 100 Hz, while calls from Sei, Blue and Fin whales (from ~20 Hz upwards) more closely align with the VSP frequency band (McDonald et al. 2001, 2005, 2006; Hofmeyr-Juritz & Best 2011; *Erbe* et al. 2017).

Effects related to impulsive noise are similar to those described for non-impulsive noise, including potential for auditory injury, temporary threshold shifts, masking and disturbance.

The underwater Noise Modelling Study conducted by ERM (2025c) used the threshold level for the onset of possible behavioural response in all marine mammals is the SPL of 160 dB re 1 µPa from a single seismic pulse. For multiple detonations (within a 24-hour period), the National Marine Fisheries Service (NMFS 2023b) relies on a behavioural threshold of -5 dB from TTS criteria.

Helicopter Noise

Helicopter transfers between Walvis Bay or Windhoek and the drilling unit may disturb coastal wildlife, especially seabirds and seals. About four weekly flights are expected, reaching noise levels of 109 dB re 1µPa at 150 m altitude, which could impact sensitive habitats like breeding and nursery areas near Walvis Bay and Windhoek.

The coastline near Walvis Bay includes several protected areas, such as the Namib-Skeleton Coast National Park and Ramsar sites like the Walvis Bay Wetlands and Sandwich Harbour. These areas are crucial for the conservation of diverse bird species and other wildlife.

Species at risk include seabirds, turtles, migratory fish and marine mammals, some threatened regionally or globally. While endangered species may be present, their populations are likely low. Seabird colonies and Southern Right whale calving sites could be affected if flight paths cross these areas.

Low-altitude flights over breeding colonies may cause temporary nest abandonment, increasing egg and chick predation. The nearest Important Bird Areas to Walvis Bay airport are Walvis Bay Wetlands and Bird Island guano platform, vital breeding habitats that could fall within helicopter routes but are far from landing and takeoff zones.

Flaring During Well Testing

Flaring during well testing creates intense light and heat at the drill site. The increased lighting can disturb pelagic seabirds and may also attract fish and cephalopods at night, making them more vulnerable to predators.

Impact Assessment

The offshore waters of PEL 82 are expected to support a diverse array of marine fauna. Fish species commonly inhabiting the continental shelf, its margin and the deeper offshore zones include large migratory pelagic taxa such as tunas, billfishes and sharks. Several of these species are designated as 'Threatened' by the International Union for the Conservation of Nature (IUCN), predominantly due to pressures from overfishing. The license area also overlaps with known spawning grounds for both monkfish and hake.

Leatherback and Loggerhead turtles have been documented within the offshore waters of the license area. Both species are globally classified as 'Vulnerable' by the IUCN.

Up to 33 species of cetaceans are found in central Namibian waters, including whales and dolphins. Within the project's vicinity, humpback whales, sperm whales and pilot whales are among the most frequently observed. Humpback whales represent the predominant baleen whale species in PEL 82, ranging from coastal to offshore habitats. Their presence is sustained year-round, with peak abundance during June–July corresponding to the northern migration, followed by a smaller peak in September–October associated with the southern breeding migration and regular observations until February due to feeding activity in the Benguela ecosystem.

Namibia supports two distinct populations of bottlenose dolphins; notably, a small population occupying the nearshore zone between Lüderitz and Cape Cross is recognized for its conservation value.

Cape fur seals breed at several inshore sites adjacent to PEL 82, with the nearest major colony located at Cape Cross. The overall seal population is regarded as stable, although recent years have seen a northward shift in their breeding distribution. PEL 82 is situated well beyond the principal foraging areas utilized by seals from these colonies.

The marine acoustic environment in PEL 82 is naturally elevated due to persistent shipping activity and dynamic metocean conditions. Anthropogenic noise introduced by drilling units and support vessels during transit, drilling and demobilisation adds to this baseline, with combined source levels reaching approximately 202 dB re 1 μPa @ 1 m RMS. These emissions fall within the auditory range of many marine species, particularly cetaceans and fish and may be detectable over significant distances before attenuating below behavioural thresholds.

<u>Non-Impulsive Noise (Drilling)</u>

The way cetaceans react to noise sources is influenced by both the nature of the sound and its perceived motion. For instance, whales tend to be more tolerant of stationary sources, like a drilling unit, than moving ones and are also less affected by continuous sounds than by those with sudden onsets. Given that PEL 82 lies within a heavily trafficked marine route where vessel noise is already elevated and considering the stationary nature of drilling operations, the risk of behavioural disturbance to cetaceans from drilling and vessel noise is considered low. Cetaceans, being highly mobile, can also avoid noise sources before any potential risk of injury arises.

According to Popper et al. (2014), non-impulsive noise sources generally pose moderate to high behavioural risks for fish found at close to intermediate distances, ranging from tens to hundreds of meters from the source. At greater distances (thousands of meters), these risks drop significantly. For the PEL 82 project, non-impulsive noise from drilling activities is estimated to potentially disturb fish behaviour up to a distance of 1 km.

Finneran et al. (2017), revising Popper (2014), reviewed research from at least five species of sea turtles to develop composite audiograms and establish thresholds for the onset of auditory injury and Temporary Threshold Shift (TTS). The findings suggest sea turtles have low hearing sensitivity, similar to fish lacking adaptations for high frequency sounds. While data on the behavioural reactions of sea turtles to sound are limited and current research doesn't allow for distinct thresholds for different sound sources, behavioural disturbances, both from impulsive and non-impulsive noise, are generally observed around 175 dB re 1 µPa RMS (as per McCauley et al. 2000 and adopted by NMFS). For PEL 82, drilling noise could potentially impact sea turtle behaviour within 100 m of each drill site.

Given the presence of marine species of conservation concern in the project area and their ability to avoid drilling-related noise, their sensitivity is rated as medium. Overall, the underwater noise generated during drilling and by support vessels is considered to have a small magnitude, limited to the vicinity of the drilling site and the duration of the campaign (90 days per well). Underwater noise may mask biologically significant sounds and lead to behavioural changes, but these potential impacts are fully reversible once operations cease. In summary, the potential effect of non-impulsive underwater noise from drilling on marine fauna primarily through behavioural changes due to sound masking is considered to be of **minor significance** without mitigation (refer to Table 7-10).

Impulsive Noise (VSP)

Impulsive noise from Vertical Seismic Profiling (VSP), if conducted, is characterized by brief duration and limited spatial distribution. Behavioural effects are predicted within 400 m for low-frequency cetaceans, with masking of biologically relevant sounds potentially occurring up to 10 km. Effects on fish and turtles are expected within 100 m and 1 km, respectively. VSP is not planned for the initial well and is considered unlikely for subsequent wells; its possible implementation has been included in assessments.

The threshold commonly used to identify potential behavioural responses in marine mammals is an SPL of 160 dB re 1 µPa from a single seismic pulse. When multiple detonations occur within a 24-hour period, the National Marine Fisheries Service (NMFS 2023b) applies a behavioural threshold of -5 dB relative to TTS criteria.

Popper *et al.* (2014) indicate that impulsive noise sources may present moderate to high behavioural risks for fish at near to intermediate distances (tens to hundreds of meters) from the source, while risks decrease at greater distances (thousands of meters). Fish have shown behavioural responses, such as avoidance o*f surv*ey areas and changes in feeding behaviour, within received levels between 130 and 180 dB re 1 µPa, with responses diminishing below these levels (Slabbekoorn et al. 2019). For VSP activities, a small airgun array would be used over a short duration (2 to 12 hours per well) and energy output would be significantly lower compared to conventional seismic surveys.

Cumulative behavioural effects may be observed when animals occupy specific coastal regions for calving or spawning or are associated with focal oceanic features like seamounts.

For VSP-generated noise, the extent of behavioural avoidance for marine fauna is assessed to be limited, affecting areas within 10 km of drilling locations during VSP operations. Potential masking of biologically important sounds and related behavioural changes may occur, but any potential impacts would last up to 12 hours per well and are expected to reverse after completion of VSP activities. Overall, underwater noise generated by VSP is considered to have minor significance regarding potential behavioural avoidance and sound masking (refer to Table 7-10).

<u>Helicopter Transfers</u>

Helicopter transfers between Walvis Bay or Windhoek and the drill site can disturb coastal wildlife, particularly seabirds and seals. Aircraft noise, which overlaps with the hearing ranges of many marine mammals and birds, may affect breeding habitats if flight paths cross Important Bird Areas. Mitigation is recommended through careful route planning and altitude restrictions.

Noise travels differently in air and water and species show varied sensitivities to aircraft sounds. Marine mammals may exhibit behavioural responses such as diving, vocalisation changes, or clustering, though these are usually short-term and diminish with increased distance or off-angle flight paths. Seals and pinnipeds tend to react with startle responses, sometimes habituating over time; most data concern those on land or ice, not in water.

Birds face risks including direct strikes and disturbance, potentially affecting habitat use, energy expenditure and breeding success, with helicopters causing greater disruption than fixed-wing aircraft. Sensitivity to disturbance varies by species and lessens with increased distance or indirect flight paths; some birds adapt to frequent noise without negative effects.

Southern right whales, historically displaced by whaling, now calve along the Namibian coast, mainly June to September. These areas should be avoided during this period to prevent disturbance. Helicopter noise from crew transfers could affect seabird and seal colonies; flight paths should avoid critical breeding sites near Walvis Bay and along the coast.

Low altitude flights over whales, seals, seabird colonies and turtles may potentially impact behaviour and breeding, with intensity depending on proximity, angle and sea conditions. While individual effects range from low to high, population-level impacts are generally low and short-term (90 days per well), limited to the immediate vicinity of operations. Overall, the magnitude of noise disturbance to marine fauna is considered <u>small</u> and temporary. Overall, noise generated by helicopters is considered to have minor significance regarding potential behavioural avoidance and sound masking (refer to Table 7-10).

<u>Flaring</u>

Flaring activities during well testing may attract pelagic species and disturb seabirds due to increased light and heat; however, these potential impacts are anticipated to be temporary and geographically confined, resulting in a magnitude assessed as negligible. In general, the noise generated by flaring is considered of incidental significance with respect to potential behavioural avoidance and sound masking.

Complete elimination of behavioural disturbance is not feasible given the inherent nature and operational requirements of exploration drilling. Taking the mitigation measures outlined below into account, the magnitude of potential impact is reduced to negligible and residual effects on marine fauna, including those resulting from underwater noise associated with vessels, drilling, VSP operations and helicopter activities are considered incidental (refer to Table 7-10).

Mitigation

Non-Impulsive Noise (Drilling)

- Limit vessel transit speeds to ≤12 knots (22 km/h) between the drilling area and port and ≤10 knots (18 km/h) within 25 km of the coastline.
- Implement a maintenance plan to check all diesel motors and generators receive adequate maintenance to minimise noise emissions.

Impulsive Noise (Vertical Seismic Profiling – VSP Operations

MMO and PAM Deployment

- Appoint a minimum of two dedicated Marine Mammal Observer (MMO), with a recognised MMO training course, on board for marine fauna observation (360 degrees around drilling unit), distance estimation and reporting. One MMO should also have Passive Acoustic Monitoring (PAM) training should a risk assessment, undertaken ahead of the VSP operation, indicate that the PAM equipment can be safely deployed considering the metocean conditions (specifically current).
- Check drilling unit vessel is fitted with PAM technology (one or more hydrophones), which detects animals through their vocalisations, should it be possible to safely deploy PAM equipment.

Pre-start Protocols for Airgun Testing and Profiling

- VSP profiling should, as far as possible, only commence during daylight hours with good visibility. However, if this is not possible due to prolonged periods of poor visibility (e.g. thick fog) or unforeseen technical issue which results in a night-time start, refer to "periods of low visibility" below.
- Undertake a 1-hr (as water depths > 200 m) pre-shoot visual and possible acoustic scan (prior to soft-starts / airgun tests) within the 500 m radius mitigation zone in order to confirm there are no cetaceans, turtles, penguins and shoaling large pelagic fish activity close to the source.

Soft-Start Procedures

- Implement a “soft-start” procedure of a minimum of 20 minutes’ duration when initiating the acoustic source (except if testing a single airgun on lowest power). This requires that the sound source be ramped from low to full power rather than initiated at full power, thus allowing a flight response by marine fauna to outside the zone of injury or avoidance.

- Delay "soft-starts" if cetaceans, turtles and shoaling large pelagic fish are observed / detected within the mitigation zone during the pre-shoot visual / acoustic scan. A "soft-start" should not begin until 20 minutes after cetaceans depart the mitigation zone or 20 minutes after they are last seen or acoustically detected by PAM in the mitigation zone. In the case of penguins, shoaling large pelagic fish and turtles, delay the "soft-start" until animals move outside the 500 m mitigation zone.

Operational Monitoring

- Maintain visual and possibly acoustic observations within the 500 m mitigation zone continuously during VSP operation to identify if there are any cetaceans present.
- Keep VSP operations under 250 pulses to remain within the 500 m exclusion zone for cetaceans.

Shut-Down Protocols

- Shut down the acoustic source if cetaceans, penguins, shoaling large pelagic fish or turtles are sighted within 500 m mitigation zone until such time as the mitigation zone is clear of cetaceans for 20 minutes or in the case of penguins, shoaling large pelagic fish or turtles, the animals move outside the 500 m mitigation zone before the soft-start procedure and production may commence.

Breaks in Airgun Firing

- Breaks of less than 20 minutes:
  - There is no requirement for a soft-start and firing can recommence at the same power level as at prior to the break (or lower), provided that continuous monitoring was ongoing during the silent period and no cetaceans, penguins, shoaling large pelagic fish or turtles were detected in the mitigation zone during the breakdown period.
  - If cetaceans are detected in the mitigation zone during the breakdown period, there must be a minimum of a 20-minute delay from the time of the last detection within the mitigation zone and a soft-start must then be undertaken. In the case of penguins, shoaling large pelagic fish or turtles, the animals move outside the 500 m mitigation zone within the 20 minute period.
- Breaks of longer than 20 minutes:
  - If it takes longer than 20 minutes to restart the airguns, a full pre-watch and soft-start process should be carried out before the survey re-commences. If an MMO/PAM operator has been monitoring during the breakdown period, this time can contribute to the 60-minute pre-watch time.

Low Visibility Procedures

- If low visibility or technical issues necessitate a nighttime start, apply the low visibility protocols.
- During periods of low visibility (where the mitigation zone cannot be clearly viewed out to 500m), including night-time, the VSP source is only used if PAM technology is in place to detect vocalisations (subject to a risk assessment indicating that the PAM equipment can be safely deployed considering the metocean conditions) or:

- There have not been three or more occasions where cetaceans, penguins, shoaling large pelagic fish or turtles have been sighted within the 500 m mitigation zone during the preceding 24-hour period; and
- A two-hour period of continual observation of the mitigation zone was undertaken (during a period of good visibility) prior to the period of low visibility and no cetaceans, penguins, shoaling large pelagic fish or turtles were sighted within the 500 m mitigation zone.

Helicopter Noise

- Avoid flying over sensitive areas near Walvis Bay, including Namib-Skeleton Coast National Park and Ramsar sites like the Walvis Bay Wetlands and Sandwich Harbour. These zones are essential for conserving birds, turtles, fish and marine mammals, some of which are threatened. Low-altitude flights can disturb breeding colonies, causing nest abandonment and higher predation risks. Key habitats like Walvis Bay Wetlands and Bird Island guano platform may overlap with flight paths but are distant from airport zones.
- Altitude Restrictions:
  - Avoid low-altitude coastal flights (<762 m or 2,500 ft and within 1 nm of shore).
  - Keep altitude above 1,000 m over the Walvis Bay coastline, which includes protected areas like Namib-Skeleton Coast National Park and Ramsar sites such as the Walvis Bay Wetlands and Sandwich Harbour. These regions support diverse bird and wildlife species, some at risk or endangered. Low-altitude flights can disrupt breeding colonies, increasing predation risks. Important Bird Areas near the airport include Walvis Bay Wetlands and Bird Island guano platform, which may intersect helicopter routes though are not close to main flight zones.
- Exceptions: take-off/landing, medical emergencies and Diaz Point (approach only from the north).

- Adhere to all aviation regulations.
- Brief pilots on ecological risks of low-level coastal flights and flying over marine mammals.
- Design well test programmes to minimise flaring duration.
- Schedule well testing during daylight hours where feasible.
- Use high-efficiency burners to optimize hydrocarbon combustion and minimise emissions and drop-out.

Continuously monitor flare performance for malfunctions or drop-out.

TABLE 7-10 POTENTIAL IMPACT OF DRILLING, VSP, HELICOPTERS AND FLARING ON BEHAVIOURAL DISTURBANCE OF MARINE FAUNA

Criteria	Drilling (No Mitigation)	Drilling (With Mitigation)	VSP (No Mitigation)	VSP (With Mitigation)	Helicopters (No Mitigation)	Helicopters (With Mitigation)	Flaring (No Mitigation)	Flaring (With Mitigation)
Type	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct
Extent	Local	Local	Local	Local	Local	Local	Local	Local
Duration	Short-term (24 hrs)	Short-term	Acute (2–12 hrs)	Acute	Intermittent	Intermittent	Episodic	Episodic
Magnitude	Medium	Small	Medium	Small	Medium	Small	Small	Negligible
Probability	Likely	Possible	Likely	Possible	Possible	Unlikely	Possible	Unlikely
Reversibility	Reversible	Reversible	Reversible	Reversible	Reversible	Reversible	Reversible	Reversible
Sensitivity	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Confidence	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Significance	Minor	Incidental	Minor	Incidental	Minor	Incidental	Incidental	Incidental

7.2.3.6 PHYSICAL AND/OR PHYSIOLOGICAL INJURY TO MARINE FAUNA

Impact Description

The following project aspects (and associated project phases) may cause physical and/or physiological injury to marine fauna:

- Underwater noise from vessel and drilling operations (non-impulsive noise).
- Underwater noise from vertical seismic profiling operations (impulsive noise), although VSP operations are unlikely.

Impact Assessment

The criteria established by Southall et al. (2019) and NOAA (2024) are widely recognized as reflecting the current scientific understanding of potential auditory effects on marine fauna. These updated guidelines build on Southall et al. (2007), incorporating recent research to refine noise exposure thresholds that predict the potential onset of auditory injury (AUD INJ) and temporary threshold shift (TTS). TTS represents a temporary reduction in hearing sensitivity, essentially auditory fatigue and does not result in permanent hearing damage. The 2024 NOAA criteria introduce slight adjustments in threshold levels and frequency weightings compared to earlier NOAA (2018) and Southall et al. (2019) guidance. Threshold values for both AUD INJ and TTS are summarised in Table 7-12 of the underwater Noise Modelling Study conducted by ERM (2025c) for drilling (continuous sources) and VSP (impulsive sources), with metrics provided for different marine mammal hearing groups (refer to Appendix F).

<u>Non-Impulsive Noise (Drilling)</u>

The overall sound level generated by drilling operations (drilling unit and support vessels) is 202 dB re 1 µPa @ 1 m RMS. The noise generated by the drilling unit thus falls within the hearing range of most fish and marine mammals and would be audible for considerable ranges before attenuating to below threshold levels. However, the sound emissions are not considered to be of sufficient amplitude to cause direct physical injury or mortality to marine life, except at close range.

For the current project in PEL 82 it was estimated potential impact zones for all hearing groups with regards to auditory injury are within less than 100 m from the source. These potential impact zones are within the safety zone of 500 m, which a Marine Mammal Observer (MMO)/ Passive Acoustic Monitoring (PAM) can be implemented.

As most pelagic species likely to be encountered within PEL 82 are highly mobile, they would be expected to move away from the sound source before trauma could occur. Therefore, if marine mammals only pass through the site near the non-impulsive stationary noise sources in a very short period of time, their noise exposure is not expected to exceed auditory injury-onset thresholds. The extent of the underwater noise impacts would, however, also depend on the variation in the background noise level with weather and with the proximity of other vessel traffic (not associated with the project), the depth of the drill site and the marine mammal hearing group, with low frequency cetaceans (i.e. mysticetes: southern right, humpback, sei, fin, blue, Bryde's, minke) showing the highest sensitivity.

For fish species that are sensitive to sound, particularly those possessing swim bladders for auditory purposes and for sea turtles, non-impulsive sources such as drilling units and support vessels are anticipated to establish zones of recoverable injury within a 100 m radius (refer to Appendix F).

PEL 82 overlaps with the distributions of a number of pelagic seabirds but lies offshore of the feeding ranges of African Penguins. The fish most likely to be encountered on the shelf, beyond the shelf break and in the offshore waters of PEL 82 are the large migratory pelagic species, including various tunas, billfish and sharks, many of which are considered threatened by the IUCN) primarily due to overfishing. Leatherback and Loggerhead sea turtles have been documented within the offshore waters of the license area. Both species are globally classified as ‘Vulnerable’ by the IUCN.

Due to their extensive distributions, the numbers of pelagic species (large pelagic fish, sea turtles and cetaceans) encountered during the drilling campaign is expected to be low and considering they are highly mobile and able to move away from the sound source before trauma could occur, the magnitude of potential physiological injury as a result of drilling and vessel noise would be small. Effects would remain local and for the duration of the drilling activities which are over the short-term.

Considering the small magnitude rating for non-impulsive noise and the probability rating of occasional, potential physical and/or physiological injury to marine fauna is considered of minor significance. Considering the mitigation measures recommended in Section 7.2.3.5 the magnitude is reduced to negligible, with the residual potential impact being incidental (Table 7-11).

Impulsive Noise (Vertical Seismic Profiling – VSP Operations

The peak pressure levels from impulsive VSP pulses, although VSP operations are unlikely to be undertaken, are likely to cause both auditory injury and TTS on-set in marine mammals and potential mortal injury in fish, turtles and plankton. The animals would, however, need to be directly adjacent to or below the VSP source (marine mammals, fish and sea turtles: 100 m) to be affected.

There is growing recognition that the sub-lethal effects of noise disturbance, which are both difficult to identify and measure, are likely to be relatively widespread and may have a greater impact than direct physical injury (Forney *et al.* 2017). Due to the highly localised and extremely short-term noise generated by VSP, sub-lethal effects (should they occur) would likely be acute rather than chronic (longer-term and associated with many overlapping activities). Nevertheless, a lack of observed response by the various faunal groups does not imply an absence of impact such as physiological stress and reduced reproduction, survival or feeding success. Apparent tolerance of disturbance may in fact have population-level impacts that are more subtle and difficult to record with conventional methodologies. As most pelagic species likely to be encountered within PEL 82 are highly mobile, they would be expected to flee and move away from the sound source before trauma could occur. However, assuming the animal does not move away from the noise source, the cumulative maximum threshold distances would apply. The extent of the potential impact zones for fish are due more to the cumulative exposure to noise from multiple VSP pulses than a single pulse, with maximum distances less than 100 m for impairment (TTS) and approximately 400 m for behavioural disturbance for fish with and without swim bladder. For sea turtles, the cumulative impact (250 discharges within 12 hours) will result in a potential auditory injury onset at maximum distances 100 m, respectively.

The zone of potential impact for zooplankton to suffer physiological injury is in relatively close proximity to the operating sound source. This faunal group, however, cannot move away from the approaching sound source and is therefore likely to suffer mortality and/or physiological injury within the zone of potential impact. Potential impacts on ichthyoplankton and pelagic invertebrates would thus be of high magnitude at close range, but transient due to the highly localised and very short-term nature of VSP operations. For large seismic arrays, mortalities and physiological injuries to zooplankton are reported to occur only at very close range (<5 m) (reviewed in Carroll *et al*. 2017 and Sivle *et al*. 2021).

The license area also overlaps with known spawning grounds for both monkfish and hake and a very small area may be temporarily affected by the highly localised VSP operations. Declines in zooplankton abundance as a result of VSP operations are therefore likely to be negligible.

Considering the small magnitude rating for impulsive noise and the probability rating of occasional, potential physical and/or physiological injury to marine fauna is considered of minor significance. Considering the mitigation measures recommended in Section 7.2.3.5 the magnitude is reduced to negligible, with the residual potential impact being incidental (Table 7-11).

TABLE 7-11 POTENTIAL IMPACT OF DRILLING AND VSP, ON PHYSICAL AND/OR PHYSIOLOGICAL INJURY TO MARINE FAUNA

Criteria	Drilling (No Mitigation)	Drilling (With Mitigation)	VSP (No Mitigation)	VSP (With Mitigation)
Type	Direct	Direct	Direct	Direct
Extent	Local	Local	Local	Local
Duration	Short-term (24 hrs)	Short-term	Acute (2–12 hrs)	Acute
Magnitude	Medium	Small	Medium	Small
Probability	Likely	Possible	Likely	Possible
Reversibility	Reversible	Reversible	Reversible	Reversible
Sensitivity	Medium	Medium	Medium	Medium
Confidence	Medium	Medium	Medium	Medium
Significance	Minor	Incidental	Minor	Incidental

7.3 PLANNED OPERATIONS: KEY SOCIAL IMPACTS

This section presents the assessment of potential socio-economic impacts that may arise in the social area of influence (AoI) for the project due to planned activities. The socio-economic impact assessment is based on the information provided in the project's description (Section 3), the socioeconomic baseline (Section 4) and feedback received from stakeholders.

Potential socio-economic impacts of the project will fall under broad themes of economy and employment and community and stakeholder.

The project may generate both direct and indirect employment opportunities for the region. Direct employment may include employment by Chevron and its contractors and sub-contractors engaged on the project. Indirect employment may be induced within the supply chain and via the presence of a workforce making use of accommodation, goods and services in Walvis Bay.

7.3.1 POTENTIAL IMPACT TO FISHING AND NAVIGATION

Impact Description

The presence of the drillship, wellhead and riser will necessitate the establishment of temporary exclusion zones. These exclusion zones will also be required for the removal of the riser. It is expected that the exclusion zones will be a 500 m (0.785 km^2 or 78.5 ha) buffer around project activities and will be enforced by a standby vessel. The operator may request a larger navigational safety zone of 2 Nm (3.7 km) around the drillship which would result in an exclusion area of 43 km^2. The navigational safety zone would be communicated as a navigational warning via South African Navy Hydrographic Office (SANHO). All unauthorised vessels would be requested to stay clear of the navigational safety zone for the duration of the drilling operations.

Commercial fisheries and artisanal fishers may experience a temporary loss of access to their navigation routes and fishing areas. Other commercial marine users may also experience disruption to usual vessel traffic routes. While exclusions zones are in place, commercial fisheries, artisanal fishers and other commercial marine users may not be able to access areas which they had previously used. Loss of access will be restored once exclusion zones are removed following completion of project activities.

Several fisheries sectors operate on a regular basis within the PEL 82 area; namely demersal trawl (hake and monk-directed), mid-water trawl, large pelagic longline, demersal longline and deep-sea crab. Table 7-12 lists the proportion of catch taken by each sector within the license area[10] and within the indicative exclusion zones. Since the exact well locations are currently unknown and could be located anywhere within the license area, the worst-case scenario presented above assumes the drilling unit is centred in the most heavily fished area within the license area.

The temporary exclusion of fisheries from the navigational safety zone could result in the displacement of fishing effort into alternative areas or, if no alternative areas are available, the loss of catch (direct negative impact).

[10] Note that the exclusion zone will not impact the entire license area at any one time, only the area around the drillship.

TABLE 7-12 SUMMARY OF PROPORTIONAL CATCH AND EFFORT, BY FISHING SECTOR, WITHIN PEL 82, THE 500 M EXCLUSION ZONE AND 2 NM (3700 M) NAVIGATIONAL SAFETY ZONES

Sector	Percentage (%) of Total Catch		
	Within PEL82	Within 500 m exclusion zone	Within 3700 m navigational safety zone
Large Pelagic Longline	2.46	<0.01	1.18[11]
Small Pelagic Purse-Seine	0	0	0
Midwater Trawl	0.98	<0.01	0.14
Demersal Trawl	3.7	<0.01	0.15
Demersal Longline	17.09	<0.01	1.01
Tuna Pole-Line	0	0	0
Linefish	<0.1	0	0
Deep-sea Crab	5.29[12]	<0.01	0.37
Deep-water Trawl	0	0	0
Rock Lobster	0	0	0

Feedback from Stakeholders

It was noted during engagements with a representative from MFMR that stakeholders from the fishing industry have historically had few objections to exploration projects. However, it was acknowledged that those involved in aquaculture are often the most vulnerable/sensitive to impacts from such projects. It was recommended that additional methods should be used to engage specifically with those in the fishing and aquaculture sectors to strengthen their participation ad incorporation of their feedback into the ESIA. Methods suggested included focus groups, clustered engagement groups with vulnerable communities and fishing associations and tailored engagement approaches to meet the needs of specific fishing community stakeholders. It has been noted that there have been recent changes in leadership of several fishing associations and cooperatives and this should be incorporated into future stakeholder mapping and communications.

No other stakeholders raised specific concerns regarding impact to fishing and navigation.

Impact Assessment

The navigational safety zone around the drillship will present a direct impact on fishing activity. Fishing operations will be precluded within this area resulting in an area of influence of between 0.785 km^2 (500 m radius) and 43 km^2 (2 Nm radius). The potential impact is considered to be local in extent, of short-term duration (up to 90 days per well) and fully

[11] Due to the large area covered by drifting pelagic long-line gear, fishing operations could potentially be affected beyond the limits of a 500 m exclusion zone. A pelagic long-line vessel would realistically not be able to deploy gear within a distance of approximately 50 km of a drillship. The area of impact has been raised accordingly for this sector.
[12] Percentage effort was used for deep-sea crab sector as catch data unavailable for the current report.

reversible (ends once the drillship moves off location after the well has been plugged and abandoned). The probability of the impact materialising is considered likely.

The following fisheries sectors routinely operate within the license area; large pelagic purse-seine, demersal longline, demersal trawl and deepwater trawl. Midwater trawl and tuna pole-line vessels operate less frequently in the area. The scale of the impact (measured as percentage of total catch taken within an indicative navigational safety zone around the drillship) is expected to be higher for the longline sectors (~1.2% for large pelagic longline, ~1% for demersal hake longline, ~0.4% for deep-sea crab) than the trawl sectors (~0.2% for midwater trawl and demersal trawl). The assessment of the following sectors shows no evidence of recent operations within PEL 82: small pelagic purse-seine (fishery has been closed since 2017), tuna pole-line, linefish, deepwater trawl (fishery has been closed since 2007) and rock lobster. Refer to Section x for a description of the areas of operation for each of these sectors.

The displacement of fishing activity is expected to result in a minor disruption to normal fishing operations as the overlap is small for all affected sectors. Due to the short-term duration (90 days per well, with a maximum of four wells per year over 3 to 5 years) the potential impact is considered to be of small magnitude.

It is likely that affected sectors would be able to redirect fishing effort to alternative locations for the duration of well-drilling activities. The sensitivity of each fishery is regarded as its ability to adapt to change. In the event that fishing vessels can plan to avoid the area and continue operations elsewhere, the sensitivity of the sector would be rated as low. Based on the small magnitude and low sensitivity of the affected fishery sectors, the potential impact is assessed to be of overall **minor significance** (refer to Table 7-13).

Mitigation and Monitoring Measures

The potential for mitigation includes effective communications with fishing sectors which could allow vessel operators the opportunity to plan fishing operations in areas unaffected by the presence of the drillship. Thus, it may be possible for operators to relocate fishing effort into alternative areas if adequate information is provided ahead of the project.

Recommended mitigation and monitoring measures include:

Pre-Operation

- Distribute a Notice to Mariners to key stakeholders prior to the well-drilling operations 3 weeks prior to operations and on completion of the campaign. Stakeholders include the relevant fishing industry associations: Confederation of Namibian Fishing Association, Large Pelagic and Hake Longlining Association of Namibia. Other key stakeholders: Directorate of Maritime Affairs, SANHO, Namibian Ports Authority and the MFMR Monitoring, Control and Surveillance Unit in Walvis Bay (Vessel Monitoring System).
- Request, in writing, SANHO to broadcast a navigational warning via Navigational Telex (Navtext) and navigational warnings twice daily on Channel 16 VHF.
- Implement a grievance mechanism that allows stakeholders to register specific grievances related to operations; by ensuring they are informed about the process and that resources are mobilised to manage the resolution of all grievances, in accordance with the Grievance Management procedure.

- Conduct careful design of pre-drilling site surveys to collect sufficient information on seabed habitats, including mapping of sensitive and potentially vulnerable habitats within 500 m of a proposed well site.
- If sensitive habitats (such as hard grounds), sensitive species (e.g., cold-water corals, sponges), or significant structural features are detected, adjust the well position to beyond 500 m, or implement technologies, procedures, and monitoring to reduce risks and assess potential damage.
- Careful selection of drilling fluid additives taking into account their concentration, toxicity, bioavailability and bioaccumulation potential; Use only, PLONOR (Pose Little Or No Risk) chemicals, low-toxicity, low bioaccumulation potential and partially biodegradable additives are used, where practicable. Maintain a full register of Safety Data Sheets (SDSs) for all chemical used, as well as a precise log file of their use and discharge.

Operation

- Manage the lighting on the drilling unit and support vessels so it is sufficiently illuminated to be visible to fishing vessels and compatible with safe operations.
- Notify fishing vessels at a radar range <24 Nm from the drillship via radio regarding the safety requirements around the drillship. If possible, transmit/broadcast the virtual safety navigational zone surrounding the rig on the AIS system, so nearby vessels will see not only the vessel location but also the restricted zone surrounding the vessel on their AIS displays.
- Implement a grievance mechanism that allows stakeholders to register specific grievances related to operations; by ensuring they are informed about the process and that resources are mobilised to manage the resolution of all grievances, in accordance with the Grievance Management procedure.
- If NADFs are used for drilling the risered sections, conduct regular maintenance of the onboard solids control package and avoid inappropriate discharge of NADF cuttings.

Monitoring

- Test drill cuttings daily for retained oil content to check specified discharge standards are maintained (average residual oil on cuttings <6.9%) at the end of the well.
- Test barite for heavy impurities prior to mixing barite on location.
- Test any other discharged fluids for visible oil contamination (static sheen).
- Where practical, monitor sediment deposition and hydrocarbon concentrations.
- Monitor cement returns with an ROV and stop cement pumping if significant discharges are detected on the seafloor.
- Monitor (using ROV) hole wash out to reduce discharge of fluids, as far as possible.

Abandonment

- Abandoned well location must be surveyed and accurately charted. If indicated, fit wellheads (in water depth less than 800 m) with an over-trawlable structure to minimise the risk of damage to demersal trawl gear, as well as potential damage to the wellheads.
- Removal of wellheads: Consultation with the trawling industry should wellheads coincide with trawling grounds.

Post- Operation

- Conduct post-drilling ROV surveys to locate and recover dropped equipment or excess cement.
- Register and distribute the location of abandoned wellheads via “Notice to Mariners” and “Notice to Fishers”.

TABLE 7-13 POTENTIAL IMPACTS TO FISHING AND NAVIGATION

Criteria	Without Mitigation	With Mitigation
Type	Direct	Direct
Extent	Local	Local
Duration	Short-term (90 days per well)	Short-term
Magnitude	Small	Small
Probability	Likely	Likely
Reversibility	Reversible	Reversible
Sensitivity	Low	Low
Confidence	High	High
Significance	Minor	Minor

7.3.2 POTENTIAL IMPACT OF DRILLING DISCHARGES ON FISHING OPERATIONS

Impact Description

Drill cuttings and mud discharged onto the seabed can cause habitat loss, physical damage and may immobilize benthic organisms if buried. The potential impact depends on organism sensitivity, deposition thickness, oxygen depletion and burial duration. Discharge modelling (refer to Section 7.2.1.1) predicts that most deposits thicker than 6.3 mm will occur within 50 m of the Gemsbok Well (Block 2112B) and within 500 m of the potential second well (Block 2212A).

Increases in the concentration of TSS can result from the discharge of drill cuttings and muds. The highest concentrations are observed near the discharge point and decrease with time and distance as the suspended solids plume dissipates and settles. Larger particles tend to settle more rapidly than finer particles, which means that a plume composed of small particles may persist and disperse farther than those consisting of larger grain sizes. Consequently, regions where small suspended particles remain may experience elevated TSS concentrations, especially when mixed with subsequent discharges. Increased TSS can reduce water clarity and may lead to clogging of fish gills.

Cuttings with NADF will be processed onboard using shakers and dryers to lower NABF retention (by average mass). The hydrocarbon-based NABF, once settled on the seabed, gradually breaks down and may enter sediment pore water or dissolve in the water column, depending on the hydrocarbon's properties.

Hydrocarbon impacts are mainly linked to aromatics. The NABF used is considered "low toxicity" because it contains less than 0.5% total aromatics and 0.001% PAHs (Sanzone et al. 2016; OGP 2003). Despite the low toxicity, hydrocarbon degradation may reduce dissolved oxygen in sediments, but this can be offset by oxygen from the overlying water.

TSS concentrations near the seabed exceeded the 35 mg/L threshold at both wells, but levels near the surface remained below this limit in all scenarios. The affected areas for Gemsbok Well (Block 2112B) were smaller than those for the second well (Block 2212A).

Feedback from Stakeholders

During the public meeting held during the scoping phase a representative from the local media raised a concern of how drilling, machinery and chemicals used for the project would affect marine ecosystems and communities living along the coasts. CNEL assured the stakeholder that the use of water-based drilling fluids would minimise harm to marine life. Additionally, CNEL stated the ESIA Report would be used to identify further mitigation measures the reduce impact where possible to the lowest practical level. The representative form MFMR engaged during a separate meeting did not raise specific concerns regarding the impact of drill discharges on fishing operations.

Impact Assessment

Sediment deposition at the seabed can lead to the covering of benthic communities and trophic level cascade effects that may alter typical feeding patterns in some fish species. Species such as benthic and demersal organisms, which spawn, lay eggs, or have juvenile stages dependent on seafloor habitats, may be affected by drill cuttings deposition. The main fish spawning areas are located further inshore on the shelf, but there is some overlap between PEL 82 and the spawning distributions of hake, monk and orange roughy, making these resources potentially subject to disturbance from drill cuttings.

The distribution and abundance of commercial fish species are not expected to experience significant changes due to well drill cuttings deposition during this project, except in areas immediately adjacent to the discharge. Increased water turbidity caused by suspended fine particulate matter may result in avoidance behavior in fish. The effect on fisheries within or near PEL 82 is assessed as small.

Drilling operations are projected to last about 90 days per well, with approximately 21 days allocated for drilling and associated discharge activities. Up to 10 wells could be drilled over 3 to 5 years; therefore, the overall impact duration is considered short-term. Risks to the water column are temporary, usually lasting only a few days as total suspended solids are likely to disperse rapidly due to local currents.

The area directly influenced was identified through discharge modelling of drill cuttings (refer to Section 7.2.1.1). Results indicate that the deposition footprint is primarily limited to a radius of 50 m around the Gemsbok Well in Block 2112B and 500 m around the potential second well in Block 2212A. Thus, the potential impact is regarded as local in scope.

Modelling predicts that the extent of depositional areas varies seasonally (refer to Section 7.2.1.1). Avoiding certain seasons when planning drilling activities is most relevant in Block 2212A, where depositional thickness is greatest in March.

Considering the magnitude of the impact and receptor sensitivity, the potential effect on fisheries is classified as minor both before and after mitigation measures are applied (refer to Table 7-14).

Mitigation and Monitoring

Refer to mitigation and monitoring measures in Section 7.3.1.

TABLE 7-14 POTENTIAL IMPACT OF DRILLING DISCHARGES ON FISHING OPERATIONS

Criteria	Without Mitigation	With Mitigation
Type	Indirect	Indirect
Extent	Local	Local
Duration	Short-term	Short-term
Magnitude	Small	Small
Probability	Occasional	Occasional
Reversibility	Reversible	Reversible
Sensitivity	Low	Low
Confidence	High	High
Significance	Minor	Minor

7.3.3 POTENTIAL IMPACT OF UNDERWATER RADIATED NOISE ON FISHING OPERATIONS

Impact Description

For this assessment, underwater noise is separated into non-impulsive and impulsive noise. Non-impulsive noises are typically continuous and produce sounds that can be narrowband, or tonal and brief or prolonged. It does not have the high peak sound pressure with rapid rise time typical of impulsive sounds (e.g., drilling and vessel engines). Impulsive noises are typically very short (in seconds), broadband and have high peak pressure with rapid time and decay back to ambient levels (e.g., noise from vertical seismic profiling).

The project activities that will generate an increase in underwater noise include the operation of the drillship and support vessels at the drill site, the transit of support/supply vessels between the drilling unit and port, and Vertical Seismic Profiling (VSP) which may be undertaken during wireline testing of the well-bore.

High sound levels can harm marine life, causing hearing threshold shifts (permanent or temporary), tissue damage and behavioural changes in fish. An Underwater Sound Transmission Loss Modelling (STLM) study was conducted to evaluate potential noise impact zones for key fish species linked to major project noise sources (ERM, 2025c), with results informing this assessment (refer to Section 7.2.1.2).

The assessment presumes the contractor will follow best international practices and BAT. Underwater noise is categorised as non-impulsive (continuous, narrowband or tonal, e.g., vessel engines) and impulsive (short, broadband, high peak pressure, e.g., vertical seismic profiling).

Table 7-15 presents the relevant effects thresholds set out by Popper et al. 2014, for drilling and continuous noise. The guidelines define quantitative thresholds for three effects: mortality and potential mortal injury, recoverable injury and TTS.

TABLE 7-15 CRITERIA FOR ONSET OF POTENTIAL INJURY TO FISH DUE TO CONTINUOUS SOUND

Type of Animal	Mortality and potential mortal Injury	Recoverable Injury	TTS
Fish: no swim bladder (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low
Fish: swim bladder is not involved in hearing (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low
Fish: swim bladder involved in hearing (primarily pressure detection)	(N) Low (I) Low (F) Low	170 dB RMS for 48h	158 dB RMS for 12h
Eggs and larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low
Notes: RMS sound pressure levels dB re 1 µPa. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined as near (N), intermediate (I) and far (F).			

Source: Popper *et al.* 2014

The potential injury criteria adopted for impulsive noise sources in this assessment are shown in Table 7-16.

TABLE 7-16 ADOPTED CRITERIA FOR POTENTIAL INJURY FOR FISH DUE TO IMPULSIVE SOUND

Type of Animal	Mortality and Potential Mortal Injury	Recoverable Injury
Fish: no swim bladder (particle motion detection)	>219 dB SELcum or >213 dB Peak	>216 dB SELcum or >213 dB Peak
Fish: swim bladder not involved in hearing (particle motion)	210 SELcum or >207 dB Peak	203 dB SELcum or >207 dB Peak
Fish: swim bladder involved in hearing (primary pressure detection) juveniles and eggs	207 SELcum or >207 dB Peak	203 dB SELcum or >207 dB Peak
Fish: Eggs and Larvae	210 SELcum or >207 dB Peak	(N/A – moderate potential near to source)

Source: Popper *et al*. 2014.

Feedback from Stakeholders

No specific concerns were raised during scoping phase public consultation regarding the potential impacts of noise on fishing operations. During a meeting with a representative from MFMR, a separate incident regarding the death of dolphins in 2020 near Lüderitz was discussed. However, the representative from MFMR stated that their investigation into the incident found no link between the dolphin deaths and any offshore oil and gas exploration activities in the region. This incident did spark public concern which was evident across social media. Therefore, the representative from MFMR stressed the importance of close engagement with the Ministry to ensure the project does not unduly impact on designated Ecologically and

Biologically Significant Marian Areas (EBSAs). While the EBSA framework is not legally binding, it supports coastal and marine management through effective zoning.

Impact Assessment

Non-Impulsive underwater noise

Underwater noise from drilling and support vessels is expected to increase local ambient noise but remains mostly within established impact thresholds. The most significant potential effects (recoverable injury or temporary hearing changes in fish) are predicted to occur only within short distances (less than 0.4 km) from the noise source. Behavioural changes in fish, such as moving away, may occur up to 1 km from the source. Overall, the noise impact is localised.

Impulsive underwater noise

Impulsive underwater noise, such as that produced by vertical seismic profiling (VSP), primarily travels downward and is less intense horizontally compared to other sources. Source levels for VSP can reach 242 dB re 1 µPa (Peak) at 1 m. The thresholds for physical effects in fish and larvae range from 207–213 dB re 1 µPa, with hearing effects occurring at cumulative exposures above 186 dB re 1 $\mu Pa^2 \cdot s$.

Fish species with swim bladders, such as hake and certain tunas, are more at risk of injury from impulsive underwater noise like VSP, though highly mobile species are likely to move away before harm occurs. Both fish with and without swim bladders could experience temporary hearing changes or behavioural effects within 0.4 km of the noise source, but significant physical injury zones remain under 100 m. Fishing activity in these areas is generally low.

The potential impact is considered to be of short-term duration (up to 90 days per well for non-impulsive underwater noise and up to 24-hours per well for VSP operations) and fully reversible (ends once the drillship moves off location after the well has been plugged and abandoned). The probability of the impact materialising is considered likely.

Based on the underwater noise modelling, behavioural disturbance to fish due to non-impulsive noise (i.e. drilling and vessel presence) may occur within a 1 km radius of the drillship. This results in an potential impact zone of approximately 3 km^2. The potential impact is therefore considered to be local in extent. The direct area of influence falls within the effective navigational safety zone for the sectors that operate within PEL 82 i.e. pelagic longline, demersal trawl, demersal longline, midwater trawl and deep-sea crab (refer to Appendix G).

The noise-induced behavioural disturbance of fish is considered a minor disruption as the overlap is small for all affected sectors and the area of influence falls within the vessel exclusion zone. Consequently, the potential impact is considered to be of small magnitude. It is likely that affected sectors would be able to redirect fishing effort to alternative locations for the duration of well-drilling activities. The sensitivity of each fishery is regarded as its ability to adapt to change. In the event that fishing vessels can plan to avoid the area and continue operations elsewhere, the sensitivity of the sector would be rated as low. Given the small impact magnitude and low sensitivity of the affected fisheries, the potential impact is considered minor before mitigation and incidental after mitigation (refer to Table 7.16).

Mitigation

The mitigation measures listed in Section 7.3.1 will ensure that the fisheries sectors are aware of the drilling operations and are able to redirect fishing activity in alternative areas. In addition, it is recommended that soft-start procedures be implemented during operation of VSP:

- Soft start procedures:
  - Gun test followed by full VSP logging phase: acoustic source must be initiated at the lowest power setting, with gradual ramp-up of the acoustic source over a 20-minute period until the full operating power level is reached.
  - For single gun tests prior to VSP logging phase: If a gun test will be less than 20-minutes in duration, a soft start procedure of equal time duration must be followed (e.g. a 10-min gun test should be preceded with a 10-min soft start only).
- Operating procedures: whilst the VSP acoustic source is operating, both during soft start procedures and survey operations, the acoustic source must be shut down if mass mortality of fish species is sighted.

TABLE 7-17 POTENTIAL IMPACTS UNDERWATER RADIATED NOISE ON FISHING OPERATIONS

Criteria	Without Mitigation	With Mitigation
Type	Direct	Direct
Extent	Local	Local
Duration	Short-term	Short-term
Magnitude	Small	Negligible
Probability	Likely	Likely
Reversibility	Reversible	Reversible
Sensitivity	Low	Low
Confidence	High	High
Significance	Minor	Incidental

7.3.4 POTENTIAL IMPACT TO MARINE TRAFFIC

Impact Description

The project may also increase the number of marine vessels present in the area and using the Port of Walvis Bay. This may change how other marine users can access the Port of Walvis Bay and navigate within the project AoI.

Feedback from Stakeholders

The public consultation meetings held during the Scoping phase did not identify any particular concerns relating to potential impacts on marine traffic.

Impact Assessment

Potentially more vessels will be calling at the Port of Walvis Bay and navigating the waters between Walvis Bay and PEL 82 as a result of the project. It is expected that one drillship will be used and up to four support vessels will be required. The drillship will stay at the drill site while undertaking activities. The support vessels will operate two to three routine rotations per week to facilitate the transport of equipment and materials between the drillship and the shore base as well as enforce the exclusion zone. The drilling unit will be serviced by up to four support vessels two to three rotations per week. They will be on standby at the drilling site as well as facilitate the transportation of equipment and materials between the drilling unit and the onshore base.

The support vessels can also be utilised for medical evacuations or crew transfers if necessary and provide assistance in firefighting, oil containment and recovery, rescue operations in case of emergencies and supply any additional equipment that may be needed.

Given the number of vessels and vessel movements required for the project the magnitude of potential impact is considered small. The sensitivity of the receptors is low. Therefore, the significance of the potential impact is minor. With the implementation of appropriate mitigation the significance reduces to incidental.

Mitigation Measures

- Ongoing engagement, as guided by the SEP with the Namibian Ports Authority to establish vessel routing optimisation and docking arrangements that minimises potential impact on other marine users.
- Use the SEP to promote collaboration with fishing associations and cooperatives, recreation users and other commercial marine users to identify areas of optimisation. This would include promoting the use of the external grievance mechanism for stakeholder to raise concerns regarding vessel traffic.
- Utilisation of monitoring systems data provided by the Ports Authority to track vessel traffic, including smaller boats used by artisanal fishers, in order to identify issues and potential improvements required in routing.
- Manage the lighting on the drilling unit and support vessels to make sure that it is sufficiently illuminated to be visible to fishing vessels and compatible with safe operations.

TABLE 7-18 POTENTIAL IMPACTS TO MARINE TRAFFIC

Criteria	Without Mitigation	With Mitigation
Type	Direct	Direct
Extent	Local	Local
Duration	Medium-term	Medium-term
Magnitude	Small	Negligible
Probability	Likely	Likely
Reversibility	Reversible	Reversible
Sensitivity	Low	Low
Confidence	High	High
Significance	Minor	Incidental

7.3.5 POTENTIAL IMPACT ON EMPLOYMENT AND JOB CREATION

Impact Description

The project may generate direct employment for individuals working on the drillship, support vessels and at the shore base. Indirect employment may also be created through the procurement of goods and services to support project activities. Those who gain direct/indirect employment with the project or enter a contract to provide goods/services will benefit from capacity enhancement associated with working on a large-scale project.

Feedback from Stakeholders

Numerous stakeholders in the scoping public meeting raised questions and concerns regarding employment linked to the project. Various community members inquired what processes people should follow in order to access any job opportunities that were available with the project. These queries often focused on what jobs may be available to youth from the local communities, reflecting difficulties faced with employment by this group. Questions were also asked about where job opportunities are to be advertised and how people can access them. Stakeholders from the local media also asked if local companies will be used for the procurement of goods and services for the project (especially in regards to offshore oil and marine services).

In relation to youth employment, a community member also asked if the project would engage with schools to provide clear information about potential job opportunities in the oil and gas industry and what skills and technical expertise are required to work on exploration and drilling activities. The community member asked if CNEL could provide guidance to local schools on what courses students should pursue after finishing school in order to start a career in the oil and gas industry. Another community member enquired what specific qualifications are required to work in the oil and gas industry. There is a notable expectation that the oil and gas industry will provide employment for local communities in the future and people appear keen to take advantage of such opportunities.

Impact Assessment

The project is expected to generate limited direct local employment during the mobilisation, drilling and demobilisation phases. Specialised drilling personnel will most likely be included with the hiring of the drilling unit. Additional personnel will be required at the logistics base and on support vessels. It is likely that the personnel working on the drilling unit will be expatriates due to the specialised skills required and the short-term nature of the contract. Personnel hired to work on support vessels or in shore-based roles at the logistics base may be local. Other project workforce requirements will be met by CNEL personnel based in the company's Windhoek Office.

As such, the project will likely generate limited direct employment opportunities at a local extent. However, there may be further employment creation as a result of the presence of the project through the procurement of goods and services which may extend regionally/nationally. Direct and indirect employment with the project may create opportunities for on the job training/upskilling of individuals and capacity enhancements of local businesses.

Given the <u>small</u> magnitude of the potential impact and <u>medium</u> receptor sensitivity, the overall significance is assessed as minor positive. With mitigation measure in place such as the SEP the residual significance remains minor positive. A summary of the potential impact is provided in Table 7-19.

Mitigation Measures

- The SEP should include requirements for ongoing engagement with local communities, business associations, NGOs and other relevant stakeholder categories regarding potential employment and procurement opportunities for local people and businesses. This engagement should include information sharing on job application processes, skills requirements and tendering processes.
- The external grievance mechanism within the SEP should be clearly communicated to these stakeholders to allow them to submit a grievance relating the employment and procurement if necessary and the grievances will be processed accordingly.
- Where possible, certain jobs as well as the provision of certain good and services should be reserved for local employees and local suppliers. This may include various unskilled and semi-skilled positions as well as the procurement of transport services, food, security services etc..

TABLE 7-19 POTENTIAL IMPACTS ON EMPLOYMENT AND JOB CREATION

Criteria	Without Mitigation	With Mitigation
Type	Direct	Direct
Extent	Local/Regional	Local/Regional
Duration	Medium-term	Medium-term
Magnitude	Small	Small
Probability	Likely	Likely
Sensitivity	Medium	Medium
Confidence	High	High
Significance	Minor Positive	Minor Positive

7.3.6 POTENTIAL IMPACTS ON THE LOCAL AND REGIONAL ECONOMY

Impact Description

Employment creation, procurement of goods and services and an increase in worker spending within the AoI as a result of the presence of the project will generate positive potential impacts for the local economy including indirect employment opportunities.

Individuals working on the drillship and support vessels will use Walvis Bay as their shore base. Additionally, those working at the logistics base will most likely be living in Walvis Bay or surrounding areas when they are ashore. It can be expected that workers’ spending on goods and services in Walvis Bay will have a positive impact on the local economy. However, this potential impact will be limited due to the size of the workforce required for the project. Procurement of goods and services for the project such as fuels, accommodation, freight, logistics, food services, security services and maintenance services will also have a positive potential impact on the local economy if local suppliers and contractors are used. Additionally, the project will pay port fees for the use of the Port of Walvis Bay (support vessels, drillship, helicopter transfers).

Feedback from Stakeholders

Several stakeholders raised questions in the scoping public meeting regarding local content opportunities. Queries covered what local content development can be expected, when local content benefits will start and what companies may be considered local and prioritised for procurements. Local content appears to be one of the key concerns of stakeholders.

Impact Assessment

The project may generate a temporary increase in spending that will benefit the local economy. It is expected that worker spending on goods and services in Walvis Bay and other coastal towns of the AoI will increase during the mobilisation, drilling and demobilisation phases of the project. However, the scale of this potential impact will be limited given the size of the workforce required and the short-term nature of the project phases. Procurement of goods and services directly by the project may also occur throughout which will also contribute to the local economy.

Indirect impacts may occur where expenditure in the local economy supports jobs and incomes within the AoI for people working for suppliers. Induced impacts may occur as jobs are supported in local businesses through the increased expenditure within the local economy of project workforce and other people who have gained an in come as a result of the project (supply chain workforce).

The project may have a temporary positive impact on the local economy through direct, indirect and induced changes to spending. This will lead to an increase in economic activity in the region. Potential areas where spending may increase include:

- Needs of the non-local workforce when they are ashore (accommodation, food, entertainment, transport);
- Supplies for the support vessels and drillship (food, water);
- Services and fees to support project activities such as port fees, port services, logistics, freight, rental fees, fuel, helicopter usage).

The magnitude of the potential impact is considered small while receptor sensitivity is small. The significance is therefore, minor positive. With mitigation measure in place, such as the SEP Chevron's internal requirements for local content, the residual significance remains minor positive. A summary of the potential impact is provided in Table 7-19.

Mitigation Measures

- Ongoing engagement with local business associations, communities and local authorities should include the sharing of local procurement opportunities including the requirements for contracting with CNEL and/or the project. This engagement should focus on managing expectations given the limited contractor and supply chain opportunities.
- Opportunities to tender should be advertised widely within the project AoI to make sure awareness is raised amongst potential local contractors and suppliers.

- The project should implement Chevron's internal local content requirements to maximise this benefit. These local content requirements should be clearly communicated to stakeholders.

TABLE 7-20 POTENTIAL IMPACTS ON THE LOCAL ECONOMY

Criteria	Without Mitigation	With Mitigation
Type	Direct/ Indirect/ Induced	Direct/ Indirect/ Induced
Extent	Regional	Regional
Duration	Medium-term	Medium-term
Magnitude	Small	Small
Probability	Likely	Likely
Reversibility	Partially Reversible	Partially Reversible
Sensitivity	Low	Low
Confidence	High	High
Significance	Minor Positive	Minor Positive

7.3.7 POTENTIAL IMPACTS ON THE MACRO-ECONOMY

Impact Description

The project operator, CNEL, will be required to make certain payments to the Namibian Government as part of mobilisation, drilling and demobilisation. These include exploration license fees and rental charges. Project spending (from direct and indirect workforce and contractors/supply chain businesses) will also increase indirect taxes paid to the government (income tax, business taxes, value added tax).

The slight increase in taxes paid due the presence of the project will potentially increase the overall tax revenue of the Nambian government which will have a positive influence in the balance of payments for the country.

Feedback from Stakeholders

Various stakeholder raised questions during the scoping public meeting regarding local content. There is a desire among stakeholders for economic benefits to be kept within Namibia and for procurement and supply chain benefits to be reserved for Namibian owned and operated businesses.

Impact Assessment

The project will have a limited potential impact on macro-economic variables through increase in the payment of taxes, fees and charges.

CNEL is liable to pay an annual petroleum license fee to the Namibian government to conduct exploration. An initial application fee is payable, following which a renewal fee is payable annually. No royalties will apply to the project as production is not yet taking place and, therefore, the project will not directly generate income and profits for CNEL.

Project expenditure on goods and services will potentially lead to increased value added tax (VAT) payments. Local people who are employed directly or indirectly as a result of the project will also pay income taxes. Specialised personnel such as those employed on the drillship will likely be recruited internationally which may limit some tax benefits associated with the project. The majority of macro-economic benefits associated with the project will only be realised if it progresses to production.

The magnitude of the potential impact on the macro-economy is considered small while receptor sensitivity is low. The significance is therefore, minor positive. The potential impact extent will be national and occur over a medium term.

Mitigation Measures

No specific mitigation is proposed for this potential impact. Similar mitigations as described in Section 7.3.6 should be implemented to ensure the project maximises local content development. Preference should be given to the recruitment of Namibian nationals and procurement of goods and services from Namibian owned and operated businesses.

TABLE 7-21 POTENTIAL IMPACTS ON THE MACRO-ECONOMY

Criteria	Without Mitigation	With Mitigation
Type	Direct/ Indirect/ Induced	Direct/ Indirect/ Induced
Extent	National	National
Duration	Medium-term	Medium-term
Magnitude	Small	Small
Probability	Likely	Likely
Reversibility	Partially Reversible	Partially Reversible
Sensitivity	Low	Low
Confidence	High	High
Significance	Minor Positive	Minor Positive

8. ASSESSMENT OF ALTERNATIVES

Section 3.8 of this ESIA Report presents a comparative evaluation of project alternatives, including drill site locations, aviation base options, scheduling of exploration and appraisal drilling, number of wells, types of drilling units, drilling fluids, cuttings disposal methods and the No-Go alternative. Following this assessment, all options, except the No-Go alternative, were excluded from further detailed evaluation. This chapter provides a focused analysis of the No-Go alternative, which entails not proceeding with the potential exploration and appraisal drilling activities.

8.1 IMPLICATIONS OF THE NO-GO ALTERNATIVE

The No-Go alternative refers to the decision not to proceed with exploration or appraisal drilling within PEL 82. Under this scenario, the identified drill sites would remain undisturbed and the hydrocarbon potential of the area would remain unconfirmed unless future exploration is undertaken by other entities or through emerging technologies.

Without exploration, the commercial viability of hydrocarbon resources in the license area cannot be established, resulting in deferred development and missed opportunities to assess and potentially utilise these resources.

From an environmental perspective, the No-Go alternative would avoid all direct impacts associated with drilling operations, including risks of accidental events and would preserve the current ecological condition of the area. Potential social impacts linked to offshore activities would also be avoided.

The No-Go alternative precludes the opportunity of potential future domestic oil and gas development (at least in PEL 82, noting that exploration is taking place under separate ECCs in other license blocks offshore Namibia), as any domestic oil and gas resources that might occur in the area of interest cannot be identified.

Precluding the opportunity of potential future domestic oil and gas development across Namibia could affect the country's economic planning and finances, as:

- Domestic demand would (continue to) be met with imports, where Namibia likely competes with global buyers in a competitive market; and
- Domestically produced resources would not be a potential source of tax and export revenue.

The No-Go alternative may facilitate Namibia meeting its NDC commitments, although a country's total GHG emissions are comprised of a highly complex interaction of many activities and interventions and avoided nationally produced GHG may be compensated by imported GHG to some extent.

Income from the sale of petroleum resources may assist the country in financing (and possibly accelerating) a transition to a low-carbon economy, but again this would be dependent on a highly complex interaction of activities and intervention that cannot be reasonably foreseen in the absence of e.g. legislated rules and mechanisms on the use of potential petroleum proceeds.

The complexities and unknowns around whether future domestic production will take place and how any produced resources and proceeds will be utilised means that a thorough and dependable analysis of the future implications of the No-Go alternative is beyond the scope of the ESIA process.

If exploration continues in other Namibian offshore blocks (for eg: Rhino Resources plans to drill the Volans-1X well with the Deepsea Mira rig around late July or early August 2025, following their Capricornus-1X light oil discovery in April). Excluding PEL 82 from development appears inconsistent, as no unique or critical environmental risks have been found in this license area.

Proceeding with exploration, together with appropriate mitigation and management measures, provides a way to evaluate economic opportunities alongside environmental considerations. This approach allows for assessment of the commercial viability of hydrocarbon resources in the license area and informs decisions regarding potential development, while seeking to reduce negative impacts

9. ASSESSMENT OF UNPLANNED ACTIVITIES

This chapter assesses the potential impacts from unplanned events using the methodology described in Section 6.

9.1 ASSESSMENT OF ACCIDENTAL EVENTS

Accidental events are unintended but may occur as a result of project activities. The most significant unintended event that may potentially occur is a well loss of containment event during drilling which would lead to an oil spill. Potential impacts may also result from other unplanned events and accidents such as vessel collisions or helicopter incidents.

9.1.1 HYDROCARBON SPILLS INCLUDING WELL LOSS OF CONTAINMENT

9.1.1.1 WELL LOSS OF CONTAINMENT

A well loss of containment refers to an uncontrolled release of fluid during drilling or abandonment operations, which may require several days or months to control. The potential for environmental impact is influenced by the quantity and characteristics of released hydrocarbons. Typically, such incidents involve a high-pressure jet of gas and liquid; gaseous components enter the atmosphere and liquid hydrocarbons form a slick on the water surface.

Well loss of containment events are considered significant unplanned events in offshore drilling, potentially resulting in hydrocarbon releases, fire and/or explosion, risks to personnel and environmental effects. The CNEL offshore exploration program in PEL 82 includes drilling one to two wells at the Gemsbok prospect in water depths ranging from 900 to 1,500 m. According to global offshore accident data, including the Worldwide Offshore Accident Databank (WOAD), the probability of a well loss of containment for a deepwater exploration well is about 0.035% per well drilled, which aligns with a seldom likelihood classification (SINTEF, 2022). Despite the low probability, mitigation measures are implemented, such as Chevron’s WellSafe Standard, real-time monitoring, blowout preventer (BOP) integrity checks and an Source Control Contingency Plan (SCCP), to prevent such events and facilitate a prompt response if necessary.

Potential ecological risks include:

- Toxicity of hydrocarbons affecting marine life.
- Physical alteration and disruption of benthic habitats.
- Increased turbidity due to gas and sediment plumes.
- Surface slicks impacting birds, marine mammals and turtles.

9.1.1.2 SUMMARY OF OIL SPILL MODELLING RESULTS

Chevron Namibia Exploration Limited II (CNEL) commissioned RPS Ocean Science, a Tetra Tech company, to conduct an oil spill modelling study for three hypothetical well loss of containment (LOC) scenarios within the PEL 82 license area, covering Blocks 2112B and 2212A offshore Namibia. The scenarios, summarised in Table 9-1, considered potential loss of containments at three well locations: Gemsbok (Block 2112B, 1,000 m water depth), Sable (Block 2212A, 1,200 m water depth) and Shallow Well (Block 2112B, 300 m water depth).

Each scenario simulated a continuous release of light crude oil over a 30-day period, with the modelling extended to 60 days to assess long-term dispersion. These scenarios represent a typical worst-case modelling approach commonly applied to offshore exploration projects. Seasonal variability was incorporated by evaluating two distinct conditions: Summer (November to April) and Winter (May to October).

The modelling approach involved two tools. OILMAPDeep was used for near-field analysis, focusing on the vertical transport of oil and gas plumes immediately following release. OILMAP/SIMAP was applied for far-field analysis, which assessed the horizontal transport and weathering of oil over time. Environmental conditions in the region are characterised by prevailing winds from the south-southeast, which are typically stronger during winter months. Ocean currents vary from north to south via west, although wind drift was identified as the dominant mechanism influencing oil movement.

TABLE 9-1 SUMMARY OF OIL SPILL SCENARIOS

ID	Release Location	Oil Type	Release Type	Season	Release Rate (bbl/day)	Release Duration (days)	Total Volume Spilled (bbl)	Simulation Duration (days)
1	Gemsbok	Light Crude Oil	Subsurface Blowout (LOC	Summer	18,668	30	560,040	60
2	Gemsbok	Light Crude Oil	Subsurface Blowout (LOC)	Winter	18,668	30	560,040	60
3	Potential second Well/ Sable	Light Crude Oil	Subsurface Blowout (LOC)	Summer	18,668	30	560,040	60
4	Potential second Well/ Sable	Light Crude Oil	Subsurface Blowout (LOC)	Winter	18,668	30	560,040	60
5	Shallow Well	Light Crude Oil	Subsurface Blowout (LOC)	Summer	18,668	30	560,040	60
6	Shallow Well	Light Crude Oil	Subsurface Blowout (LOC)	Winter	18,668	30	560,040	60

Source: RPS Ocean Science, 2025

Stochastic Results

Stochastic modelling was used to assess the probability and spatial extent of oil exposure across the sea surface, shoreline and water column. Six scenarios were modelled, representing subsurface loss of containment at three well locations (Gemsbok, Sable and Shallow Well) during both summer (November–April) and winter (May–October). Each scenario simulated a continuous release of 18,668 barrels per day of light crude oil over 30 days, with a total release volume of 560,040 barrels and a simulation duration of 60 days.

Key findings include:

- Surface oiling above the 10 g/m² threshold was consistently transported northwest due to prevailing offshore currents.
- Summer scenarios produced larger surface oiling footprints, extending up to 1,500 km.
- No shoreline oiling above threshold levels was predicted.
- Water column oiling above 1,000 µg/L remained within 10 km of the release locations.

Deterministic Results

- Deterministic modelling provided detailed insights into the maximum concentrations and environmental fate of hydrocarbons under defined worst-case conditions. Outputs included:
- Maximum surface oil concentration.
- Maximum total hydrocarbon concentration (THC) in the water column.
- Mass balance of oil fate.
- Vertical cross-section views of subsurface oiling.

The mass balance analysis tracked the transformation of oil into various environmental compartments, including surface oil, evaporated oil, entrained oil, degraded oil and shoreline deposition. Notably, no shoreline oiling was predicted in any scenario.

The table below summarises the fate, trajectory and shoreline impact predictions for six worst-case scenarios. Key findings across all scenarios include:

- Evaporation was the dominant fate mechanism, accounting for 34% to 50% of the released oil.
- Degradation via photo-oxidation and biodegradation ranged from 10% to 28%.
- Surface oil remaining at the end of the 60-day simulation ranged from approximately 13% to 35%, influenced by seasonal and wind conditions.
- No shoreline oiling was predicted in any scenario.
- Oil exhibited dynamic movement between surface and subsurface compartments throughout the simulation period.

The deterministic modelling indicates that, under worst-case conditions, oil released from the PEL 82 License Area would remain offshore, with limited environmental exposure beyond the immediate vicinity of the release. These findings support the conclusion that the risk of shoreline contamination and widespread ecological impact is low, assuming appropriate spill response measures are in place.

TABLE 9-2 SUMMARY OF WORST-CASE DETERMINISTIC MODELLING RESULTS

ID	Location	Season	Total Oil Released (bbl)	Fate Summary	Trajectory	Shoreline Impacts
1	Gemsbok	Summer	560,040	~37% evaporated, ~21% degraded, ~30% remained on surface	Surface oil transported ~350 km NW; water column oil within 50 km NW	None
2	Gemsbok	Winter	560,040	~34% evaporated, ~28% degraded, ~24% remained on surface	Surface oil transported ~175 km NW; water column oil within 50 km NW	None
3	Potential second Well/ Sable	Summer	560,040	~40% evaporated, ~18% degraded, ~35% remained on surface	Surface oil transported ~500 km NW; water column oil within 25 km NW	None
4	Potential second Well/ Sable	Winter	560,040	~35% evaporated, ~28% degraded, ~20% remained on surface	Surface oil transported ~175 km WNW; water column oil within 50 km NW	None
5	Shallow Well	Summer	560,040	~50% evaporated, ~10% degraded, ~27% remained on surface	Surface oil transported ~350 km NW; water column oil within 25 km N	None
6	Shallow Well	Winter	560,040	~50% evaporated, ~15% degraded, ~13% remained on surface	Surface oil transported ~300 km NW/W; water column oil within 15 km W	None

Note: These results reflect the final distribution of oil at the end of the 60-day simulation and do not represent peak concentrations during the simulation period.

Source: RPS Ocean Science, 2025

9.1.1.3 POTENTIAL IMPACT ON MARINE FAUNA

Impact Description

Although the likelihood is low, a significant oil release can occur in the event of well control loss or a blow-out. The primary environmental risk associated with offshore drilling operations is the potential for a substantial crude oil spill resulting from either a blow-out or well control failure. A blow-out refers to the uncontrolled discharge of crude oil and/or natural gas from a well after the failure of pressure control systems.

The drilling contractor will work to ensure that the potential drilling campaign adheres to recognized international industry standards and Best Available Techniques (BAT). CNEL, as a member of OSRL, benefits from access to specialized expertise, equipment, wildlife response resources and the global dispersant stockpile. In the event of a blow-out, CNEL will have access to a compatible capping stack for the installed wellhead. These capping stacks are engineered to contain uncontrolled subsea wells and are strategically positioned worldwide for rapid deployment and transport by sea should an incident arise, thereby significantly minimizing the duration of any spill. The primary capping stack, a 10K unit, is housed at OSRL's Saldanha Bay Base in South Africa and is available for global mobilisation.

In the event of a sub-sea loss of containment event, a number of critical resources would be mobilised to the location. These include debris removal, stabilization and monitoring equipment subsea dispersant injection kit, and the capping stack. The capping stack allows for the safe capture and/or closure of the oil flow. Before its arrival, a Remotely Operated Vehicle (ROV) inspects the seabed, removes debris and prepares the wellhead.

Additional project controls include the development and implementation of a Shipboard Oil Pollution Emergency Plan (SOPEP), Oil Spill Contingency Plan (OSCP) and Well Source Control Contingency Plan (SCCP).

The release of oil into the marine environment would have an immediate and direct effect on water quality and detrimental effects on marine fauna. These could range from mortality (due to toxicity or suffocation) to sub-lethal physiological damage and long-term effects including disruption of behavioural mechanisms, reduced tolerance to stress and incorporation of carcinogens into the food chain (Beyer et al. 2016).

Impact Assessment

This assessment examines the potential environmental impacts of hydrocarbon spills on marine fauna using oil spill modelling results (Section 9.1.1.1 and Appendix E) and relevant scientific literature. The analysis incorporates both stochastic and deterministic modelling outputs for six well loss of containment scenarios within the PEL 82 license area, offshore Namibia.

Oil released into the marine environment can create acute and chronic risks to marine organisms. The extent of impact depends on the oil's physical and chemical characteristics, prevailing environmental conditions (e.g., wind, currents, sea state) and biological factors such as species sensitivity, life stage and exposure duration.

Upon release, oil undergoes various weathering processes, including evaporation, dispersion, emulsification, dissolution, oxidation, sedimentation and biodegradation. These processes influence the distribution and persistence of contamination. Approximately 40% of surface oil is lost due to weathering (McNutt et al., 2012), while residual fractions may persist in the environment.

Marine fauna may encounter hydrocarbons through:

- Inhalation of volatile compounds (e.g., benzene, toluene);
- Ingestion of contaminated prey or sediments;
- Dermal contact, especially among surface-dwelling species;
- Bioaccumulation and trophic transfer of PAHs and other compounds.

Potential Impacts on Plankton and Pelagic Fish

Phytoplankton and zooplankton demonstrate varying sensitivities to oil exposure. Some species may show reduced productivity or growth, while others could increase in abundance. Copepods and other zooplankton can experience lower reproductive success and may ingest emulsified oil droplets, resulting in bioaccumulation and possible transfer to higher trophic levels.

Pelagic fish embryos and larvae are susceptible to PAHs, with reported effects including pericardial oedema, craniofacial malformations and impaired cardiovascular development (Incardona et al., 2014; Esbaugh et al., 2016). These effects may affect recruitment, particularly if spills coincide with spawning periods for species such as kingklip, squid, hake, anchovy and pilchard.

Potential Impacts on Benthic Invertebrates

Oil may reach the seabed via subsurface plumes, marine snow, or sediment aggregation. Effects on benthic fauna include changes in abundance and diversity, particularly among soft-bottom communities. Some infauna may tolerate or exploit oiled sediments; however, long-term exposure can alter community structure and function.

Sessile and motile invertebrates (e.g., mussels, crustaceans) may be exposed to direct oiling and ingestion of hydrocarbons. Larval stages are generally more sensitive than adults and filter-feeders face elevated risk due to their feeding mechanisms.

Potential Impacts on Seabirds

Seabirds can be affected by oil spills, especially diving species that frequent the water's surface. Oil damages plumage, reducing buoyancy and insulation, which may lead to hypothermia, drowning, or mortality. Ingestion during preening can cause internal toxicity and affect reproduction, development and survival. Even small amounts of oil transferred to eggs can result in embryo loss.

Potential Impacts on Sea Turtles

Sea turtles may be exposed through inhalation, ingestion, or dermal contact. Hatchlings face greater risk and oiling may impact recruitment rates. Turtles feeding in convergence zones may encounter concentrated oil. Direct contact can affect movement and thermoregulation, potentially leading to increased mortality.

Potential Impacts on Marine Mammals

Pinnipeds (e.g., seals) may experience hypothermia due to fur contamination. Cetaceans are less affected by dermal exposure but might inhale volatile compounds, which can lead to respiratory and neurological effects. Coastal odontocetes with strong site fidelity may be at higher risk compared to wide-ranging offshore species.

Modelling Results

Oil spill modelling for the PEL 82 license area suggests that, in all six scenarios, oil would drift offshore in a north-westerly direction, with no shoreline oiling anticipated. Stochastic modelling indicates surface oiling above the 10 g/m² threshold could extend up to 1,500 km during summer, while water column oiling above 1,000 µg/L remains within 10 km of the release sites. Deterministic modelling shows evaporation as the primary fate mechanism (34–50%), degradation accounting for 10–28% and residual surface oil ranging from 13–35% after 60 days. Oil exhibits movement between surface and subsurface layers but remains offshore, indicating low risk of shoreline contamination and widespread ecological impact, assuming appropriate spill response actions are taken.

In the event of a well loss of containment, the magnitude of a major spill is considered large due to high toxicity and ecological disruption, along with potential long-term and widespread effects. Before mitigation, potential impacts on marine fauna are considered catastrophic; after best practice measures (like source control and capping stack deployment), impacts may be reduced to severe but cannot go lower and are deemed As Low As Reasonably Practicable (ALARP). Although well loss of containment events are highly unlikely, their potential impact requires robust prevention and response plans (Table 9-3).

Mitigation

Recommended mitigation measures to reduce impacts related to a major oil spill are presented below.

- As far as possible, schedule drilling operations to align with periods of favourable weather and sea state and always within the drilling unit's safe working weather limits. Modelling results suggest that Summer (November – April) present the worst-case conditions in terms of spill extent, however no shoreline oiling was predicted in any of the modelled seasons. In the case of exploration wells drilled in a sequence covering this period, response needs to be enhanced.
- Develop a well-specific response strategy and plans (OSCP and SCCP), aligned with the National OSCP (Oil Spill Contingency Plan), for each well location that identifies the resources and response required to minimise the risk and potential impact of oiling. Note that oil spill modelling undertaken for this study predicts no shoreline oiling will occur. This response strategy and associated plans must take cognisance to the local oceanographic and meteorological seasonal conditions, local environmental receptors and local spill response resources.
- The development of the site-specific response strategy and plans must include the following:
  - Assessment of onshore and offshore response resources (equipment and people) and capabilities at time of drilling, location of such resources (in-country or international) and associated mobilisation / response timeframes.
  - Selection of response strategies that reduce the mobilisation / response timeframes as far as is practicable. Use the best combination of local and international resources to facilitate the fastest response.

- ◦ Should there be any significant changes in the existing modelling input data closer to the spud date of the well, update the modelling report taking into consideration site- and temporal-specific information, the planned response strategy and associated resources.
- ◦ Develop intervention plans for the most sensitive areas to minimise risks and potential impacts and integrate these into the well-specific response strategy and associated plans.

- If modelling and intervention planning indicates that the well-specific response strategy and plans cannot reduce the response times to less than the time it would take oil to disperse, additional proactive measures must be committed to. For example:
  - ◦ Implement measures to reduce surface response times (e.g. pre-mobilise a portion of the dispersant stock on the support vessels, contract additional response vessels and aircrafts, minimise the time it takes to install the subsea dispersant injection (SSDI) kit by ensuring there is a kit on standby, improve dispersant spray capability, etc.).
  - ◦ Deploy and/or pre-mobilise shoreline response equipment (e.g. response trailers, shoreline flushing equipment, shoreline skimmers, storage tanks, shoreline booms, skirt booms, shore sealing booms, etc.) to key localities for the full duration of drilling operation phase to proactively protect sensitive coastal habitats and areas.
  - ◦ Include wildlife response in collaboration with specialist wildlife response organisations with experience in oiled wildlife response as part of the OSCP.
  - ◦ Schedule joint oil spill exercises including the operator and local departments / organisations to test the Tier 1, 2 & 3 responses.
  - ◦ Check contract arrangements and service agreements are in place to implement the SCCP, e.g. capping stack, SSDI kit, surface response equipment (e.g. booms, dispersant spraying system, skimmers, etc.), dispersants, response vessels, etc.
  - ◦ Use low toxicity dispersants that rapidly dilute to concentrations below most acute toxicity thresholds. Dispersants should be used cautiously and only with the permission of MFMR.
  - ◦ Contracted support vessels will be equipped for dispersant spraying and can be used for mechanical dispersion (using the propellers of the ship and/or firefighting equipment). It should have at least 5 m3 of dispersant onboard for initial response.
  - ◦ As far as possible, and whenever the sea state permits, attempt to control and contain the spill at sea with suitable recovery techniques to reduce the spatial and temporal impact of the spill.
  - ◦ In the event of a spill, use drifter buoys and satellite-borne Synthetic Aperture Radar-based (SAR) oil pollution monitoring to track the behaviour and size of the spill and optimise available response resources.
  - ◦ Submit all forms of financial insurance and assurances to MIME to manage all damages and compensation requirements in the event of an unplanned pollution event.

TABLE 9-3 POTENTIAL IMPACT RATING FOR POTENTIAL IMPACT ON MARINE FAUNA DUE TO MAJOR SPILL FOLLOWING A WELL BLOW-OUT

Criteria	Without Mitigation	With Mitigation
Type	Direct	Direct
Extent	National/ International	Inter-regional
Duration	Long term (10 to 20 years)	Medium (5 to 10 years)
Magnitude	Large	Medium
Probability	Remote	Unlikely
Reversibility	Partial	Partial
Sensitivity	High	High
Confidence	High	High
Significance	Catastrophic	Severe

9.1.1.4 POTENTIAL IMPACT ON COMMERCIAL FISHING

Impact Description

As detailed in Section 9.1.1.3, well loss of containment events are recognized as major unplanned incidents within offshore drilling operations, with the potential to cause hydrocarbon releases, fires or explosions, risks to personnel and adverse environmental impacts. The likelihood of a well loss of containment events occurring during deepwater exploration activities is estimated at approximately 0.035% per well drilled, which corresponds to a seldom likelihood classification (SINTEF, 2022).

According to the project description (refer to Section 3), the drilling contractor will ensure full compliance with established international industry standards and BAT. CNEL's membership in OSRL provides access to advanced technical expertise, equipment, wildlife response resources and the global dispersant stockpile. In the event of a well loss of containment event, CNEL can deploy a compatible capping stack appropriate for the installed wellhead. These capping stacks, designed to control uncontrolled subsea wells, are strategically located worldwide for rapid deployment and maritime transport in the case of an incident, thereby substantially reducing spill duration. The primary capping stack, rated for 10,000 psi, is stored at OSRL's Saldanha Bay Base in South Africa and is available for global mobilisation.

Should a subsea loss of containment occur, essential resources such as debris removal, stabilisation and monitoring equipment, as well as the capping stack, would be mobilised to the affected site. The capping stack facilitates the safe capture and/or cessation of oil flow. Prior to its installation, a ROV conducts seabed inspection, debris clearance and prepares the wellhead accordingly.

Further project controls include the preparation and implementation of a SOPEP and SCCP.

Impact Assessment

The release of diesel, hydraulic fluid, or oil into the marine environment may directly affect water quality and potentially impact marine organisms. Potential consequences include mortality due to toxicity or suffocation, physiological changes and longer-term effects such as altered behavioural mechanisms, reduced stress tolerance (Thomson et al. 2000). If a spill reaches the coastline, sensitive coastal habitats could be covered by contaminants and susceptible species which are part of the food chain could potentially concentrate carcinogenic PAHs. Spills occurring at offshore drilling units are generally more difficult to contain and disperse more widely but are less likely to reach the shore because of their location.

Modelling results (refer to Section 9.1.1.1 and Appendix E) indicate that an unplanned, large-scale release of 30 days could cause significant offshore oil contamination. However, prevailing wind and current patterns in the region suggest that oil contamination is unlikely to extend inshore of the 500 m depth contour and no modelled scenarios resulted in shoreline oiling regardless of season. The primary surface water contamination was oriented northwest of the release point, with hydrocarbon concentrations remaining near the spill site.

The Area of Influence was defined by oil spill modelling results. To assess national and transboundary impacts, the potential contamination area of fishing grounds was evaluated based on various spill probability footprints (refer to Table 9-4). Below is a summary of the oil spill modelling outcomes for the project, indicating the seasonal scenarios with the greatest likelihood of surface oil presence, both without and with response measures, particularly during the summer season at the second well location.

TABLE 9-4 ESTIMATED OIL SPILL CONTAMINATION AREA (KM^2) FOR FISHING GROUNDS, BASED ON STOCHASTIC MODELLING FROM THE SECOND WELL RELEASE POSITION DURING SUMMER

Sector	Oil Spill Contamination	Probability of Surface Oiling			
Namibia		1%	10%	50%	90%
Large Pelagic Longline	Contaminated surface area of fishing ground (km^2)	135115	75789	8925	1271
	Proportion of total fishing grounds	16.6%	9.3%	1.1%	0.2%
Small Pelagic Purse-Seine	Contaminated surface area of fishing ground (km^2)	640	-	-	-
	Proportion of total fishing grounds	1.3%	-	-	-
Midwater Trawl	Contaminated surface area of fishing ground (km^2)	5218	798	318	-
	Proportion of total fishing grounds	8.4%	1.3%	0.5%	-
Demersal Trawl	Contaminated surface area of fishing ground (km^2)	11703	799	-	-
	Proportion of total fishing grounds	15.3%	1.0%	-	-
Demersal Longline	Contaminated surface area of fishing ground (km^2)	3038	-	-	-
	Proportion of total fishing grounds	6.6%	-	-	-
Tuna Pole-Line	Contaminated surface area of fishing ground (km^2)	1941**	-	-	-
	Proportion of total fishing grounds	8.5%	-	-	-
Linefish	Contaminated surface area of fishing ground (km^2)	-	-	-	-
	Proportion of total fishing grounds	-	-	-	-
Deep-sea Crab	Contaminated surface area of fishing ground (km^2)	16181	5763	717	79
	Proportion of total fishing grounds	46.9%	16.7%	2.1%	0.2%
Deep-water Trawl	Contaminated surface area of fishing ground (km^2)	8336	2088	79	-
	Proportion of total fishing grounds	21.8%	5.5%	0.2%	-
Rock Lobster	Contaminated surface area of fishing ground (km^2)	-	-	-	-

Sector	Oil Spill Contamination	Probability of Surface Oiling			
	Proportion of total fishing grounds	-	-	-	-

Note: Dash indicated the threshold is not met ** outside EEZ (Frio Ridge Seamount)

Operators avoid polluted areas that impact fishing gear and cooling systems. If a large-scale blow-out occurs, there is a 50% chance surface water contamination will reach certain fishing sectors: deep-sea crab (2.1%), large pelagic longline (1.1%), midwater trawl (0.5%) and deep-water trawl (0.2%, currently closed). Demersal trawl has a 10% risk (1.0%), while small pelagic purse-seine (1.3%), demersal longline (6.6%) and tuna pole-line (8.5%) face a 1% risk. Linefish and rock lobster grounds are not expected to be contaminated.

Spawning areas for major commercial fish mainly lie inshore of PEL 82, with some overlap for hake, monkfish and orange roughy. Plankton levels are expected to be low within the license area, but spawn products like eggs and larvae will drift throughout. Since these originate from various sources, they are likely to be widely dispersed and not significantly affect fishery recruitment.

None of the simulations indicated oil would reach closed fishing areas meant to protect nursery habitats for various fish species. Juvenile fin fish use these nurseries from November to March before migrating; small pelagic species move south and hake migrate offshore and deeper. A major contamination event at the drilling site could severely affect small pelagic fisheries, especially if it occurs during larval peak seasons, leading to egg and larvae mortality and impacting local commercial fisheries over several years. Recruitment impacts on anchovy, sardine and hake may be staggered due to their life cycles. Modelling suggests no oil contamination risk for the mariculture sector as the coastline is unaffected.

Large scale effects would also be likely to include area closures and exclusion of fisheries from areas that may be polluted or closed to fishing due to contamination of sea water by the oil or the chemicals used for cleaning oil spills. Operators of fishing vessels would also avoid areas of large-scale contamination. Not only is it likely that fishery resources would move out of an area, but operators also avoid polluted areas that contaminate fishing gear and affect cooling water intake systems. Check contract arrangements and service agreements are in place for:

- Capping stack (e.g. in Saldanha Bay and international locations).
- SSDI kit and surface response equipment.
- Dispersants and response vessels.
- Use low-toxicity dispersants that dilute rapidly and only with MFMR approval.

Table 9-5 shows the impact ratings on all fisheries combined of the potential effects of a large scale oil spill.

Assuming the worst-case scenario, the potential impact of a blow-out of hydrocarbons would likely persist over the short term, with the extent ranging from local to regional, dependent on the fishing sector. The impacts of a blow-out can therefore be expected to be of medium magnitude and the sensitivity of the fisheries sectors is rated as medium (limited capacity to adapt/recover). In the event of a major oil spill, the impact on fisheries before mitigation are thus considered to be of major significance. With the implementation of best management practices, the residual impact could be reduced to minor significance.

Mitigation

- Develop well-specific Source Control Contingency Plans (SCCP), including oil wildlife response actions, aligned with the National OSCP (Oil Spill Contingency Plan). Tailor plans to local oceanographic and meteorological conditions, environmental receptors and spill response resources.

- Assess onshore and offshore response resources (equipment and personnel), their location (local/international) and mobilization timeframes.
- Select response strategies that minimise mobilisation time, using the best combination of local and international.
- Develop intervention plans for sensitive areas and integrate these into the response strategy.
- Tailor plans to local oceanographic and meteorological conditions, environmental receptors and spill response resources.
- Conduct well-specific oil spill modelling using site- and time-specific data.
- If response time cannot prevent shoreline oiling, commit to additional proactive measures including:
  - Pre-mobilising dispersant stock on support vessels.
  - Contracting additional response vessels and aircraft.
  - Ensuring SSDI kit is on standby and rapidly deployable.
  - Improving dispersant spray capability.
  - Schedule joint oil spill exercises to test Tier 1, and 3 responses.
  - Maintain a support vessel within proximity of the drilling unit, equipped for:
  - Dispersant spraying.
  - Mechanical dispersion (via propellers or firefighting equipment).
  - Carrying at least 4 m^3 of dispersant onboard.
  - Control and contain spills at sea using recovery techniques, when sea state permits.
  - Use drifter buoys and SAR-based satellite monitoring to track spill behaviour and optimise response.

Establish a functional grievance mechanism:

- Inform stakeholders of the process.
- Mobilise resources for grievance resolution.
- Follow the Grievance Management Procedure.
- Check contract arrangements and service agreements are in place for:
- Capping stack (e.g. in Saldanha Bay and international locations).
- SSDI kit and surface response equipment.
- Dispersants and response vessels.
- Use low-toxicity dispersants that dilute rapidly and only with MFMR approval.

TABLE 9-5 IMPACT RATING FOR POTENTIAL IMPACT ON COMMERCIAL FISHING FROM MAJOR SPILL FOLLOWING A POTENTIAL WELL LOSS OF CONTAINMENT

Criteria	Without Mitigation	With Mitigation
Type	Direct	Direct
Extent	Local and Regional	Local
Duration	Short to Medium-term	Short-term
Magnitude	Medium	Small

Criteria	Without Mitigation	With Mitigation
Probability	Likely	Likely
Reversibility	Fully Reversible	Fully Reversible
Sensitivity	Medium	Medium
Confidence	High	High
Significance	Major	Minor

9.1.1.5 IMPACT ON COMMUNITIES (SOCIO-ECONOMIC)

Impact Description

There are several possible direct and secondary impacts of hydrocarbon spills on fisheries:

- Contamination of Product: Oil spills in marine environments can lead to the contamination of fish and seafood products. Fish exposed to oil spills may absorb toxic substances, such as polycyclic aromatic hydrocarbons (PAHs), which can accumulate in their tissues (Gracia et al. 2020). This contamination poses significant risks to human health if contaminated fish are consumed. Studies have shown that PAHs can cause various health issues, including carcinogenic effects and reproductive toxicity (Short, 2017; Sandifer *et al.*, 2021). Furthermore, the presence of oil residues can render fish visually unappealing and unsuitable for sale, leading to financial losses for fishing operations (Pascoe and Innes, 2018).
- Avoidance of Contaminated Fishing Areas: Impacts on fisheries livelihoods from oil spills have included periodic closure of fishing grounds for clean-up and rejuvenation, long-term displacement from fishing areas to minimise pollution effects, lost jobs and unemployment and lost seafood markets and revenues (Levy and Gopalakrishnan, 2010; Watts and Zalik, 2020). Following an oil spill, fishing vessels may avoid areas affected by contamination to prevent the capture of contaminated fish and ensure product safety (Gracia et al. 2020; Andrews, N. et al. 2021). This avoidance behaviour can disrupt fishing operations, as vessels may need to relocate to alternative fishing grounds, resulting in increased fuel costs and reduced catch efficiency (Gracia et al. 2020). Studies have documented the displacement of fishing activities away from oil-affected areas following major spills, such as the Deepwater Horizon oil spill in the Gulf of Mexico (Pascoe and Innes, 2018; Andrews, N. et al. 2021). Avoidance of contaminated areas may also lead to competition among fishing vessels for access to unaffected fishing grounds, exacerbating resource conflicts and management challenges. Additionally, fish species have been shown to avoid areas contaminated with PAHs (Schlenker *et al.*, 2019).
- Loss of Marketable Product: In cases where fish are exposed to oil spills and subsequently captured by fishing operations, there is a risk of product rejection due to contamination. Fish contaminated with oil residues may fail to meet quality standards set by regulatory agencies and seafood markets, resulting in the rejection of entire catch batches (Challenger and Mauseth, 2011; Gracia et al. 2020). This rejection not only leads to financial losses for fishing operations but also undermines consumer confidence in seafood products sourced from affected regions. Studies have shown that seafood market demand can decline significantly in the aftermath of oil spills, particularly in regions directly impacted by contamination (Challenger and Mauseth, 2011; Gracia et al. 2020).

Loss of market access can have long-term economic consequences for fishing communities reliant on seafood trade.

- Indirect Impact on Fisheries from Contamination: The introduction of oil into marine ecosystems can lead to a range of adverse effects on phytoplankton. Petrogenic carbon may contain toxic compounds such as PAHs and heavy metals, which can inhibit photosynthesis, disrupt cellular processes and impair growth and reproduction in phytoplankton species (Quigg *et al.*, 2021; Gracia et al. 2020; Tang *et al.*, 2019). Additionally, the physical presence of oil slicks can block sunlight, thereby reducing light availability for photosynthesis and further suppressing phytoplankton productivity (Quigg *et al.*, 2021; Gracia et al. 2020; Tang *et al.*, 2019). The reduced productivity is likely to lead to reduced productivity on higher trophic levels, such as economically important fish species.

Secondary impacts on fisheries will lead to socio-economic impacts on communities that rely on the local fisheries sector for employment and income.

Impact Assessment

Indirect impacts on fisheries resulting from a major spill may include contamination, loss of marketable product and loss of fishing grounds, all of which can lead to socio-economic consequences for affected communities. Individuals involved in fishing could experience job loss or financial setbacks if activities in the project area become unviable.

Modelling (refer to Section 9.1.1.1 and Appendix E) indicates that an unplanned, large-scale well loss of containment events lasting 30 days may cause extensive offshore oil contamination. This scenario would necessitate the closure of fishing areas due to both oil and chemical contaminants associated with remediation efforts. Sectors most susceptible to such impacts, as indicated by modelling, include deep-sea crab, large pelagic longline, midwater trawl and deep-water trawl operations. Fishing activities may need to relocate to unaffected areas, and contaminated gear and equipment would require thorough cleaning or replacement. Contaminated catches would not be eligible for sale.

Furthermore, fish stock numbers, distribution, and breeding habitats may be adversely affected by oil spill contamination, potentially leading to decreased yields. The overall impact magnitude on commercial fisheries and community socio-economics is assessed as <u>medium</u>, with the affected fisheries exhibiting a <u>medium</u> sensitivity and limited ability to adapt or recover. Consequently, prior to mitigation, a major impact on certain fisheries sectors can be anticipated. Implementation of mitigation measures may reduce the residual impact significance to minor (refer to Table 9-6).

Mitigation

The same mitigation measures described in Section 9.1.1.4 should be implemented to reduce the potential impact significance for major spills on communities.

TABLE 9-6 IMPACT RATING FOR POTENTIAL IMPACT ON COMMUNITIES DUE TO MAJOR SPILL FOLLOWING A POTENTIAL WELL LOSS OF CONTAINMENT

Criteria	Without Mitigation	With Mitigation
Type	Indirect	Indirect

Criteria	Without Mitigation	With Mitigation
Extent	Local	Local
Duration	Medium-term	Medium-term
Magnitude	Medium	Small
Probability	Likely	Likely
Reversibility	Fully Reversible	Fully Reversible
Sensitivity	Medium	Medium
Confidence	High	High
Significance	Major	Minor

9.1.2 VESSEL COLLISIONS

Impact Description

Local and international shipping traffic is expected to pass near the project area, as noted in Section 4. An increase in vessel activity related to the project may raise the probability of collisions, which could present health and safety concerns for coastal communities. Collisions may involve large-scale commercial marine vessels as well as smaller vessels used for fishing, aquaculture, tourism, or recreation.

Vessel collisions can result from various factors, including human error, environmental conditions and mechanical issues. Inadequate navigation practices, such as poor communication between vessels or failure to follow safety protocols, may contribute to collision risks. Adverse weather, including strong winds, reduced visibility due to fog, or rough seas, can also impact crew response. Mechanical problems with engines or rudders, as well as vessel overloading or improper loading that affects stability, are additional considerations.

During the CNEL offshore exploration campaign in PEL 82, the drilling unit will be serviced by up to four support vessels operating two to three rotations per week over a 90-day drilling period. While these operations are routine, collision risk between support vessels and the drillship remains an important safety factor. Industry data and historical offshore incident records estimate the overall frequency of a moderate to severe collision at 1.0×10^{-4} per vessel visit, classified as seldom. Mitigation measures include dynamic positioning systems, pre-drill navigational surveys, real-time vessel tracking and strict compliance with Chevron's marine safety protocols, all aimed at reducing collision probability and improving incident response preparedness.

Feedback from Stakeholders

The representative from MFMR did not specifically raise concerns about vessel collisions. It was noted that those involved in the fishing industry are often to most sensitive to impact from oil and gas exploration activities. However, these impacts tend to be associated with environmental change rather than accidental events.

Impact Assessment

In the unlikely event of a vessel collision, serious injuries or fatalities may occur, particularly if crew members are thrown overboard, trapped within the vessel, or struck by falling equipment and debris. The nature and severity of these outcomes depend on the type of collision, whether frontal or lateral and the extent to which the vessel's structural integrity is compromised. This may include breaches to the hull, damage to the engine or rudder, or failure of critical systems.

The potential consequences are further influenced by the crew's ability to avoid both direct and indirect effects. Direct effects involve physical contact with the collision site, while indirect effects include forces that cause movement of objects, crew projection, or flooding. The assessment considers the hazard type, for example, collision or capsizing, the presence and readiness of health and safety measures, such as personal protective equipment and emergency protocols and organisational factors, such as safety culture and procedural compliance.

Strong adherence to safety protocols and operational procedures significantly reduces the likelihood of severe outcomes. Given the robust safety measures in place and the low probability of procedural deviation, referred to as "drifting behaviour", the significance of crew-related impacts is assessed as moderate but cannot go lower and are deemed ALARP (Table 9-7).

<u>Bio receptors</u>

In the unlikely event of a vessel collision, there is potential for the release of hazardous substances such as fuel, chemicals, ballast water, wastewater, or sewage. These discharges may alter water quality and sediment characteristics, thereby creating pathways for additional ecological impacts. The introduction of pollutants can result in both localised and widespread effects, ranging from sublethal stress to mortality among marine organisms. The nature and extent of these outcomes are influenced by the collision type (whether frontal or lateral) as each presents distinct consequences. The severity of the incident depends on the degree to which the vessel's structural integrity is compromised and the critical systems affected, which may or may not result in contaminant release. Notably, the release of diesel is considered one of the more probable scenarios, owing to vessels' reliance on diesel-powered engines. Damage to or rupture of fuel tanks may cause diesel to be discharged into the surrounding environment.

According to NOAA (2023), most diesel spilled on water will evaporate or disperse naturally within days or less, especially in incidents involving vessels with fuel tank capacities between 500 and 5,000 gallons (1,892.7 to 18,924.1 litres). This rapid dispersal helps to limit environmental impacts (NOAA, 2023). As project vessels typically have larger tank capacities, these figures represent potential spill volumes rather than total tank breaches; more severe consequences would follow a complete breach. Outcomes depend on timely incident response, management capacity and preparedness to implement emergency protocols. Response effectiveness varies based on collision type and structural compromise and may require external support should the crew be unable to initiate necessary procedures.

To address such risks, the following control measures have been established:

- Oil Spill Contingency Plan detailing scalable actions for various diesel release scenarios.

- Offshore training drills to assess staff and equipment response readiness for spillage events.
- Contractual arrangements to facilitate spill response, consistent with standard marine operational practices.
- Adherence to MARPOL Regulations regarding the Prevention of Pollution by Oil and Sewage from Ships.
- A permanent 500 m safety zone will be maintained during activities to reduce the risk of collisions at sea.

The risk of significant harm is considered severe, provided that safety protocols are correctly followed. While potential consequences are severe before mitigation, they are reduced to moderate, classified as ALARP, after applying further mitigation (Table 9-7). This assessment highlights the importance of strict adherence to procedures and effective spill response, especially for diesel, in minimizing impacts.

Mitigation

Recommended mitigation measures to reduce impacts related to vessels collisions are presented below.

- Information about installation operations will be shared with vessel operators through national communication channels, including notices and radio navigation warnings.
- Offshore training drills will assess the response readiness of all staff and equipment for a fuel or chemical spill event.
- Appropriate contracts will be established to facilitate a response to a release, as is routine for all marine vessel activities.
- Check adequate resources are provided to collect and transport oiled birds to a cleaning station as per specific protocols for capturing oiled and injured seabirds as outlined in the Wildlife Response Plan (to be created as part of the OSCP) and coordinated with SANCCOB (Contact Us - SANCCOB).
- Check offshore bunkering is not undertaken in the following circumstances:
  - Wind force and sea state conditions of ≥6 on the Beaufort Wind Scale;
  - During any workboat or mobilisation boat operations;
  - During helicopter operations;
  - During the transfer of in-sea equipment; and
  - At night or times of low visibility.

TABLE 9-7POTENTIAL IMPACT RATING FOR VESSELS COLLISIONS

Criteria	Without Mitigation	With Mitigation
Type	Direct	Direct
Extent	Local	Local
Duration	short term (3 months to 2 years)	short term (3 months to 2 years)
Magnitude	Medium	Small
Probability	Unlikely	Seldom

Criteria	Without Mitigation	With Mitigation
Reversibility	Partial	Partial
Sensitivity	High	High
Confidence	High	High
Significance	Severe	Moderate

9.1.3 HELICOPTER INCIDENTS

The project will utilise helicopters to transfer crew from the shore base to the drillship. This activity introduces a potential risk to community health and safety due to the possibility of helicopter-related incidents. Such risks are most relevant near the Port of Walvis Bay and coastal areas.

Helicopters are used for crew transfers between the shore base and the drillship, typically occurring two times per week and increasing to four times per week during drilling activities. These flights support crew changes, emergency procedures and logistical needs. To evaluate helicopter incident risk, an individual risk approach is applied, considering factors such as accident frequency per flight, the proportion of fatal accidents and the number of personnel involved. Based on historical data from the UK offshore sector, the individual risk per journey is calculated as follows:

$$IR = 1.7 \times 10^{-6} \times \text{flying time (hours)} + 2.7 \times 10^{-7} \times \text{number of flight stages per journey}$$

For a typical offshore trip involving one hour of flight and two flight stages, the individual risk is estimated at 2.24×10^{-6} per journey, classified as remote likelihood. Although the probability is low, the consequences of a helicopter incident can be significant; mitigation measures (such as compliance with international aviation safety standards, regular maintenance and preparedness drills) will be implemented.

No specific helicopter-related issues were brought up by the MFMR; however, fishing industry stakeholders expressed general sensitivity toward exploration activities, primarily regarding environmental impacts rather than accidental events. Helicopter risks were acknowledged within broader community safety considerations.

Historically, helicopter accidents have occurred in offshore oil and gas operations, particularly in the North Sea, sometimes resulting in injuries or fatalities. Beyond risks to occupants, helicopter accidents may lead to damage to the drillship during take-off, landing, or when the helicopter is on the helideck. However, the consequences of such incidents are assessed as Minor ALARP relative to other risk sources associated with drillship operations.

Mitigation

Below are key measures to reduce vessel collision impacts and ensure safe helicopter operations:

- Information about installation operations will be shared with vessel operators through national communication channels, including notices and radio navigation warnings.
- Offshore training drills will assess the response readiness of all staff and equipment for a fuel or chemical spill event.

- Appropriate contracts will be established to facilitate a response to a release, as is routine for all marine vessel activities.
- Follow all flight safety protocols and coordinate with local emergency services.
- Communicate flight schedules and routes in advance to the community.
- Monitor and report incidents publicly.
- Confirm helicopter airworthiness via a competent authority prior to hiring.
- Check pilots are trained on similar aircraft.
- Coordinate with air traffic control and the drillship.
- Restrict helicopter operations at night or during bad weather.
- Provide basic rescue and survival training for all helicopter passengers.
- Check personnel are adequately trained in both accident prevention and immediate response, and resources are available on each vessel.
- Use low toxicity dispersants cautiously and only with the approval of MFMR.
- As far as possible, and whenever the sea state permits, attempt to control and contain the spill at sea with suitable recovery techniques to reduce the spatial and temporal impact of the spill.
- Check adequate resources are provided to collect and transport oiled birds to a cleaning station as per specific protocols for capturing oiled and injured seabirds as outlined in the Wildlife Response Plan (to be created as part of the OSCP) and coordinated with SANCCOB (Contact Us - SANCCOB).
- Check offshore bunkering is not undertaken in the following circumstances:
- Wind force and sea state conditions of ≥6 on the Beaufort Wind Scale;
- During any workboat or mobilisation boat operations;
- During helicopter operations;
- During the transfer of in-sea equipment; and
- At night or times of low visibility.
- Provide basic rescue and survival training for all helicopter passengers.

10. ASSESSMENT OF CUMULATIVE IMPACTS

This section presents the assessment of the potential cumulative impacts of the potential project and other developments in the region. Cumulative impacts include those which result from combined impacts on areas of influence and/or resources from a potential project and any other past, present, or reasonably foreseeable future projects or activities in the same area of influence or which may impact on the same resources/receptors. Cumulative effects may be collectively significant despite the individual impacts of a project/activity being minor. The potential project and any future activities will have a cumulative impact on the receiving environments (physical and socio-economic).

It is difficult to predict cumulative effects as they entail the interaction of numerous projects and/or activities. The exact details of future planned activities are unknown; therefore, the assessment of cumulative impacts must be assessed qualitatively.

Currently various exploration activities have been undertaken or are planned across various PEL blocks. Without knowing which exploration activities may yield commercially viable results, it is difficult to predict where and when future oil and gas activity (ongoing exploration or production) may occur. The extent, duration and scale of these activities is also unknown. The methods used for the exploration, production and transport of petroleum products will also vary depending on the resource type, the area and the operator.

To effectively manage cumulative impacts, the project will need to cooperate with other operators in the area and government-level stakeholders. The project should implement mitigation measures that are proportionate to the contribution made to cumulative impacts.

Activities in the vicinity of the offshore component of the project area have the potential to cause cumulative impacts. The activities considered in assessing offshore cumulative impacts include:

- The oil and gas exploration activities in the vicinity of the project area;
- The offshore mining activities in the vicinity of the project area; and
- The shipping and fishing related traffic in the project area.

10.1 ENVIRONMENTAL IMPACTS

10.1.1 ATMOSPHERIC EMISSIONS

Atmospheric emissions associated with the project will primarily result from the combustion of fuel by vessels and helicopters involved in offshore activities. These emissions are expected to be intermittent, small in volume and localized within the immediate project area.

When considered cumulatively, the emissions from project-related activities are not expected to cause any significant deterioration in local air quality (refer to Section 7.1). In addition to project-specific sources, other vessels (such as commercial ships and fishing boats) may also contribute to air emissions in the area. However, due to the variability and unpredictability of this external marine traffic, their emissions cannot be reliably quantified.

Despite this uncertainty, there is no indication that the combined emissions from all marine traffic, including those associated with the project, would result in a meaningful decline in air quality or pose a risk to sensitive receptors. Therefore, the overall impact on air quality is assessed as Incidental and no specific mitigation measures are proposed.

10.1.1 WASTE GENERATION AND EFFLUENT DISCHARGE

The project's waste generation (including both liquid and solid waste, whether hazardous or not) will be localised, of small scale and limited in time. No other significant waste generators have been identified in the vicinity of the project area and the cumulative impacts linked to the generation and management of waste by other sea users is considered to be incidental.

10.1.2 MARINE ECOLOGY

Several project activities have the potential to impact marine ecology and have cumulative impacts, including:

- Seabed disturbance from drilling and discharges;
- Presence of residual cement or permanent infrastructure (following well abandonment) on the seabed; and
- Increased ambient noise.

As described in Section x, project impacts on marine ecology are expected to be predominantly minor and incidental with appropriate mitigation measures in place. These rating are due to the small area affected and the sensitivity of ecosystems.

Cumulative impacts on marine ecology from other exploration activities are expected to be limited as exploration wells disturb a small proportion of the seabed and therefore, a small proportion of the bioregions within the Namibian marine habitat. Additionally, most impacts on marine ecology from drilling are considered partially or fully reversible. As such, the total area being impacted at any one time will be small.

The presence of residual cement and other permanent abandoned infrastructure on the seabed may increase the amount of hard surface available for colonisation by benthic organisms. However, given that no oil and gas projects have moved the production in PEL 82, there will be limited permanent structures on the seabed in the project area. The project will not substantially increase the footprint of permanent abandoned infrastructure on the seabed. Additionally, the depths of the project are greater than 200 m making colonisation by invasive species unlikely.

The noise associated with drilling and increased vessel movements will have a cumulative impact on marine ecology, especially marine fauna through physical and/or physiological injury and behavioural disturbances. The appointed drilling contractor will ensure exploration activities conform to good international industry practice and Best Available Techniques (BAT) to minimise noise disturbance. Noise levels will return to ambient levels once drilling is completed. Overall, the cumulative impact on marine ecology is assessed as incidental in significance as no other drilling activities will be occurring in PEL 82 simultaneously with the project. No further mitigation is required, that has not already been considered.

10.2 SOCIAL IMPACTS

The oil and gas sector is remaining resilient in Namibia which has set the stage for future exploration and possible production activities. Within Namibia, around 20 exploration wells have been drilled to date, with an increase in drilling activity expected from 2025 onwards. It is anticipated that there will continue to be new opportunities for oil and gas exploration licensing within Namibian waters. Therefore, drilling may continue at a moderate pace. If more commercially viable discoveries of oil and gas deposits are made, drilling may intensify sand a significant increase on production activity is possible.

10.2.1 COMMERCIAL FISHERIES

If drilling activities increase and certain project enter production phases, impacts to commercial fisheries may be significant. If multiple exclusion zones are implemented within an area used by commercial fisheries or significant impacts to the marine environment occur there may be an associated loss of income for fisheries. Certain fisheries may no longer be economically viable if catch volumes decrease. However, the cumulative impact contribution of the project is expected to be minor significance during demobilization phase due to permanent exclusion to trawling around wellheads. No further mitigation is required, that has not already been considered.

10.2.2 ECONOMY AND EMPLOYMENT

Positive impacts associated with direct, indirect and induced employment, capacity enhancement and local and macro-economic development are likely to occur as a result of the project. If the project discovers commercially viable deposits that can be developed into production, this may encourage further exploration activities in the region from other developers. This stimulation of growth of the oil and gas sector would lead to an increase in job creation in Walvis Bay as well as other key coastal areas. Increase employment will lead to increased income and spending within the local economy as well as an increase in taxes paid to the national government. Overall higher incomes and spending will stimulate the local and regional economy through an increase in demand for goods and services. Given that the current project is not expected to contribute substantially to the local economy through employment and procurement, the cumulative impact on economy and employment is expected to be minor in significance. No further mitigation is required, that has not already been considered.

10.2.3 INTERFERENCE WITH SHIPPING AND NAVIGATION OF OTHER SEA USERS

The vessels taking part in the project activities will increase shipping traffic in the area, which could increase the risk of collision between vessels. However, very little information is available with respect to other ships that might be present in the project area during the period of the potential project. Offshore mining in Namibia is concentrated in the Orange basin, in the south of Namibia, bordering South Africa. Nonetheless, given the limited number of vessels involved in the exploratory drilling and the limited duration of the project, increased risk would not be expected to be significant and therefore the impact due to the interference with other sea users will be incidental. No mitigation measures are proposed as the impact is incidental.

11. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

This section presents the ESMP for the potential project, detailing how the mitigation measures identified in Sections 7 to 10 will be incorporated into the project design and subsequently implemented throughout the duration of the project.

The ESMP identifies actions required, assigns responsibilities and sets target dates for completion. The plan will be incorporated into the overall environmental and social management of the project. The plan will act as a “live” document to track progress through to completion of the potential project The plan also provides a mechanism for monitoring the environmental performance of the contractor, and where required instigating further remedial action as required.

11.1 SCOPE AND OBJECTIVES

The ESMP for the potential project serves as a practical tool to ensure that all environmental and social commitments identified in the impact assessment chapters are effectively implemented throughout the project phases of the drilling campaign. Its main objectives are to:

- Provide a structured mechanism to ensure full compliance with Namibian environmental legislation, CNEL’s HSE policies, international standards, and recognized best practices in the offshore oil and gas industry.
- Translate the mitigation and management measures identified in the ESIA into actionable steps during the mobilisation, exploration, and demobilisation phases of the project.
- Establish a framework to identify and manage any unexpected environmental or social impacts that may arise during the project phases.
- Evaluate the effectiveness of implemented mitigation measures and adapt them as necessary. This includes modifying existing measures or introducing new ones to ensure continuous improvement and risk reduction.
- Set up monitoring and record-keeping systems to gather additional environmental and social data during the project execution. This helps validate the ESIA findings and supports transparent reporting and decision-making.

The ESMP also plays a strategic role in supporting the long-term success and sustainability of the exploration drilling project. Its broader objectives include:

- Ensuring that health, safety, environmental, and social (HSES) considerations are embedded in the project’s risk management and business planning processes.
- Coordinating and optimizing environmental, health, and social activities across all phases of the project to enhance efficiency, reduce duplication, and add value.
- Encouraging all employees and contractors to uphold the highest standards of environmental protection and safety performance through training, accountability, and leadership.
- Providing a consistent framework for planning, implementation, auditing, and continuous improvement of environmental and social performance.

- project leadership to identify, prioritize, and address key environmental and social issues proactively throughout the project lifecycle.

11.2 OVERVIEW OF THE ACTIVITY BEING CONSIDERED

CNEL is considering offshore exploration well drilling in Petroleum Exploration License Area 82 (PEL 82), covering Blocks 2112B and 2212A, located 72 to 300 km offshore in the Walvis Basin in water depths of 200 to 2,500 m (Figure 1-1). Activities may include up to 5 exploration wells, 5 appraisal wells, Vertical Seismic Profiling (VSP), well testing, plugging and abandonment. The first well on the Gemsbok Prospect may be drilled in the 2026/2027 timeframe. These activities are part of a broader effort to understand whether there are commercially viable oil and gas resources in the area.

11.3 SUMMARY OF THE POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS

11.3.1 ACTIVITIES EXCLUDED FROM THE ASSESSMENT

The following activities were excluded from the assessment due to their potential negligible environmental or social effects impact:

- Air quality effects from vessels and exploration.
- Disturbance to marine fauna and seabirds from offshore artificial lighting.
- Seawater contamination and marine fauna impacts from drillship operations, support vessel discharges and well testing.
- Increased hard seabed surfaces from wellhead placement, residual cement discharge, and abandoned wellheads.
- Disturbance of seabed geology from drilling.
- Health, safety, and community concerns regarding interactions between foreign/migrant workers and local residents.
- Noise from helicopters affecting communities.
- Visual impact of the drillship.
- Traffic and transportation impacts from offshore and onshore operations, including supply movements and crew changes.
- Effects on tourism and recreation from support vessel and helicopter operations.
- Increase in onshore non-hazardous and hazardous waste disposal.
- Fresh water use for drinking by crew on all vessels.
- Pressure on local utilities and infrastructure from disposal of waste onshore.
- Potential introduction of invasive species via ballast water from international supply vessels.

11.3.2 SUMMARY OF POTENTIAL IMPACTS FROM PLANNED ACTIVITIES

Table 11-1 below presents a consolidated summary of the environmental and social impacts for the planned activities from the potential project.

TABLE 11-1 CONSOLIDATED SUMMARY OF THE POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS FOR PLANNED ACTIVITIES

Potential Impact	Activities	Initial Significance	Residual Significance
Climate Change	• Vessel / drill unit air emissions (Mobilisation, Operation, Decommissioning) • Operation of helicopters Mobilisation, Operation, Decommissioning) • Emergency flaring of gas and liquid hydrocarbons (Operation) if conducted.	Minor	Minor
Smothering and disturbance of benthic fauna on unconsolidated sediment	• Seabed disturbance from drilling (Operation) • Discharge of drill cuttings and mud and residual cement to the seabed (Operation) • Discharge of treated drill cuttings from the drill unit (Operation) • Sediment dislodging from ROV operation (Operation) • Discharge of residual cement to seabed (Demobilisation)	Moderate to Incidental	Minor to Incidental
Smothering and disturbance of benthic fauna on hard substrate	• Same as above	Minor to Incidental	Incidental
Bioaccumulation, toxicity and hypoxic effects on benthic fauna	• Discharge of drill cuttings and mud • Discharge of treated drill cuttings from the drilling unit	Moderate to Minor	Incidental
Bioaccumulation, toxicity and hypoxic effects on pelagic fauna	• Same as above	Incidental	Incidental
Potential behavioural disturbance of marine fauna	• Underwater noise from manoeuvring (Mobilisation, Operation, Decommissioning) • Underwater noise from dynamic positioning (Operation) • Underwater noise from drilling (Operation) • VSP impulsive underwater noise (Operation), if VSP is conducted • Helicopter atmospheric and underwater noise (Operation)	Minor	Incidental
Potential injury of marine fauna	• Underwater noise from vessel and drilling operations (Mobilisation, Operation, Decommissioning) • VSP impulsive underwater noise (Operation)	Minor	Incidental
Changes in catch due to behavioural change in fish due to noise	• Underwater noise from manoeuvring (Mobilisation, Operation, Decommissioning)	Minor	Incidental

Potential Impact	Activities	Initial Significance	Residual Significance
	• Underwater noise from dynamic positioning (Operation) • Underwater noise from drilling (Operation) • VSP impulsive underwater noise (Operation), if VSP is conducted • Helicopter atmospheric and underwater noise (Operation)		
Changes in catch due to drilling discharges	• Discharge of drill cuttings and mud and residual cement to the seabed (Operation) • Discharge of treated drill cuttings from the drill unit (Operation)	Minor	Minor
Displacement of fishing vessels and navigation	• Implementation of safety exclusion zone (Operation)	Minor	Minor
Marine traffic	• Increased vessel presence (Mobilisation, Operation, Decommissioning)	Minor	Incidental
Employment	• Direct and indirect job creation (Mobilisation, Operation, Decommissioning)	Minor Positive	Minor Positive
Local economy	• Spending in Walvis Bay, procurement (Mobilisation, Operation, Decommissioning)	Minor Positive	Minor Positive
Macro-economy	• Taxes, fees to government (Mobilisation, Operation, Decommissioning)	Minor Positive	Minor Positive

11.3.3 SUMMARY OF POTENTIAL IMPACTS FROM UNPLANNED EVENTS

Table 11-2 below presents a consolidated summary of the potential environmental and social impacts for the unplanned activities from the potential project.

TABLE 11-2 CONSOLIDATED SUMMARY OF THE POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS FOR UNPLANNED ACTIVITIES

Impact Category	Activities	Initial Significance	Residual Significance
Fisheries & marine fauna	• Well loss of containment (Operation)	Catastrophic	Severe (ALARP)
Commercial fishing	• Well loss of containment (Operation)	Moderate	Minor (ALARP)
Communities	• Well loss of containment (Operation)	Major	Minor (ALARP)
Health & safety	• Vessel collision (Mobilisation, Operation, Decommissioning)	Severe	Moderate (ALARP)
Health & safety	• Helicopter incidents	Minor	Minor (ALARP)

11.3.4 SUMMARY OF POTENTIAL CUMULATIVE IMPACTS

Table 11-3 below presents a consolidated summary of potential cumulative impacts from the potential project.

TABLE 11-3 CONSOLIDATED SUMMARY OF POTENTIAL CUMULATIVE IMPACTS

Impact Category	Significance Level
Atmospheric emissions	Incidental
Waste and effluent discharge	Incidental
Marine ecology	Incidental
Commercial fisheries	Minor
Economy and employment	Minor
Shipping and navigation	Incidental

11.4 SUPPORTING DOCUMENTATION / ACTIONS

This Section lists the plans / documents / Actions that will be prepared prior to the start of any activities for this project, in accordance with Chevron's Operational Excellence Management System.

11.4.1 WELL DRILLING DESIGN

CNEL will complete the well drilling design in line with relevant policies and standards, covering location, depth, architecture, fluids, treatment, abandonment plans and logistics. All details will be compiled into a Permit to Drill notification, submitted to MIME at least 30 days before mobilisation.

11.4.2 CONTRACTOR HSE PLAN

The Contractor HSE Plan will present the HSE requirements that applies to the specified project and will be developed in accordance with Chevron's Operational Excellence Management System. It describes the operational details, equipment used, and considerations related to environmental, socio-economic, and health factors, as well as the organisational structure supporting the project (such as objectives, resources, documentation, risk management, and control). This document also includes procedures for managing air emissions, discharges to the sea, waste, spills, and associated log books. All personnel and sub-contractors must adhere to this plan while working on the project.

11.4.3 CONTRACTOR PROJECT HSE PLAN

The drilling contractor will develop a Contractor Project HSE Plan detailing the management of all health and safety risks, major incident controls, and conformance with Namibian regulations, including the provision of a rig safety case.

Additionally, the drilling contractor will prepare an HSE-MS Bridging Document in collaboration with their sub-contractors. This document will establish key procedures to ensure effective integration of the various companies' HSE management systems involved in project execution, both at the worksite and throughout the supply chain.

11.4.4 CONTRACTOR KICK-OFF MEETING AND CREW AWARENESS

The Contractor Kick-Off Meeting aims to introduce the team, review the project background, identify key environmental and social sensitivities, discuss risk mitigation, and establish efficient work methods. Before operations begin, an on-board representative or contractor will conduct HSE awareness training for all project personnel, covering the HSE system, emergency procedures, spill management, and project-specific requirements. Contractors are responsible for providing this HSE information to new staff and suppliers after the initial session.

11.4.5 COMMITMENTS REGISTER SECTION

Section 11.12 details the specific management commitments that will be implemented during all project phases (planning, mobilisation, operation and demobilisation) to prevent, minimise or manage significant potential negative impacts and optimise and maximise any potential benefits of the project.

11.4.6 PLANS AND PROCEDURES

This ESMP will form part of an overall Operational Excellence Management System (OEMS) which will be prepared before the start of the exploration campaign. It will include the documents listed below and will include all of the project controls and mitigation measures detailed in the Commitments Register (refer to Section 11.12).

11.4.6.1 EMERGENCY MANAGEMENT PLAN

The objective of an Emergency Management Plan (EMP) is to be prepared to respond to accidental and emergency situations in a manner appropriate to the operational risks, and to prevent their potential negative consequences. The ERP will apply to each stage of the project lifecycle (mobilisation, drilling and demobilisation) and commensurate with the potential risks and impacts identified in the ESIA Report.

11.4.6.2 OIL SPILL CONTINGENCY PLAN

Project specific Oil Spill Contingency Plan (OSCP) will be developed with support from Oil Spill Response Limited (OSRL) for CNEL’s potential Exploration Program in PEL 82. This plan would instruct employees as to the correct response procedures for any unlikely oil spill that may occur during the exploration drilling operation. This plan of intervention, providing contacts lists and mobilization procedures will be drafted prior to the commencement of drilling activities.

The oil spill contingency plan should include or address, but not be limited to, the following:

- Alert procedure.
- Initial / immediate actions.
- Oil Spill Response Options / Strategies.
- Roles and responsibilities (including Emergency Directory).
- Response Actions.
- Response termination condition.
- Oil Spill Modelling Report.
- Oil Spill Risk Assessment (environmental sensitivities and priorities for protection).
- Oil Spill Response Equipment Inventory.

- Response technical guidelines and limitations.
- Response equipment and maintenance / Inspection plan.
- Drills and training.

11.4.6.3 SHIPBOARD OIL POLLUTION EMERGENCY PLAN (SOPEP)

Before mobilisation to site, the drilling contractor's SOPEP and procedures to be implemented in the event of an accidental spill of oil (or other polluting substances) at sea will be submitted for approval to MIME.

This plan will require:

- The implementation of measures to immediately stop the spill (sealing the leak, repairing leaking tanks, etc.).
- Recovery of spilled fluids.
- The notification of the Namibian authorities concerning the spill.
- The implementation of external response measures in the event of a large spill.
- Immediate reporting of any oil or chemical spills in water to the Port Control Walvis Bay and the Maritime Rescue Centre and regular updates to be sent during pollution clean-up operations.

The SOPEP will include procedures in line with international good practice for the accidental release of chemicals and fuels during exploration activities. The plan will include the following:

- Definition of roles and responsibilities.
- Identification of potential sources of accidental pollution (storage, use, etc.).
- Definition of design standards adopted to ensure the integrity and reliability of the equipment.
- Description of the security systems in place to prevent pollution.
- Inspection reports for the proper maintenance of safety equipment and systems.
- Procedures for handling chemicals and fuels to reduce the risk of accidental pollution (refer to Section 11.4.6.6) for the Hazardous Substances Management Plan.
- An action plan with instructions for the oil pollution prevention team. This is a list of duties the crew members will fulfil in case of a spill.

11.4.6.4 SOURCE CONTROL CONTINGENCY PLAN (SCCP)

The SCCP outlines well control procedures and details the response plan and intervention strategy for well control incidents, aiming to ensure prompt and effective action. Since blow-out scenarios and interventions can vary, a general contingency document cannot address every possibility. Instead, the SCCP provides structured guidelines with examples and triggers for rapid response; it is an internal document.

11.4.6.5 STAKEHOLDER ENGAGEMENT PLAN

Objectives

The Stakeholder Engagement Plan, prepared by ERM provides the framework to allow effective engagement with external stakeholders and details the planning for information disclosure and stakeholder engagements. It supports the right stakeholders to be notified in a timely manner about the project activities with information that is accurate and clear. The plan includes a Grievance Mechanism for stakeholders to engage with the project about their concerns and expectations and provides a process for CNEL to receive, document and address comments received. This mechanism aligns with the CNEL Grievance Mechanism Procedure (2025).

The main objectives of the SEP are as follows:

- Identify all those affected by or who can affect the project to strive to include them in the engagement process.
- Understand the views of stakeholders and make sure that they adequately understand the positive and negative impacts of the potential project.
- Inform stakeholders throughout the ESIA process, including local benefits and partner opportunities.
- Build relationships and trust through supporting open dialogue and engagement with stakeholders. Establish transparency in activities being undertaking and build trust with stakeholders.
- Engage with all stakeholders, including vulnerable and marginalised groups, by having an inclusive approach to consultation and participation. This may include the use of differential measures to maximise effective participation of vulnerable stakeholders.
- Manage expectations and concerns by providing a mechanism for stakeholders to engage with the project about their concerns and expectations and provide a mechanism for receiving, documenting and addressing comments received.

An engagement plan covers the ESIA phase, pre-mobilisation phase, mobilisation, drilling, and testing phase, and demobilisation phases. The plan includes engagement activities to be undertaken to inform stakeholders of project activities and updates, if needed, collect feedback, and manage expectations around recruitment and procurement.

Stakeholder Database

A stakeholder database has been developed. This has been based on extensive stakeholder identification. Once identified, stakeholders were mapped to determine the engagement approach to be used with each group/category. The database will be maintained regularly with updated information as the project progresses and engagements take place.

Engagement tools and resources

The SEP includes descriptions of the information dissemination tools that can be used during the implementation of the plan. Communicating information and engaging with stakeholders in a manner that is accessible is key to the success of an engagement programme. Various communication methods will be used to facilitate engagement during the project. The level and purpose of engagement will determine the methods and channels.

Project stakeholders' literacy levels and education levels may vary, and careful consideration will be given to the target audience when preparing engagement materials. Engagement methods include one-on-one meeting, public meetings, focus groups, letters, emails, website updates, media updates etc.

Disclosure

A public information and disclosure programme will be implemented to ensure stakeholders are informed of exploration activities. Sufficient information will be provided for stakeholders to become aware and understand the components of the exploration to be able to make informed comments and representations. Through the disclosure, relevant information or documentation will be broadly available to stakeholders, including people with limited access to technology, education, or resources. The SEP includes special measures for vulnerable groups who may face difficulties in accessing project information. At minimum disclosure methods will include:

- Placing hardcopies of relevant documents at public venues at beneficiary communities.
- Placing hardcopies of relevant documents at municipal offices.
- Main documents will be prepared in English (as the official language).
- Translation of key documents to local indigenous languages where required.
- Meetings and focus groups with stakeholders, as required.
- Monitoring of and engaging with other vessels.

The drilling unit will be equipped with appropriate radar and communications to ensure that other vessels adhere to the safe operational limits. Other vessels (e.g., fishing, transport, etc.) will be alerted about the drilling operation.

Any fishing vessels at a radar range of 24 nm from the drilling unit will be notified via radio regarding the safety requirements around the vessel / drilling unit.

Grievances are complaints or comments (or questions/suggestions) concerning the way in which a project is being implemented.

Grievances can encompass minor concerns as well as serious or long-term issues. They might be felt and expressed by a variety of parties including individuals, groups, communities, entities, or other parties affected or interested in the social or environmental impacts of the project. It is essential to have a robust and credible mechanism to systematically handle and resolve any complaints that might arise in order that they do not escalate and present a risk to operations or the reputation of the company (nationally or internationally). If well-handled, an effective GM can help foster positive relationships and build trust with stakeholders.

CNEL has established a grievance mechanism procedure (2025) to define the process for managing stakeholder concerns and complaints in alignment with the Chevron Operational Excellence Stakeholder Engagement and Issues Management Process and the Chevron Human Rights Policy. CNEL's existing 2025 grievance mechanism will be applicable to the project.
Waste, Emissions and Discharge Management Plan

Objectives

The Waste and Discharge Management Plan establishes procedures for the storage, collection, management, and disposal of waste, including air emissions, liquid and solid waste (hazardous and non-hazardous wastes). Certain waste will be treated and disposed of offshore, while other waste will be transported ashore. The plan will, therefore, describe the procedures to be followed to ensure the treatment, transfer and/or disposal of waste both offshore and onshore.

Compliance with International Conventions

The drilling unit and all project vessels will have equipment, systems and protocols in place for prevention of pollution by oil, sewage and garbage in accordance with the MARPOL convention.

MARPOL 73/78 was developed by the IMO with an objective to minimise pollution of the oceans and seas, including dumping, oil and air pollution.

Specific MARPOL requirements are included in the detailed Environmental and Social Mitigation Management Commitment Register (refer to Section 11.12).

Waste Management General Principles

Waste management during the drilling campaign will be planned in accordance with the waste prevention and management principles described in Table 11-4.

TABLE 11-4 WASTE PREVENTION AND MANAGEMENT PRINCIPLES

Principle	Implementation Measures
Waste Minimisation	• Choose equipment and supplies that produce minimal waste and packaging • Select materials that generate the least hazardous waste
Storage Security	• Store waste based on its type and risk classification following hygiene and safety rules • Define storage areas on the drilling unit, vessels and logistics base • Store compatible waste together and hazardous waste separately with retention and ventilation if flammable • Control access to storage areas and keep them clean and orderly
Waste Hierarchy	• Avoid generating waste • Minimise waste • Reuse non-hazardous waste • Recycle • Treat or incinerate onboard if permitted • Dispose of waste according to regulations and best practices
Recording and Monitoring	• Maintain a register of waste types and quantities to ensure traceability and identify avoidable waste • Track waste sent ashore including disposal methods and service providers • Keep transfer and disposal certificates for verification
Staff Training	• Train personnel on waste management procedures • Environmental protection and impact prevention • Reuse and recycling practices • Safe handling of hazardous waste • Recordkeeping and traceability

Management of Discharge and Emissions

The plan also addresses discharges and emissions related to project activities. Procedures will comply with national regulations and international best practices and will include:

- Identification and characterisation of discharges and emissions
- Definition of treatment objectives both qualitative and quantitative
- Assignment of responsibilities for measurement, recording and reporting
- Specification of tools and methods for monitoring
- Description of equipment and procedures used to treat discharges and emissions within defined limits.

Monitoring Requirements

Monitoring requirements are presented in Section 11.7.1.

11.4.6.6 HAZARDOUS SUBSTANCES MANAGEMENT PLAN

A Hazardous Substances Management Plan will be developed by the drilling contractor to detail the measures to minimise potential pollution. The plan will be applied to all phases of the Project and will include all hazardous products used during the project including drilling fluids and cement used during well drilling. The Hazardous Substances Management Plan is based on the principles of life cycle assessment. A standard plan will include:

- Inventory of chemical products (identification, classification, quantification and method of delivery).
- Product properties (dangerousness, toxicity, health and safety recommendations) based on product safety sheets (Safety data sheets, eco-toxicological data).
- Evaluation of the use of alternative products.
- Storage and handling procedures including personal protective equipment for personnel.
- Emergency procedures.
- Evaluation of recycling possibilities.
- Disposal procedures for unused products (return to the supplier for example).

11.4.6.7 PREVENTIVE MAINTENANCE PLAN

A Preventive Maintenance Plan will be available on board the drilling unit and all project vessels in order to minimise the risk of mechanical failure likely to lead to reduced efficiency (e.g. sewage treatment plan, incinerator, macerator/grinder, oil/water separator etc.) and other unplanned events (e.g. oil leaks or diesel spills). Control and maintenance procedures will be implemented at regular intervals by the various service providers.

This plan will provide for the implementation of leak detection and maintenance programmes for:

- Valves, flanges, fittings, seals, hydraulic systems, hoses etc.
- All diesel motors and generators receive adequate maintenance to minimise soot and unburnt diesel released to the atmosphere
- Waste treatment facilities, e.g. sewage treatment plan, incinerator, macerator/grinder etc.

This plan will also detail the procedure to follow if certain facilities (e.g. oil/water separator) are not available due to maintenance or overload.

This plan will also ensure that all equipment (e.g. wellheads, BOPs etc.) that has been used in other regions is thoroughly cleaned prior to deployment.

11.4.6.8 BALLAST WATER MANAGEMENT PLAN

Ballast water discharge will follow the requirements of the IMO 2004 International Convention for the Control and Management of Ships' Ballast Water. All ships engaged in international traffic are required to manage their ballast water to a certain standard according to a ship-specific Ballast Water Management Plan. This plan deals with the ballast water management system on each of the project vessels including how it operates and procedures for monitoring and reporting including ballast log book.

11.4.6.9 CORRECTIVE ACTION PLAN

Events (incidents or accidents) will undergo a root cause analysis while non-compliances identified during audit findings (refer to Section 11.7.2) will be investigated to identify underlying causes to non-compliance situations and then rectified. Management actions will be taken to correct the underlying causes behind the audit findings and improvements will be made before another audit is conducted. This audit process allows for problems to be corrected, compliance to be improved and prevention of the same findings during subsequent audits.

Where corrective actions are deemed necessary specific measures will be developed with designated responsibility and timing and implemented. In this way continuous improvement in performance will be achieved. Corrective actions will be captured in a Corrective Action Plan which will document the actions to correct an issue, problem, non-compliance or underperformance. It is essentially a plan to improve performance and/or reduce potential risk.

11.5 ROLES AND RESPONSIBILITIES

The project will have dedicated, competent personnel that will manage and oversee the HSE aspects over the project lifecycle. CNEL, as operator of PEL 82, will retain the primary responsibility for meeting environmental and social commitments throughout the project life span. The key HSE management roles and responsibilities supported by a project-specific organogram will be defined by the drilling contractor and validated by the operator prior to the commencement of any exploration activities.

11.5.1 CNEL

CNEL will be responsible for the overall implementation of the ESMP and meeting the environmental and social commitments. CNEL will have the following key responsibilities:

- Develop the drilling design for the Tender Document(s), which will include this ESMP.
- Select the preferred contractor(s) and ensure that the ESMP forms part of the contract for all contractors.
- Ensure the contractors implement the ESMP and any additional approval conditions contained in the ECC issued by MEFT.
- Ensure that environmental audits are undertaken to measure compliance with the agreed environmental performance objectives.
- Ensure that environmental monitoring and reporting are undertaken by all contractors.
- Engage with MIME, MEFT and relevant stakeholders when necessary at key stages of the project.
- Coordinate with contractors to ensure that key stakeholders are timely informed about the project activities, and that concerns and questions are responded to and grievances are managed properly, in alignment with the Grievance Mechanism.
- When considered necessary, appoint a representative onboard the drilling unit to ensure compliance with the various commitments and supervise contractor coordination, especially with MMO and PAM personnel, if needed. Note: MMOs and PAM personnel would only be used if VSP is conducted.

11.5.2 DRILLING CONTRACTOR

The drilling contractor appointed by CNEL shall have overall responsibility for the specified exploration activities and the management of any sub-contractors. All obligations endorsed by CNEL shall apply to the contractors and any sub-contractors. CNEL shall inform the contractors of these obligations in the appointment contract.

- Be responsible for and convey the requirements of the ESMP to all staff and any sub-contractors including MMOs, PAM operators and other subcontractors such as support vessels, helicopter, emergency support and catering.
- Ensure that sufficient resources are deployed in order to efficiently implement this ESMP.
- Ensure that personnel with responsibilities are adequately trained and experienced and are supported with essential resources.
- Ensure that all staff are given an environmental and social induction and that further training is undertaken at crew changes.
- Conduct monitoring, auditing and implement corrective actions as per the requirements of the ESMP.
- Be responsible for ensuring the health and safety of all personnel on the drilling unit and project vessels.

11.5.3 MARINE MAMMAL OBSERVERS (MMOS)

Should VSP activities be undertaken, MMOs must have the following qualifications and experience:

- Experience in seabird, turtle, large pelagic fish and marine mammal identification and observation techniques.
- Certification from the Joint Nature Conservation Committee (JNCC) or an equivalent body.
- The lead MMO should have appropriate training or certification and relevant seafaring experience.
- Safety certificate such as BOSIET or equivalent.
- Medical certificate such as OGUK, ENG1 or equivalent.
- The MMO shall have the following responsibilities during VSP operations:
- Provide effective regular briefings to crew members and establish clear lines of communication and procedures for onboard operations.
- Record airgun activities including sound levels, soft-start procedures and pre-firing regimes.
- Observe and record responses of marine fauna to VSP operations including penguins, large pelagic fish, turtles and cetaceans. Record species identification, position, distance and bearing from the drilling unit, swimming speed and direction and any changes in behaviour.
- Record any attraction of predatory seabirds, large pelagic fish or cetaceans and incidents of feeding behaviour among hydrophone streamers.
- Record meteorological conditions at the beginning and end of the observation period and whenever weather conditions change significantly.

- Request the delay of start-up or temporary termination of VSP operations as appropriate and maintain a log of all termination decisions.
- Use a recording spreadsheet such as JNCC 2017 to document all observations and decisions.
- Prepare a close-out report summarising MMO findings with the records database appended.

11.5.4 PASSIVE ACOUSTIC MONITORING (PAM) OPERATORS

Should VSP activities be undertaken, PAM operators will be utilised and must have the following qualifications and experience:

- Experience in marine mammal detection and identification techniques.
- Experience in appropriate deployment of PAM equipment.
- Certification from JNCC or an equivalent body.
- The lead PAM operator should have appropriate training certificate and relevant seafaring experience.
- Safety certificate such as BOSIET or equivalent.
- Medical certificate such as OGUK, ENG1 or equivalent.
- The PAM operator will have the following responsibilities during VSP operations:
- Provide effective regular briefings to crew members and establish clear lines of communication and procedures for onboard operations.
- Ensure that the PAM hydrophone cable is optimally placed, deployed, tested and repaired or replaced when necessary for acoustic detections of marine mammals.
- Record all airgun activities including timeline log, sound levels, soft-start procedures and pre-firing regimes.
- Confirm that there is no marine mammal activity within 500 meters of the airgun array prior to commencing soft-start procedures.
- Record species identification, position, distance and bearing from the vessel and acoustic source where possible.
- Record general environmental conditions.
- Request the delay of start-up and temporary shut-down of VSP operations as appropriate.

11.6 TRAINING, AWARENESS AND COMPETENCY

CNEL and the contractor will implement environmental awareness and training and ensure the competency of staff with responsibilities in terms of the ESMP.

CNEL will, at the Kick-Off meeting, highlight the contractor's responsibility in terms of identifying, planning, monitoring and recording the training needs of personnel whose work may have a significant adverse impact upon safety, the environment and in the community. Employees at all levels will be made aware of the potential impacts of their activities and the roles and responsibilities in achieving conformance with the ESMP and internal policy and procedures.

The personnel with responsibilities in specific HSE practices will be adequately trained to ensure effective implementation of the work instructions and procedures for which they have responsibilities. This training will include awareness and competency with respect to the following:

- General awareness relating to exploration activities including environmental and social impacts that could potentially arise from project activities.
- Legal requirements in relation to safety and environmental performance.
- Necessity of conforming to the requirements of the Environmental Authorisation and ESMP including reporting requirements such as incident reporting.
- Activity-specific training such as waste management practices and grievance management.
- Roles and responsibilities to achieve compliance including change management and emergency response.
- Training will take cognisance of the level of education, designation and language preferences of the personnel.

The appointed contractor and any sub-contractors will also be required to institute training programmes for its personnel. The contractor will be responsible for site HSE awareness training for personnel working on the project and for identification of any additional training requirements to maintain required competency levels.

The contractor training programme will be subject to approval by the operator and it will be audited to ensure that:

- Training programmes are adequate and all personnel requiring training have been trained
- Competency is being verified.

11.7 COMPLIANCE VERIFICATION AND CORRECTIVE ACTIONS

Monitoring and auditing will be undertaken to confirm adequate implementation of the ESMP as well as the effectiveness of mitigation measures in avoiding or minimising impacts. CNEL’s and contractor’s HSE staff will implement a formal tracking procedure for investigating cause and identifying corrective actions in response to accidents, HSE and/or social non-compliances. Corrective actions include those intended to improve performance, non-compliances and non-conformances.

11.7.1 MONITORING

Monitoring will be conducted to ensure compliance with regulatory requirements and the performance objectives specified in the ESMP as well as to evaluate the effectiveness of operational controls and mitigation measures. Monitoring will include but not be limited to those criteria listed in Table 11-5 which will be reviewed and updated to incorporate any additional aspects that may need to be monitored.

The main objectives of the monitoring programme include:

- Gathering, recording and analysing data required for regulatory and ESMP purposes.
- Verifying the predictions and conclusions made in the ESIA Report.
- Identifying changes in the physical, biological and social environment.
- Producing information to evaluate environmental performance specified in the ESMP.
- Producing information about emergencies that require an immediate response.

- Obtaining information on the potential environmental and social impacts of exploration activities.
- Using monitoring results as a source of information and as grounds for decision making regarding the design of new mitigation measures.
- Describing whether and to what extent discharges from exploration activities have had impacts on the marine environment.

As a general approach CNEL will ensure that all monitoring programmes comprise the following:

- A formal procedure.
- Use of appropriately calibrated equipment.
- The date, time and monitoring point of each sample is to be recorded.
- Where samples require analysis these will be preserved according to laboratory specifications.
- Accredited laboratories will be used to undertake sample analyses and/or internal laboratory results will periodically be checked by independent and accredited laboratories.
- Analysis where relevant must be carried out in accordance with methods prescribed by the Namibian National Standards in terms of the Standards Act 2005 (No. 18 of 2005) or similar.
- Monitoring data will be stored in an appropriate database.
- Data will be interpreted and reports on trends in the data will be compiled on a regular basis.
- Both the data and the reports will be kept on record for the duration of operations.

Monitoring will include but not limited to the following:

TABLE 11-5 MONITORING REQUIREMENTS

Aspect	Criteria to be monitored Timing / Frequency	Timing / Frequency
Sensitive seabed structures and sediments quality	• Hard substrate and rocky outcrops • Type and quantity of benthic fauna • Granulometry, hydrocarbons, metals and heavy metals	Prior to drilling and once during campaign
Ballast water prior to arrival on location	• Volume discharged, treatment and location (compliance with International Convention for the Control and Management of Ships' Ballast Water and Sediments	Before/during first de-ballasting in country
Drilling fluids	• Volume on board • Volume used • Volume discharged • Toxicity, barite contamination, Organic Phase Drilling Fluid concentration (NADF), chloride concentration (WBM-brine) • Update MSDS of chemicals and products on board of vessels	Daily during drilling operations
Cement	• Volume used and excess of cement discharged overboard/at sea bottom during riserless operations	During cementing operations

Aspect	Criteria to be monitored Timing / Frequency	Timing / Frequency
	• Monitor (using ROV) cement returns and if significant discharges are observed on the seafloor terminate cement pumping, as far as possible. • Monitor (using ROV) hole wash out to reduce discharge of fluids, as far as possible. Conducting pre-drilling ROV surveys to ensure wells are placed away from known sensitive or vulnerable hardground habitats, aiming to select level areas for spudding and wellhead installation.	
Chemicals and hazardous materials	• Cement chemicals and additives • Volume stored • Volume consumed • Monitoring requirements: • • Test drill cuttings daily for retained oil content to ensure specified discharge standards are maintained (average residual oil on cuttings <6.9%) at the end of the well. • Test barite for heavy impurities prior to mixing barite on location. • Test any other discharged fluids for visible oil contamination (static sheen). • Where practical, monitor sediment deposition and hydrocarbon concentrations. • Monitor (using ROV) cement returns and if significant discharges are observed on the seafloor terminate cement pumping, as far as possible. • Monitor (using ROV) hole wash out to reduce discharge of fluids, as far as possible.	Daily during drilling operations
Drill cuttings	• Volume discharged • Oil content in drill cuttings	Daily during drilling operations
Deck drainage /machinery space /bilge water	• Correct operation of oil separating/filtering equipment and oil content meter (compliance with MARPOL 73/78 standards, Annex I Regulation for the Prevention of Pollution by Oil)	Prior to drilling and once during campaign
Sewage discharge	• Correct operation of sewage treatment system (compliance with MARPOL 73/78 standards, Annex IV (Regulation for Prevention of Sewage from ships)	At start and once during campaign
Galley waste	• Type and volume discharged • Correct operation for discharge (compliance with MARPOL 73/78 standards, Annex V Regulation for Prevention of Pollution by Garbage from ships)	Daily during drilling operations
General waste	• Type and volume of waste generated • Type and volume transferred for onshore waste disposal facility • Compliance with waste Management Plan	Daily during drilling operations
Hazardous waste	• Volume of waste generated • Volume transferred for onshore disposal • Compliance with Waste Management Plan	Daily during drilling operations

Aspect	Criteria to be monitored Timing / Frequency	Timing / Frequency
Fuel usage	• Type and volume on board • Volume consumed	Daily during drilling operations
Accidental oil and chemical spills	• Type • Volume • Compliance with Shipboard Oil Spill Emergency Plan	Daily during drilling operations
Radioactive sources	• Correct containment and storage on board and during transportation	At start and once during campaign
Vertical Seismic Profiling (if applicable)	• Marine mammals observations and final report • Application of JNCC best practice	During pre-watch period and continuous during VSP
Well (flow) testing (if required)	• Volumes of hydrocarbon fluids	Daily during well testing operations
Dropped objects	• Establish a hazards database listing: the type of gear left on the seabed date of abandonment/loss location; and where applicable, the dates of retrieval	Daily during drilling operations
Disruption/ interference to fishing/shipping	• Interactions with other vessels (via radio) • Number of grievances/incidents logged	Daily during drilling operations
Fauna interaction	• Bird and sea fauna incidents of injury/death • Stray land birds resting on drillship	Daily during drilling operations

11.7.2 AUDITING

Contractors will be required to conduct routine HSE inspections (internal and independent audits) to monitor compliance and implementation of conditions stipulated in this ESMP. The results of the inspection and monitoring activities will be reported to the operator (CNEL).

Beyond the routine inspection and monitoring activities conducted by the contractors, formal audits will be carried out internally by CNEL’s onboard HSE representatives to determine the level of compliance with the ESMP and its own HSE standards and policies. The audit data will include the contractor’s monitoring and inspection records.

The audit will include amongst other things, checking:

- Completeness of HSE documentation, including planning documents and inspection records.
- Conformance with monitoring requirements.
- Efficacy of activities to address any non-conformance with monitoring requirements.
- Training activities and record keeping.

Findings will be documented in audit reports, which will be submitted to the relevant Manager for action and follow-up.

11.7.3 CORRECTIVE ACTIONS

CNEL and its contractors' HSE personnel will implement a structured procedure for tracking non-compliance and corrective actions, ensuring thorough investigation of root causes and appropriate identification of corrective measures in response to accidents, HSE concerns, or social non-compliances.

Audit findings will be systematically monitored until they are resolved. Management will address the underlying causes identified during audits and implement necessary improvements prior to subsequent reviews. This approach facilitates timely correction of issues, enhances compliance, and reduces the likelihood of recurring findings in future audits.

When corrective actions are required, detailed measures will be defined and documented in a Corrective Action Plan, specifying responsibilities and timelines for implementation. This systematic approach supports ongoing performance improvement.

HSE personnel from CNEL and its contractors will maintain comprehensive records of all corrective actions and oversee modifications to environmental or social protection protocols and training programs, thereby preventing recurrence of non-conformances and non-compliances.

11.8 IMPLEMENTATION OF THE ESMP

The development and implementation of the ESMP is an ongoing process that is iterative in nature. This document must thus be seen as a 'living' document and amendments may need to be implemented during the project. Typical changes that can affect the ESMP include:

- A material project design change that occurs after the ESMP has been compiled and approved.
- Changes in the feasibility/availability of specific mitigation measures.
- Personnel changes and/or planning on the project.
- Equipment failure during the survey or drilling.

This document is the first version of the ESMP. Certain aspects of this document may be expanded/made more specific during the detailed design stage to ensure, firstly, that it includes all conditions of approval and, secondly, that it addresses all potential impacts related to the detailed design. It may also need to be amended if audit findings indicate:

- Insufficient mitigation of potential environmental impacts associated with the undertaking of the activity; or
- Insufficient levels of compliance with the ECC or ESMP.

11.9 COMMUNICATION

CNEL and its contractors are responsible for securely filing all records pertaining to the implementation of this ESMP, including inspection and audit reports, incident reports, monitoring records and other relevant documentation. These records must be stored in a secure location where they can be readily accessed.

11.9.1 STAKEHOLDER ENGAGEMENT

Open liaison channels must be established between CNEL local government authorities, contractors, subcontractors, and adjacent land-users such that any queries, complaints or suggestions can be dealt with timeously and by the appropriate person(s).

CNEL will implement a Grievance Mechanism (GM) to address the concerns of affected parties about the project's environmental and social performance.

The project's grievance procedures will be accessible to any affected community member or aggrieved party. These procedures has been customized to include input from affected parties when applicable and in compliance with the law.

A grievance and complaints register will be used and maintained to record any complaints or comments. As a minimum, the following information should be recorded:

- Time, date and nature of enquiry or complaint.
- The means by which the enquiry or complaints was made.
- Personal details of the person / party lodging the enquiry or complaint (subject to privacy/anonymity considerations).
- Actions taken to investigate and time and date to close-out the complaint as well as complainant feedback.

Any actions that cannot be managed immediately should be assigned to the appropriate personnel and managed according to the grievance procedure. The action will only until it is closed off by the CNEL Project Manager one a satisfactory resolution has been agreed upon by all parties concerned.

11.9.2 AUTHORITY COMMUNICATION

A notification document with well drilling details must be submitted to MIME and MEFT at least 30 days prior to mobilisation.

CNEL will submit an ESMP close-out compliance report to the Competent Authority (MIME) within 90 days of the end of each drilling campaign (Section 11.10.4).

11.10 DOCUMENT CONTROL AND REPORTING

11.10.1 DOCUMENTATION

CNEL will manage HSE documents (such as licenses, approvals, plans, procedures, checklists, forms, audits, and reports) using a formal process for document control. This procedure covers communication methods, electronic filing, document tracking, and version control. Contractors will create and maintain their own HSE document systems and describe them in their HSE plans.

11.10.2 INCIDENT REPORTING

After any HSE incident, CNEL investigates and reports on the events, root causes, and corrective actions taken. Incidents that exceed local regulations are reported to MIME and MEFT.

11.10.3 AUDIT REPORTS

Audit findings (refer to Section 11.7.2) will be documented in audit reports, which will be submitted to the relevant Manager for action and follow-up.

11.10.4 ESMP CLOSE-OUT COMPLIANCE REPORT

CNEL will submit an ESMP close-out compliance report to MIME within 90 days after each drilling campaign, detailing mitigation measures and compliance with ESMP performance objectives.

11.11 INCIDENT MANAGEMENT AND MITIGATION

Table 11-6 outlines the requirements for incident management and mitigation.

TABLE 11-6 ROLES AND RESPONSIBILITIES

Designation	Roles and Responsibility
Reporting of Environmental Incidents	• Any environmental incident should be reported immediately to the CNEL HSE Manager and in accordance with CNEL procedures. • Immediate correspondence should be taken with the relevant staff members to determine mitigation and close-out requirements. • All significant incidents should be reported to the relevant authority(s) as per the legal requirements.
Contents of Environmental Incident Records	Environmental incident reporting and recording must include the following information: • Time, date and nature of the incident. • Response and investigation undertaken. • Actions taken and by whom.
Continual Improvement	• Corrective and preventative action requests should be forwarded to the responsible person so that corrective action can be taken. Open non-conformances must only be closed on verification by the HSE Manager that the corrective action has been implemented effectively to meet the ESMP requirements. • The cause of all incidents should be investigated to determine root cause and to ensure that corrective action is able to be implemented to ensure that there is no repeat of the incident. • If required following an incident, a review of the efficacy of the ESMP should be undertaken by CNEL to identify possible areas of improvement or updating or amendment required within the ESMP.

11.12 ENVIRONMENTAL AND SOCIAL MITIGATION MEASURES

This section details the specific management commitments to be implemented to prevent, minimise or manage potential significant negative impacts and optimise and maximise any potential benefits of the project. These commitments are presented for the three project phases: mobilisation, operation (including planning, drilling activities and well plugging and abandonment) and demobilisation.

This ESMP Commitments Register (Table 11-7 for planned events and Table 11-8 for unplanned events) is structured in the following manner so that the mitigation measures have a clear and logical context within which they are designed, implemented, monitored and evaluated:

- Aspect and Potential impact;

- Mitigation /Management Action;
- Responsibility; and
- Timing.

TABLE 11-7 ESMP COMMITMENTS REGISTER FOR PLANNED EVENTS

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
Air emissions Use of drilling and supply vessels during all phases	All	• Comply with MARPOL 73/78 Annex VI regulations regarding the reduction of SOx, NOx, ODS, VOC and emissions from shipboard incineration. • All diesel motors and generators will undergo routine inspections and receive adequate maintenance to minimise soot and unburnt diesel released to the atmosphere. • Leak detection and repair programmes will be implemented for valves, flanges, fittings, seals, etc. • Use of a low sulphur fuel for project vessels, if available. • Prohibition of waste incineration within port limits. • Regular maintenance of engines to optimise performance and reduce emissions. • Implementation of leak detection and repair programmes.	Drilling contractor	Throughout vessel operations and drilling campaign
Ecosystem disturbance Disposal of cuttings to the seafloor and overboard, disposal of excess cement potentially leading to seawater and sediment quality	Operation	Pre-Operation • Conduct careful design of pre-drilling site surveys to collect sufficient information on seabed habitats, including mapping of sensitive and potentially vulnerable habitats within 500 m of a proposed well site., aiming to select level areas for spudding and well head installation.	Drilling contractor	Throughout drilling campaign

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
degradation /contamination and impacts on marine fauna		• If sensitive habitats (such as hard grounds), sensitive species (e.g., cold-water corals, sponges), or significant structural features are detected, adjust the well position to beyond 500 m, or implement technologies, procedures, and monitoring to reduce risks and assess potential damage. Operation • Establish clear operational procedures for ROVs to avoid seabed contact. • Limit the area physically affected by infrastructure to the minimum required. • Use WBM where possible or switch to low-toxicity Group III NADF with offshore treatment to reduce oil content in cuttings (<6.9%) before discharge. • Discharge risered cuttings through a caisson at depths >10 m to limit surface dispersion. • Careful selection of drilling fluid additives taking into account their concentration, toxicity, bioavailability and bioaccumulation potential; Use only, PLONOR (Pose Little Or No Risk) chemicals, low-toxicity, low bioaccumulation potential and partially biodegradable additives are used, where practicable. Maintain a full register of Safety Data Sheets (SDSs) for all chemical used, as well as a precise log file of their use and discharge. • Monitor sediment deposition and hydrocarbon concentrations where practical. • Employ high-efficiency solids control equipment to reduce liquid content in cuttings and maximize mud reuse.		

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
		• Optimize reuse and recycling of WBM and NADF across wells and sections. • Regularly maintain onboard solids control systems. • Limit excess cement slurry during riserless drilling. • Ship unused cement onboard to shore for reuse, storage, or disposal. • Use NADFs for risered sections and maintain solids control systems to prevent improper discharge. • If NADFs are used for drilling the risered sections, conduct regular maintenance of the onboard solids control package and avoid inappropriate discharge of NADF cuttings. • Minimise fluid discharge wherever possible. Post- Operation • Conduct post-drilling ROV surveys to locate and recover dropped equipment or excess cement. • Register and distribute the location of abandoned wellheads via “Notice to Mariners” and “Notice to Fishers”. Monitoring • Test drill cuttings daily for retained oil content to check specified discharge standards are maintained (average residual oil on cuttings <6.9%) at the end of the well. • Test barite for heavy impurities prior to mixing barite on location. • Test any other discharged fluids for visible oil contamination (static sheen). • Where practical, monitor sediment deposition and hydrocarbon concentrations.		

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
		• Monitor cement returns with an ROV and stop cement pumping if significant discharges are detected on the seafloor. • Monitor (using ROV) hole wash out to reduce discharge of fluids, as far as possible.		
Ecosystem Flaring activities during well testing potentially leading to disturbance to marine fauna	Operation	Well Testing • Design well test programmes to minimise flaring duration. • Schedule well testing during daylight hours where feasible. • Use high-efficiency burners to optimize hydrocarbon combustion and minimise emissions and drop-out. • Continuously monitor flare performance for malfunctions or drop-out.	Drilling contractor	During well testing and logging
Ecosystem disturbance Drillship and vessels lighting potentially leading to disturbance to marine fauna	All	• Lighting on the support vessels, and drill rig, should be reduced to a minimum compatible with safe operations whenever and wherever possible. • Light sources should, if possible and consistent with safe working practices, be positioned in places where emissions to the surrounding environment can be minimised • Optimise well test programme to reduce flaring as much as possible during the test. • Commence with well testing during daylight hours, as far as possible. • Monitor flare (continuous) for any malfunctioning, etc. (including any drop-out).	Drilling contractor	Throughout vessel operations and drilling campaign

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
Ecosystem disturbance Drillship and vessels noise due to dynamic positioning and moving, noise from drilling activities potentially leading to disturbance to marine fauna	All	• Limit vessel transit speeds to ≤12 knots (22 km/h) between the drilling area and port and ≤10 knots (18 km/h) within 25 km of the coastline. • Implement a maintenance plan to check all diesel motors and generators receive adequate maintenance to minimise noise emissions.	Drilling contractor	Throughout vessel operations and drilling campaign
Ecosystem disturbance Helicopter Noise potentially leading to disturbance of marine fauna	All	• Avoid flying over sensitive areas near Walvis Bay, including Namib-Skeleton Coast National Park and Ramsar sites like the Walvis Bay Wetlands and Sandwich Harbour. These zones are essential for conserving birds, turtles, fish and marine mammals, some of which are threatened. Low-altitude flights can disturb breeding colonies, causing nest abandonment and higher predation risks. Key habitats like Walvis Bay Wetlands and Bird Island guano platform may overlap with flight paths but are distant from airport zones. • Altitude Restrictions: o Avoid low-altitude coastal flights (<762 m or 2,500 ft and within 1 nm of shore). o Keep altitude above 1,000 m over the Walvis Bay coastline, which includes protected areas like Namib-Skeleton Coast National Park and Ramsar sites such as the Walvis Bay Wetlands and Sandwich Harbour. These regions support diverse bird and wildlife species, some at risk or endangered. Low-altitude flights can disrupt	Helicopter contractor	Throughout helicopter operations and drilling campaign

Aspect and Potential impact	Project Phase	Mitigation /Management Action	Responsibility	Timing
		breeding colonies, increasing predation risks. Important Bird Areas near the airport include Walvis Bay Wetlands and Bird Island guano platform, which may intersect helicopter routes though are not close to main flight zones. o Exceptions: take-off/landing, medical emergencies and Diaz Point (approach only from the north). • Adhere to all aviation regulations. • Brief pilots on ecological risks of low-level coastal flights and flying over marine mammals.		
Ecosystem disturbance Drillship and vessels noise due to Vertical Seismic Profiling potentially leading to disturbance to marine fauna	Operation	MMO and PAM Deployment • Appoint a minimum of two dedicated Marine Mammal Observer (MMO), with a recognised MMO training course, on board for marine fauna observation (360 degrees around drilling unit), distance estimation and reporting. One MMO should also have Passive Acoustic Monitoring (PAM) training should a risk assessment, undertaken ahead of the VSP operation, indicate that the PAM equipment can be safely deployed considering the metocean conditions (specifically current). • Check drilling unit vessel is fitted with PAM technology (one or more hydrophones), which detects animals through their vocalisations, should it be possible to safely deploy PAM equipment. Pre-start Protocols for Airgun Testing and Profiling • VSP profiling should, as far as possible, only commence during daylight hours with good visibility. However, if this is not possible due to	Drilling contractor	Throughout VSP operations

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
		prolonged periods of poor visibility (e.g. thick fog) or unforeseen technical issue which results in a night-time start, refer to "periods of low visibility" below. • Undertake a 1-hr (as water depths > 200 m) pre-shoot visual and possible acoustic scan (prior to soft-starts / airgun tests) within the 500 m radius mitigation zone in order to confirm there are no cetaceans, turtles, penguins and shoaling large pelagic fish activity close to the source. Soft-Start Procedures • Implement a “soft-start” procedure of a minimum of 20 minutes’ duration when initiating the acoustic source (except if testing a single airgun on lowest power). This requires that the sound source be ramped from low to full power rather than initiated at full power, thus allowing a flight response by marine fauna to outside the zone of injury or avoidance. • Delay “soft-starts” if cetaceans, turtles and shoaling large pelagic fish are observed / detected within the mitigation zone during the pre-shoot visual / acoustic scan. A “soft-start” should not begin until 20 minutes after cetaceans depart the mitigation zone or 20 minutes after they are last seen or acoustically detected by PAM in the mitigation zone. In the case of penguins, shoaling large pelagic fish and turtles, delay the “soft-start” until animals move outside the 500 m mitigation zone. Operational Monitoring		

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
		• Maintain visual and possibly acoustic observations within the 500 m mitigation zone continuously during VSP operation to identify if there are any cetaceans present. • Keep VSP operations under 250 pulses to remain within the 500 m exclusion zone for cetaceans. Shut-Down Protocols • Shut down the acoustic source if cetaceans, penguins, shoaling large pelagic fish or turtles are sighted within 500 m mitigation zone until such time as the mitigation zone is clear of cetaceans for 20 minutes or in the case of penguins, shoaling large pelagic fish or turtles, the animals move outside the 500 m mitigation zone before the soft-start procedure and production may commence. Breaks in Airgun Firing • Breaks of less than 20 minutes: o There is no requirement for a soft-start and firing can recommence at the same power level as at prior to the break (or lower), provided that continuous monitoring was ongoing during the silent period and no cetaceans, penguins, shoaling large pelagic fish or turtles were detected in the mitigation zone during the breakdown period. o If cetaceans are detected in the mitigation zone during the breakdown period, there must be a minimum of a 20-minute delay from the time of the last detection within the mitigation zone and a soft-start must then be undertaken. In the case of penguins, shoaling large pelagic fish or turtles, the		

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
		animals move outside the 500 m mitigation zone within the 20 minute period. • Breaks of longer than 20 minutes: o If it takes longer than 20 minutes to restart the airguns, a full pre-watch and soft-start process should be carried out before the survey re-commences. If an MMO/PAM operator has been monitoring during the breakdown period, this time can contribute to the 60-minute pre-watch time. Low Visibility Procedures • If low visibility or technical issues necessitate a nighttime start, apply the low visibility protocols. • During periods of low visibility (where the mitigation zone cannot be clearly viewed out to 500m), including night-time, the VSP source is only used if PAM technology is in place to detect vocalisations (subject to a risk assessment indicating that the PAM equipment can be safely deployed considering the metocean conditions) or: • There have not been three or more occasions where cetaceans, penguins, shoaling large pelagic fish or turtles have been sighted within the 500 m mitigation zone during the preceding 24-hour period; and • A two-hour period of continual observation of the mitigation zone was undertaken (during a period of good visibility) prior to the period of low visibility and no cetaceans, penguins, shoaling large pelagic fish or turtles were sighted within the 500 m mitigation zone.		
Ecosystem disturbance	All	Pre-Operation	Drilling contractor	Throughout vessel

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
Wastewater discharge potentially leading to seawater quality degradation /contamination and impacts on marine fauna		• Implement an awareness programme that addresses reduced water usage and waste generation at the various sites, shore-based and marine. • Develop and implement a Waste Management Plan to guide segregation, storage, handling, and disposal of non-hazardous and hazardous waste. • Develop and implement a Hazardous Substances Management Plan to manage safe handling and containment of hazardous materials. • Implement a Ballast Water Management Plan to prevent the introduction of invasive species and protect marine ecosystems. Operation • Compliance of project vessels with MARPOL 73/78 Annex I Regulations for the Prevention of Pollution by Oil. Including, Annex IV Regulations for the Prevention of Pollution by Sewage from Ships, Annex V prevention of pollution by garbage from Ships. • Continue execution of the Waste Management Plan and Hazardous Substances Management Plan throughout the drilling campaign. • Maintain and monitor ballast water systems as per the Ballast Water Management Plan. • Prohibit operational discharges when transiting through the MPAs and EBSAs during transit to and from the drill site. • Use drip trays to collect run-off from equipment that is not contained within a bunded area and route contents to the closed drainage system. • Implement leak detection and repair programmes for valves, flanges, fittings, seals, etc.		operations and drilling campaign

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
		• Use a low-toxicity biodegradable detergent for the cleaning of the deck and any spillages.		
Waste Management Potential increase in non-hazardous and hazardous waste disposal	All	Pre-Operation • Develop and implement a Waste Management Plan to guide segregation, storage, handling, and disposal of non-hazardous and hazardous waste. • Develop and implement a Hazardous Substances Management Plan to manage safe handling and containment of hazardous materials. Operation • Compliance of project vessels with MARPOL 73/78 Annex I Regulations for the Prevention of Pollution by Oil. Including, Annex IV Regulations for the Prevention of Pollution by Sewage from Ships, Annex V prevention of pollution by garbage from Ships.	Drilling contractor	Throughout vessel operations and drilling campaign
Community and Stakeholders Riser / BOP structure removal, MODU presence at site, drilling discharges, underwater noise potentially leading to disturbance to fishing and navigation	All	*Pre-Operation* • Distribute a Notice to Mariners to key stakeholders prior to the well-drilling operations 3 weeks prior to operations and on completion of the campaign. Stakeholders include the relevant fishing industry associations: Confederation of Namibian Fishing Association, Large Pelagic and Hake Longlining Association of Namibia. Other key stakeholders: Directorate of Maritime Affairs, SANHO, Namibian Ports Authority and the MFMR Monitoring, Control and Surveillance Unit in Walvis Bay (Vessel Monitoring System). • Request, in writing, SANHO to broadcast a navigational warning via Navigational Telex (Navtext)	Drilling contractor	Throughout vessel operations and drilling campaign

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
		and navigational warnings twice daily on Channel 16 VHF. • Implement a grievance mechanism that allows stakeholders to register specific grievances related to operations; by ensuring they are informed about the process and that resources are mobilised to manage the resolution of all grievances, in accordance with the Grievance Management procedure. • Conduct careful design of pre-drilling site surveys to collect sufficient information on seabed habitats, including mapping of sensitive and potentially vulnerable habitats within 500 m of a proposed well site. • If sensitive habitats (such as hard grounds), sensitive species (e.g., cold-water corals, sponges), or significant structural features are detected, adjust the well position to beyond 500 m, or implement technologies, procedures, and monitoring to reduce risks and assess potential damage. • Careful selection of drilling fluid additives taking into account their concentration, toxicity, bioavailability and bioaccumulation potential; Use only, PLONOR (Pose Little Or No Risk) chemicals, low-toxicity, low bioaccumulation potential and partially biodegradable additives are used, where practicable. Maintain a full register of Safety Data Sheets (SDSs) for all chemical used, as well as a precise log file of their use and discharge. Operation • Manage the lighting on the drilling unit and support vessels so it is sufficiently illuminated to be visible to fishing vessels and compatible with safe operations.		

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
		• Notify fishing vessels at a radar range <24 Nm from the drillship via radio regarding the safety requirements around the drillship. If possible, transmit/broadcast the virtual safety navigational zone surrounding the rig on the AIS system, so nearby vessels will see not only the vessel location but also the restricted zone surrounding the vessel on their AIS displays. • Implement a grievance mechanism that allows stakeholders to register specific grievances related to operations; by ensuring they are informed about the process and that resources are mobilised to manage the resolution of all grievances, in accordance with the Grievance Management procedure. • If NADFs are used for drilling the risered sections, conduct regular maintenance of the onboard solids control package and avoid inappropriate discharge of NADF cuttings. Monitoring • Test drill cuttings daily for retained oil content to check specified discharge standards are maintained (average residual oil on cuttings <6.9%) at the end of the well. • Test barite for heavy impurities prior to mixing barite on location. • Test any other discharged fluids for visible oil contamination (static sheen). • Where practical, monitor sediment deposition and hydrocarbon concentrations. • Monitor cement returns with an ROV and stop cement pumping if significant discharges are detected on the seafloor.		

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
		• Monitor (using ROV) hole wash out to reduce discharge of fluids, as far as possible. VSP Soft start procedures: • Gun test followed by full VSP logging phase: acoustic source must be initiated at the lowest power setting, with gradual ramp-up of the acoustic source over a 20-minute period until the full operating power level is reached. • For single gun tests prior to VSP logging phase: If a gun test will be less than 20-minutes in duration, a soft start procedure of equal time duration must be followed (e.g. a 10-min gun test should be preceded with a 10-min soft start only). Operating procedures: • Whilst the VSP acoustic source is operating, both during soft start procedures and survey operations, the acoustic source must be shut down if mass mortality of fish species is sighted. Abandonment • Abandoned well location must be surveyed and accurately charted. If indicated, fit wellheads (in water depth less than 800 m) with an over-trawlable structure to minimise the risk of damage to demersal trawl gear, as well as potential damage to the wellheads. • Removal of wellheads: Consultation with the trawling industry should wellheads coincide with trawling grounds		

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
Stakeholders GHG emissions during the drilling program potentially leading to global climate change	All	• Use of low sulphur fuel (ISO 8217) in accordance with MARPOL Annex VI. • Prohibition of waste incineration within port limits. • Regular maintenance of engines to optimise performance and reduce emissions. • Implementation of leak detection and repair programmes.	Drilling contractor	Throughout vessel operations and drilling campaign
Stakeholders Number of marine vessels Increase potentially leading to marine traffic disturbance	All	• Ongoing engagement, as guided by the SEP with the Namibian Ports Authority to establish vessel routing optimisation and docking arrangements that minimises potential impact on other marine users. • Use the SEP to promote collaboration with fishing associations and cooperatives, recreation users and other commercial marine users to identify areas of optimisation. This would include promoting the use of the external grievance mechanism for stakeholder to raise concerns regarding vessel traffic. • Utilisation of monitoring systems data provided by the Ports Authority to track vessel traffic, including smaller boats used by artisanal fishers, in order to identify issues and potential improvements required in routing. • Manage the lighting on the drilling unit and support vessels to make sure that it is sufficiently illuminated to be visible to fishing vessels and compatible with safe operations.	CNEL	Throughout vessel operations and drilling campaign
Stakeholders Drilling program potentially leading	All	• The SEP should include requirements for ongoing engagement with local communities, business associations, NGOs and other relevant stakeholder categories regarding potential employment and	CNEL	Throughout drilling campaign

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
to direct / indirect employment		procurement opportunities for local people and businesses. This engagement should include information sharing on job application processes, skills requirements and tendering processes. • The external grievance mechanism within the SEP should be clearly communicated to these stakeholders to allow them to submit a grievance relating the employment and procurement if necessary and the grievances will be processed accordingly. • Where possible, certain jobs as well as the provision of certain good and services should be reserved for local employees and local suppliers. This may include various unskilled and semi-skilled positions as well as the procurement of transport services, food, security services etc.		
Stakeholders Drilling program potentially leading to positive impacts to the local economy	All	• Ongoing engagement with local business associations, communities and local authorities should include the sharing of local procurement opportunities including the requirements for contracting with CNEL and/or the project. This engagement should focus on managing expectations given the limited contractor and supply chain opportunities. • Opportunities to tender should be advertised widely within the project AoI to make sure awareness is raised amongst potential local contractors and suppliers. • The project should implement Chevron's internal local content requirements to maximise this benefit. These	CNEL	Throughout drilling campaign

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
		local content requirements should be clearly communicated to stakeholders.		

TABLE 11-8 ESMP COMMITMENTS REGISTER FOR UNPLANNED EVENTS

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
Ecosystem disturbance Alien invasive species	All	• All ships that carry ballast water must de- and re-ballast in adherence with the International Maritime Organization (IMO) guidelines and standards governing discharge of ballast waters at sea. • Implement a Ballast Water Management Plan to prevent the introduction of invasive species and protect marine ecosystems.	Drilling contractor	Throughout vessel operations
Ecosystem disturbance Vessel collision with marine fauna	All	• Keep a constant watch from all vessels (Vessel Captain and crew) for cetaceans and turtles in the path of the vessel. Alter course and avoid animals when necessary. • vessel transit speed between the Area of Interest and port is a maximum of 12 kts (22 km/h), except within 25 km of the coast where it is reduced further to 10 knots (18 km/h) as well as when sensitive marine fauna are present in the vicinity. • Report any collisions with large whales to the International Whaling Commission (IWC) database, which has been shown to be a valuable tool for identifying the species most affected, vessels involved in collisions, and correlations between vessel speed and collision risk (Jensen & Silber 2003). • If a seabird impacts the vessel but is unharmed: • Place in a dark container (e.g., cardboard box) for release during daylight. • For injured seabirds: • Follow protocols outlined by wildlife response specialists.	Drilling contractor	Throughout vessel operations
Ecosystem disturbance Loss of equipment disturbance of	All	• Check containers are sealed / covered during transport and loads are lifted using the correct lifting procedure and within the maximum lifting capacity of crane system.	Drilling contractor	Throughout vessel operations

Aspect and Potential impact	Project Phase	Mitigation /Management Action	Responsibility	Timing
seabed and potential temporary disturbance of benthic fauna		• Minimise the lifting path between vessels. • Maintain an inventory of all equipment and undertake frequent checks that items and stored and secured safely on board each vessel. • Undertake a post drilling ROV survey to scan seafloor for any dropped equipment and other removable features around the well site. In the event that equipment is lost, assess safety and metocean conditions before performing any retrieval operations. • Notify SAN Hydrographer of any hazards left on the seabed or floating in the water column, with the dates of abandonment/loss and locations and request that they send out a Notice to Mariners with this information.		
Ecosystem disturbance Small Spills		• Information about installation operations will be shared with vessel operators through national communication channels, including notices and radio navigation warnings. • Check personnel are adequately trained in both accident prevention and immediate response, and resources are available on each vessel. • Develop an Oiled Wildlife Contingency Plan (OWCP) in collaboration with specialist wildlife response organisations with experience in oiled wildlife response. The OWCP should be integrated into the site-specific OSPC and include detailed protocols on the collection, handling and transport of oiled marine fauna. • Obtain permission from MFMR to use low toxicity dispersants should these be required; Use cautiously. • As far as possible, and whenever the sea state permits, attempt to control and contain the spill at sea with suitable recovery techniques to reduce the spatial and temporal impact of the spill		

Aspect and Potential impact	Project Phase	Mitigation /Management Action	Responsibility	Timing
		• Check adequate resources are provided to collect and transport oiled birds to a cleaning station. Capturing and transportation of oiled or injured seabirds must be undertaken according to specific protocols as outlined in the OWCP. • Don't allow offshore bunkering in the following circumstances: • Wind force and sea state conditions of ≥6 on the Beaufort Wind Scale; • During any workboat or mobilisation boat operations; • During helicopter operations; • During the transfer of in-sea equipment; and • At night or times of low visibility.		
Ecosystem Disturbance Well loss of containment event potentially leading to disturbance of fisheries and marine fauna	Operation	• If modelling and intervention planning indicates that the well-specific response strategy and plans cannot reduce the response times to less than the time it would take oil to disperse, additional proactive measures must be committed to. For example: • Implement measures to reduce surface response times (e.g. pre-mobilise a portion of the dispersant stock on the support vessels, contract additional response vessels and aircrafts, minimise the time it takes to install the subsea dispersant injection (SSDI) kit by ensuring there is a kit on standby, improve dispersant spray capability, etc.). • Deploy and/or pre-mobilise shoreline response equipment (e.g. response trailers, shoreline flushing equipment, shoreline skimmers, storage tanks, shoreline booms, skirt booms, shore sealing booms, etc.) to key localities for the full duration of drilling operation phase to proactively protect sensitive coastal habitats and areas • Include wildlife response in collaboration with specialist wildlife response organisations with	CNEL / Drilling contractor	Throughout drilling campaign

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
		experience in oiled wildlife response as part of the OSCP. • Schedule joint oil spill exercises including the operator and local departments / organisations to test the Tier 1, 2 & 3 responses. • Check contract arrangements and service agreements are in place to implement the SCCP, e.g. capping stack, SSDI kit, surface response equipment (e.g. booms, dispersant spraying system, skimmers, etc.), dispersants, response vessels, etc. • Use low toxicity dispersants that rapidly dilute to concentrations below most acute toxicity thresholds. Dispersants should be used cautiously and only with the permission of MFMR. • Contracted support vessels will be equipped for dispersant spraying and can be used for mechanical dispersion (using the propellers of the ship and/or firefighting equipment). It should have at least 5 m^3 of dispersant onboard for initial response. • As far as possible, and whenever the sea state permits, attempt to control and contain the spill at sea with suitable recovery techniques to reduce the spatial and temporal impact of the spill • In the event of a spill, use drifter buoys and satellite-borne Synthetic Aperture Radar-based (SAR) oil pollution monitoring to track the behaviour and size of the spill and optimise available response resources • Submit all forms of financial insurance and assurances to MIME to manage all damages and compensation requirements in the event of an unplanned pollution event.		
Stakeholders Well loss of containment event potentially leading to	Exploration phase	• Develop well-specific Source Control Contingency Plans (SCCP), including oil wildlife response actions, aligned with the National OSCP (Oil Spill Contingency Plan). Tailor plans to local oceanographic and meteorological	CNEL / Drilling contractor	Throughout drilling campaign

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
disturbance of commercial fishing		conditions, environmental receptors and spill response resources. • Assess onshore and offshore response resources (equipment and personnel), their location (local/international) and mobilization timeframes. • Select response strategies that minimise mobilisation time, using the best combination of local and international. • Develop intervention plans for sensitive areas and integrate these into the response strategy. • Tailor plans to local oceanographic and meteorological conditions, environmental receptors and spill response resources. • Conduct well-specific oil spill modelling using site- and time-specific data. If response time cannot prevent shoreline oiling, commit to additional proactive measures including: • Pre-mobilising dispersant stock on support vessels. • Contracting additional response vessels and aircraft. • Ensuring SSDI kit is on standby and rapidly deployable. • Improving dispersant spray capability. • Schedule joint oil spill exercises to test Tier 1, and 3 responses. Maintain a support vessel within proximity of the drilling unit, equipped for: • Dispersant spraying. • Mechanical dispersion (via propellers or firefighting equipment). • Carrying at least 4 m^3 of dispersant onboard. • Control and contain spills at sea using recovery techniques, when sea state permits.		

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
		• Use drifter buoys and SAR-based satellite monitoring to track spill behaviour and optimise response. • Establish a functional grievance mechanism: • Inform stakeholders of the process. • Mobilise resources for grievance resolution. • Follow the Grievance Management Procedure. Check contract arrangements and service agreements are in place for: • Capping stack (e.g. in Saldanha Bay and international locations). • SSDI kit and surface response equipment. • Dispersants and response vessels. • Use low-toxicity dispersants that dilute rapidly and only with MFMR approval.		
Community Vessels collisions, helicopter incidents potentially leading to community health and safety issues	All	• Information about installation operations will be shared with vessel operators through national communication channels, including notices and radio navigation warnings. • Offshore training drills will assess the response readiness of all staff and equipment for a fuel or chemical spill event. • Appropriate contracts will be established to facilitate a response to a release, as is routine for all marine vessel activities. • Follow all flight safety protocols and coordinate with local emergency services.	CNEL, Drilling contractor	Throughout vessel operations and drilling campaign

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
		• Communicate flight schedules and routes in advance to the community. • Monitor and report incidents publicly. • Confirm helicopter airworthiness via a competent authority prior to hiring. • Check pilots are trained on similar aircraft. • Coordinate with air traffic control and the drillship. • Restrict helicopter operations at night or during bad weather. • Provide basic rescue and survival training for all helicopter passengers. • Check personnel are adequately trained in both accident prevention and immediate response, and resources are available on each vessel. • Use low toxicity dispersants cautiously and only with the approval of MFMR. • As far as possible, and whenever the sea state permits, attempt to control and contain the spill at sea with suitable recovery techniques to reduce the spatial and temporal impact of the spill. • Check adequate resources are provided to collect and transport oiled birds to a cleaning station as per specific protocols for capturing oiled and injured seabirds as outlined in the Wildlife Response Plan		

Aspect and Potential impact	Project Phase	Mitigation / Management Action	Responsibility	Timing
		(to be created as part of the OSCP) and coordinated with SANCCOB (Contact Us - SANCCOB). • Check offshore bunkering is not undertaken in the following circumstances: ◦ Wind force and sea state conditions of ≥6 on the Beaufort Wind Scale; ◦ During any workboat or mobilisation boat operations; ◦ During helicopter operations; ◦ During the transfer of in-sea equipment; and ◦ At night or times of low visibility. • Provide basic rescue and survival training for all helicopter passengers.		
Stakeholders Loss of equipment to sea potential impact on commercial fishing	All	• Ensuring that loads are lifted using the correct lifting procedure and within the maximum lifting capacity of the crane system. • Minimise the lifting path between vessels. • Undertake frequent checks to make sure items and equipment are stored and secured safely on board each vessel. • Retrieval of lost objects / equipment, where practicable, after assessing the safety and metocean conditions. Establish a hazards database listing the type of gear left on the seabed and / or in the area	CNEL, Drilling contractor	Throughout vessel operations and drilling campaign

Aspect and Potential impact	Project Phase	Mitigation /Management Action	Responsibility	Timing
		with the dates of abandonment / loss and locations and, where applicable, the dates of retrieval. • Notify SANHO of any hazards left on the seabed or floating in the water column, and request that they send out a Notice to Mariners with this information.		

12. CONCLUSION

The Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP) for the potential offshore exploration drilling activities in PEL 82, Walvis Basin, Namibia, has systematically identified, assessed and addressed the potential environmental and socio-economic impacts associated with the project. The assessment considered both planned and unplanned activities, including routine drilling operations, well testing, vessel and helicopter support, as well as accidental events such as well loss of containment event and vessel collisions.

The ESIA process concluded that, with the implementation of the recommended mitigation and management measures, the potential negative impacts, such as disturbance to marine fauna, benthic habitats, water quality, fisheries and community health and safety can be reduced to minor or incidental significance when the recommended mitigation measures are implemented.

Unplanned events, particularly a major oil spill, represent the most significant potential risk. However, the probability of such events is seldom and robust prevention, preparedness, and response measures (including Chevron's WellSafe standards, OSCP, SCCP, SOPEP and access to international capping stack resources are in place) to reduce the likelihood and severity of impacts to as low as reasonably practicable (ALARP).

The ESMP provides a comprehensive framework for the management of environmental and social risks throughout the project lifecycle. It details specific mitigation actions, monitoring requirements, roles and responsibilities, stakeholder engagement processes, and mechanisms for continuous improvement and corrective action. The ESMP is designed as a "living document" to be updated as necessary in response to project changes, monitoring results, audit findings and stakeholder feedback.

The project is aligned with Namibian legal and policy frameworks, international standards, and Chevron's internal requirements for operational excellence, environmental stewardship, and stakeholder engagement. The assessment confirms that, provided all commitments are fully implemented and compliance is maintained, the potential exploration drilling campaign can proceed in an environmentally and socially responsible manner, supporting Namibia's strategic objectives for sustainable resource development while safeguarding the receiving environment and local communities.

Drawing on the outcomes of the ESIA process and relevant technical and specialist studies, ERM concludes that this ESIA Report is comprehensive and provides adequate information for MIME and MEFT to render an informed decision regarding the potential project. ERM further recommends that, should the application be approved, the commitments outlined in the ESMP be made conditions of the Environmental Clearance Certificate (ECC).

13. BIBLIOGRAPHY

Amorim, K. & M.L. Zettler, 2023. Gradients And Instability: Macrozoobenthic Communities In The Benguela Upwelling System Off Namibia. Estuarine, Coastal And Shelf Science 291: 108421.

Andre, N., 2024. Erongo governor meets churches over crime, Erongo governor meets churches over crime - News - The Namibian.

Atkinson, L.J., 2009. Effects Of Demersal Trawling On Marine Infaunal, Epifaunal And Fish Assemblages: Studies In The Southern Benguela And Oslofjord. PhD Thesis. University Of Cape Town. 141.

Atkinson, L.J., 2010. Benthic Impact Specialist Report For Proposed Well Drilling In Petroleum Licence Block 11b/12b, South Coast, South Africa By Cnr International Ltd. Report Prepared For CCA Environmental. 30

Atkinson, L.J., Field, J.G. & L. Hutchings, 2011. Effects Of Demersal Trawling Along The West Coast Of Southern Africa: Multivariate Analysis Of Benthic Assemblages. Marine Ecology Progress Series 430: 241-255.

Atkinson, L.J. And T. Shipton, 2009. Benthic Specialist Basic Assessment Report For The Proposed Drilling Exploration Permit In Petroleum Lease Block 1, West Coast, South Africa. Pp. 28.

Bailey, G.W., 1991. Organic Carbon Flux And Development Of Oxygen Deficiency On The Modern Benguela Continental Shelf South Of 22°S: Spatial And Temporal Variability. In: Tyson, R.V., Pearson, T.H. (Eds.), Modern And Ancient Continental Shelf Anoxia. Geol. Soc. Spec. Publ., 58: 171–183.

Bailey, G.W., 1999. Severe Hypoxia And Its Effect On Marine Resources In The Southern Benguela Upwelling System. Abstract, International Workshop On Monitoring Of Anaerobic Processes In The Benguela Current Ecosystem Off Namibia.

Bailey, G.W., Beyers, C.J. De B. And S.R. Lipschitz, 1985. Seasonal Variation Of Oxygen Deficiency In Waters Off Southern South West Africa In 1975 And 1976 And Its Relation To Catchability And Distribution Of The Cape Rock-Lobster Jasus Lalandii. S. Afr. J. Mar. Sci., 3: 197-214.

Bailey G.W. And P. Chapman, 1991. Chemical And Physical Oceanography. In: Short-Term Variability During An Anchor Station Study In The Southern Benguela Upwelling System. Prog. Oceanogr., 28: 9-37.

Bakke, T., Green, A.M.V. & P.E. Iversen, 2011. Offshore Environmental Monitoring In Norway - Regulations, Results And Developments. In: Lee, K. & J. Neff, (Eds.), Produced Water. Springer, Ny (Chapter 25).

Bakke, T., Klungsøyr, J. & S. Sanni, 2013. Environmental Impacts Of Produced Water And Drilling Waste Discharges From The Norwegian Offshore Petroleum Industry. Mar. Environ. Res. 92: 154-169.

Banks, A. Best, P.B., Gullan, A., Guissamulo, A., Cockcroft, V. And K. Findlay, 2011. Recent Sightings Of Southern Right Whales In Mozambique. Document Sc/S11/Rw17

Submitted To Iwc Southern Right Whale Assessment Workshop, Buenos Aires 13-16 Sept. 2011.

Barendse, J., Best, P.B., Thomton, M., Pomilla, C. Carvalho, I. And H.C. Rosenbaum, 2010. Migration Redefined? Seasonality, Movements And Group Composition Of Humpback Whales Megaptera Novaeangliae Off The West Coast Of South Africa. Afr. J. Mar. Sci., 32(1): 1-22.

Barendse, J., Best, P.B., Thornton, M., Elwen, S.H., Rosenbaum, H.C., Carvalho, I., Pomilla, C., Collins, T.J.Q. And M.A. Meÿer, 2011. Transit Station Or Destination? Attendance Patterns, Regional Movement, And Population Estimate Of Humpback Whales Megaptera Novaeangliae Off West South Africa Based On Photographic And Genotypic Matching. African Journal Of Marine Science, 33(3): 353-373.

Barnard, P., 1998. Biological Diversity In Namibia - A Country Study. Namibian National Biodiversity Task Force, Windhoek.

Baturin, G.N., 2002. Nodular Fraction Of Phosphatic Sand From The Namibia Shelf. Lithology And Mineral Resources, 37: 1–17.

Benthic Solutions Ltd, 2019. Venus 1x Environmental Baseline Survey. Vol 2: Environmental Baseline Survey And Habitat Assessment Report. Prepared For Total E And P Namibia B.V. May 2019, Pp152.

Berg, J.A. And R.I.E. Newell, 1986. Temporal And Spatial Variations In The Composition Of Seston Available To The Suspension-Feeder Crassostrea Virginica. Estuar. Coast. Shelf. Sci., 23: 375–386.

Best, P.B., 2001. Distribution And Population Separation Of Bryde's Whale Balaenoptera Edeni Off Southern Africa. Mar. Ecol. Prog. Ser., 220: 277 – 289.

Best, P.B., 2007. Whales And Dolphins Of The Southern African Subregion. Cambridge University Press, Cape Town, South Africa.

Best, P.B. And C. Allison, 2010. Catch History, Seasonal And Temporal Trends In The Migration Of Humpback Whales Along The West Coast Of Southern Africa. Iwc Sc/62/Sh5.

Best, P.B. And C.H. Lockyer, 2002. Reproduction, Growth And Migrations Of Sei Whales Balaenoptera Borealis Off The West Coast Of South Africa In The 1960s. South African Journal Of Marine Science, 24: 111-133.

Best P.B., Meÿer, M.A. And C. Lockyer, 2010. Killer Whales In South African Waters – A Review Of Their Biology. African Journal Of Marine Science. 32: 171–186.

Beyer, J., Goksøyr, A., Hjermann, D.Ø. & J. Klungsøyr, 2020. Environmental Effects Of Offshore Produced Water Discharges: A Review Focused On The Norwegian Continental Shelf. Mar. Environ. Res., 162: 105155.

Beyers, C.J. De B., Wilke, C.G. & P.C Goosen, 1994. The Effects Of Oxygen Deficiency On Growth, Intermoult Period, Mortality And Ingestion Rates Of Aquarium-Held Juvenile Rock Lobster Jasus Lalandii. South African Journal Of Marine Science 14, 79-88.

Bianchi, G., Carpenter, K.E., Roux, J.-P., Molloy, F.J., Boyer, D. And H.J. Boyer, 1999. Fao Species Identification Guide For Fishery Purposes. Field Guide To The Living Marine Resources Of Namibia, 256 Pp.

Bianchi, G., Hamukuaya, H. And O. Alvheim, 2001. On The Dynamics Of Demersal Fish Assemblages Off Namibia In The 1990s. South African Journal Of Marine Science 23: 419-428.

Biccard, A. & B.M. Clark, 2016. De Beers Marine Namibia Environmental Monitoring Programme In The Atlantic 1 Mining License area: 2013 Benthic Sampling Campaign. Report Prepared For De Beers Marine Namibia By Anchor Environmental Consultants (Pty) Ltd. Report No. 1527/3.

Biccard, A., Clark, B.M. & E.A. Brown, 2016. De Beers Marine Namibia Environmental Monitoring Programme In The Atlantic 1 Mining License area: 2014 Benthic Sampling Campaign. Report Prepared For De Beers Marine Namibia By Anchor Environmental Consultants (Pty) Ltd. Report No. 1527/4.

Biccard, A., Clark, B.M., Brown, E.A., Duna, O., Mostert, B.P., Harmer, R.W., Gihwala, K. & A.G. Wright, 2017. De Beers Marine Namibia Environmental Monitoring Programme: Atlantic 1 Mining License area 2015 Benthic Sampling Campaign. Report Prepared For De Beers Marine Namibia By Anchor Environmental Consultants (Pty) Ltd. Report No. 1527/4.

Biccard, A., Gihwala, K., Clark, B.M., Mostert, B., Brown, E., Hutchings, K., Massie, V. And M. Melidonis, 2018. Desktop Study Of The Potential Impacts Of Marine Mining On Marine Ecosystems And Marine Biota In South Africa – Final Report. Report Prepared By Anchor Research & Monitoring (Pty) Ltd For Council For Geoscience. Report No. 1795/1.

Biccard A, Gihwala K, Clark Bm, Harmer Rw, Brown Ea, Mostert Bp, Wright Ag & A Masosonke. 2018. De Beers Marine Namibia Environmental Monitoring Programme: Atlantic 1 Mining License area 2016 Benthic Sampling Campaign. Report Prepared For De Beers Marine Namibia By Anchor Environmental Consultants (Pty) Ltd. Report No. 1726/1.

Biccard, A., K. Gihwala, B.M. Clark, E.A. Brown, B.P. Mostert, A. Masosonke, C. Swart, S. Sedick, B. Tshingana & J. Dawson, 2019. De Beers Marine Namibia Environmental Monitoring Programme: Atlantic 1 Mining License area 2017 Benthic Sampling Campaign. Report Prepared For De Beers Marine Namibia By Anchor Environmental Consultants (Pty) Ltd. Report No. 1775/1.

Bickerton, I.B. And R.A. Carter, 1995. Benthic Macrofauna Distributions On The Inner Continental Shelf Off Lüderitz. In: Csir, 1995. Environmental Impact Assessment For The Proposed Mining Of Concession Area M46/3/1607 Off Lüderitz Bay: Namibia. Csir Report Emas-C95040b, Stellenbosch, South Africa.

Birch, G., 1990. Phosphorite Deposits On The South African Continental Margin And Coastal Terrace. In: Burnett, W.C. And S.R. Riggs (Eds.) Phosphate Deposits Of The World, Vol. 3, Neogene To Modern Phosphorites. Cambridge University Press, Cambridge, Uk:153-158

Birch G.F., Rogers J., Bremner J.M. And G.J. Moir, 1976. Sedimentation Controls On The Continental Margin Of Southern Africa. First Interdisciplinary Conf. Mar. Freshwater Res. S. Afr., Fiche 20a: C1-D12.

Birdlife International, 2004. Tracking Ocean Wanderers: The Global Distribution Of Albatrosses And Petrels. Results From The Global Procellariiform Tracking Workshop, 1–5 September, 2003, Gordon's Bay, South Africa. Cambridge, Uk: Birdlife International.

Birdlife South Africa, 2022. Threatened Seabird Habitats In The South African Exclusive Economic Zone: Biodiversity Feature Layer Submission To The National Coastal And Marine Spatial Biodiversity Plan. Birdlife South Africa Scp Report 2022/1.

Birdlife, 2025. Accessed https://maps.birdlife.org/marineIBAs

Blaber, S.J.M. & T.G. Blaber, 1980. Factors Affecting The Distribution Of Juvenile Estuarine And Inshore Fish. Journal Of Fish Biology 17: 143-162.

Boyd, A..J. And G.P.J. Oberholster, 1994. Currents Off The West And South Coasts Of South Africa. S. Afr. Shipping News And Fish. Ind. Rev., 49: 26-28.

Boyer, D. And H. Boyer 2015. Albatrosses, White-Chinned Petrel And Northern Giant-Petrel. In: Simmons, R.E., Brown, C.J. And J. Kemper (Eds). Birds To Watch In Namibia: Red, Rare And Endemic Species. National Biodiversity Programme, Windhoek, Namibia

Brandão, A., Vermeulen, E., Ross-Gillespie, A., Findlay, K. And D.S. Butterworth, 2017. Updated Application Of A Photo-Identification Based Assessment Model To Southern Right Whales In South African Waters, Focussing On Inferences To Be Drawn From A Series Of Appreciably Lower Counts Of Calving Females Over 2015 To 2017. Paper Sc/67b/Sh22 To The 67th Meeting Of The Scientific Committee Of The International Whaling Commission, Bled, Slovenia.

Breeze, H., Davis, D.S. Butler, M. And V. Kostylev, 1997. Distribution And Status Of Deep Sea Corals Off Nova Scotia. Marine Issues Special Committee Special Publication No. 1. Halifax, Ns: Ecology Action Centre. 58 Pp.

Bremner, J.M., 1980. Concretionary Phosphorite From Sw Africa. J. Geol. Soc. London, 137: 773-786.

Bricelj, V.M. And R.E. Malouf, 1984. Influence Of Algal And Suspended Sediment Concentrations On The Feeding Physiology Of The Hard Clam Mercenaria Mercenaria. Mar. Biol., 84: 155–165.

Bröker, K.C.A., 2019. An Overview Of Potential Impacts Of Hydrocarbon Exploration And Production On Marine Mammals And Associated Monitoring And Mitigation Measures. Aquatic Mammals, 45(6): 576-611.

Brown, N.A. (1976). Cavitation Noise Problems And Solutions.

Brüchert, V., Barker Jǿrgensen, B., Neumann, K., Riechmann, D., Schlösser M. And H. Schulz, 2003. Regulation Of Bacterial Sulfate Reduction And Hydrogen Sulfide Fluxes In The Central Namibian Coastal Upwelling Zone. Geochim. Cosmochim. Acta, 67(23): 4505-4518.

Brunnschweiler, J.M., Baensch, H., Pierce, S.J. & D.W. Sims, 2009. Deep-Diving Behaviour Of A Whale Shark Rhincodon Typus During Long-Distance Movement In The Western Indian Ocean. Journal Of Fish Biology, 74: 706–714.

BW Energy. (2025, July 28). BW Energy contracts Deepsea Mira for drilling Kudu appraisal well. BW Energy. https://www.bwenergy.no/press-releases/2025/bw-energy-contracts-deepsea-mira-for-drilling-kudu-appraisal-well/.

Carlucci, R., Manea, E., Ricci, P., Cipriano, G., Fanizza, C., Maglietta, R. & E. Gissi, 2021. Managing Multiple Pressures For Cetaceans' Conservation With An Ecosystem-Based Marine Spatial Planning Approach. Journal Of Environmental Management, 287:112240.

Chapman, P. And L.V. Shannon, 1985. The Benguela Ecosystem. Part Ii. Chemistry And Related Processes. Oceanogr. Mar. Biol. Ann. Rev., 23: 183-251.

Chevron, 2022. Accessed From 2022 Corporate Sustainability Report,

Chevron Operational Excellence Management System, 2021. Online: OEMS Overview.

Child, M.F., Roxburgh, L., Do Linh San, E., Raimondo, D. And H.T. Davies-Mostert, (Editors). 2016. The Red List Of Mammals Of South Africa, Swaziland And Lesotho. South African National Biodiversity Institute And Endangered Wildlife Trust, South Africa (Https://Www.Ewt.Org.Za/Reddata/Order%20cetacea.Html).

Christians F., 2020. Country profile - Primary healthcare and family medicine in Namibia. African Journal of Primary Health Care Family Medicine. 2020 Jan 27;12(1):e1-e3, Country profile – Primary healthcare and family medicine in Namibia - PMC.

Chivers, S., Leduc, R., Robertson, K., Barros, N. And A. Dizon, 2004. Genetic Variation Of Kogia Spp. With Preliminary Evidence For Two Species Of Kogia Sima. Marine Mammal Science, 21: 619-634.

Christie, N.D., 1974. Distribution Patterns Of The Benthic Fauna Along A Transect Across The Continental Shelf Off Lamberts Bay, South Africa. Ph.D. Thesis, University Of Cape Town, 110 Pp And Appendices.

Christie N.D. And A.G. Moldan, 1977. Effects Of Fish Factory Effluent On The Benthic Macro-Fauna Of Saldanha Bay. Marine Pollution Bulletin, 8: 41-45.

Clark, B.M., 1997a. Variation In Surf Zone Fish Community Structure Across A Wave Exposure Gradient. Estuarine & Coastal Shelf Science 44: 659-674.

Clark, B.M., 1997b. Dynamics And Utilisation Of Surf Zone Habitats By Fish In The South-Western Cape, South Africa. Unpublished Phd Thesis, University Of Cape Town.

Clark, B.M., Bennett, B.A. And S.L. Lamberth, 1994. A Comparison Of The Ichthyofauna Of Two Estuaries And Their Adjacent Surf Zones, With An Assessment Of The Effects Of Beach-Seining On The Nursery Function Of Estuaries For Fish. South African Journal Of Marine Science, 14: 121-131.

Clark, M.R., O'shea, S., Tracey, D. And B. Glasby, 1999. New Zealand Region Seamounts. Aspects Of Their Biology, Ecology And Fisheries. Report Prepared For The Department Of Conservation, Wellington, New Zealand, August 1999. 107 Pp.

Cliff, G., Anderson-Reade, M.D., Aitken, A.O., Charter, G.E. & V.M. Peddemors, 2007. Aerial Census Of Whale Sharks (Rhincodon Typus) On The Northern Kwazulu-Natal Coast, South Africa. Fish Res., 84: 41–46.

ClimateWatch, 2025. From https://www.climatewatchdata.org/countries/NAM?end_year=2022&start_year=1990#ghg-emissions.

Cockcroft, A.C, Schoeman, D.S., Pitcher, G.C., Bailey, G.W.And D.L. Van Zyl, 2000. A Mass Stranding, Or 'Walk Out' Of West Coast Rock Lobster, Jasus Lalandii, In Elands Bay, South Africa: Causes, Results And Implications. In: Von Vaupel Klein, J.C.And F.R. Schram (Eds), The Biodiversity Crisis And Crustacea: Proceedings Of The Fourth International Crustacean Congress, Published By Crc Press.

Coetzee, J.C., Van Der Lingen, C.D., Hutchings, L. And T.P. Fairweather, 2008. Has The Fishery Contributed To A Major Shift In The Distribution Of South African Sardine? Ices Journal Of Marine Science 65: 1676–1688.

Compagno, L.J.V., 2001. Sharks Of The World: An Annotated And Illustrated Catalogue Of Shark Species Known To Date. Bullhead, Mackerel And Carpet Sharks (Heterodontiformes, Lamniformes And Orectolobiformes). Fao Species Catalogue For Fisheries Purposes No. 1, Vol. 2. Food And Agriculture Organization Of The United Nations, Rome, Italy

Compagno, L.J.V., Ebert, D.A. And P.D. Cowley, 1991. Distribution Of Offshore Demersal Cartilaginous Fish (Class Chondrichthyes) Off The West Coast Of Southern Africa, With Notes On Their Systematics. S. Afr. J. Mar. Sci. 11: 43-139.

Compton, J.S. & E.W. Bergh, 2016. Phosphorite Deposits On The Namibian Shelf. Marine Geology, 380: 290-314.

Costa, D., Schwarz, L., Robinson, P., Schick, R., Morris, P.A., Condit, R., Et Al., 2016. A Bioenergetics Approach To Understanding The Population Consequences Of Disturbance: Elephant Seals As A Model System. In: Popper, A.N. & A. Hawkins (Eds.), The Effects Of Noise-On Aquatic Life Ii: Advances In Experimental Medicine And Biology, 875: 161-169.

Cox, T. M., Ragen, T. J., Read, A. J., Vos, E., Baird, R. W., Balcomb, K., ... and Benner, L. 2001. Understanding the impacts of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management. 7(3):177-187.

Cox, T.M. & 35 Others. 2006. Understanding The Impacts Of Anthropogenic Sound On Beaked Whales. J. Cetacean Res. Manage., 7(3): 177-187.

Cox, T.M., Ragen, T.J., Read, A.J., Vos, E., Baird, R.W., Balcomb, K., Barlow, J., Caldwell, J., Cranford, T. and Crum, L., 2006. Understanding the impacts of anthropogenic sound on beaked whales.

Crawford, R.J.M. & G. De Villiers, 1985. Snoek And Their Prey – Interrelationships In The Benguela Upwelling System. S. Afr. J. Sci., 81(2): 91–97.

Crawford, R.J.M., Shannon, L.V. And D.E. Pollock, 1987. The Benguela Ecosystem. 4. The Major Fish And Invertebrate Resources. Oceanogr. Mar. Biol. Ann. Rev., 25: 353 - 505.

Crowther Campbell And Associates Cc And Centre For Marine Studies (Cca And Cms). 2001. Generic Environmental Management Programme Reports For Oil And Gas Prospecting Off The Coast Of South Africa. Prepared For Petroleum Agency Sa, October 2001.

Cruikshank, R.A., 1990. Anchovy Distribution Off Namibiadeduced From Acoustic Surveys With An Interpretation Of Migration By Adults And Recruits. S. Afr. J. Mar. Sci., 9: 53-68.

Csir, 1996. Elizabeth Bay Monitoring Project: 1995 Review. Csir Report Env/S-96066.

Csir, 1999. Synthesis And Assessment Of Information On The Bclme. Bclme Thematic Report 4: Integrated Overview Of The Offshore Oil And Gas Industry In The Benguela Current Region. Csir Report Env-S-C 99057.

Cunha, H.A., De Castro, R.L., Secchi, E.R., Crespo, E.A., Lailson-Brito, J., Azevedo, A.F., Lazoski, C. & A.M. Solé-Cava, 2015. Molecular And Morphological Differentiation Of Common Dolphins (Delphinus Spp.) In The Southwestern Atlantic: Testing The Two Species Hypothesis In Sympatry. Plos One 10:E0140251.

Currie, H., Grobler, K. And J. Kemper (Eds), 2009. Namibian Islands' Marine Protected Area. Ministry Of Fisheries And Marine Resources, Namibia. Http://Www.Nacoma.Org.Na/Key_Activities/Marine Protected Areas.Htm.

Daniels, O., 2020. HAFA drives job creation, HAFA drives job creation - Republikein - Jou Land, Jou Taal, Jou Nuus.

Da Silva, C., Kerwath, S.E., Wilke, C., Meÿer, M. & S.J. Lambert, 2010. First Documented Southern Transatlantic Migration Of Blue Shark Prionace Glauca Tagged Off South Africa. African Journal Of Marine Science, 32(3) : 639-642.

David, J.H.M, 1989., Seals. In: Oceans Of Life Off Southern Africa, Eds. Payne, A.I.L. And Crawford, R.J.M. Vlaeberg Publishers. Halfway House, South Africa.

De Cauwer, V., 2007. Bep/Bac/03/02 Mapping Of The Bclme Shoreline, Shallow Water & Marine Habitats: Physical Mapping Project. Project In Collaboration With The Benguela Environment Fisheries Interaction & Training Programme (Benefit) For The Bclme Programme.

De Decker, A.H., 1970. Notes On An Oxygen-Depleted Subsurface Current Off The West Coast Of South Africa. Invest. Rep. Div. Sea Fish. South Africa, 84, 24 Pp.

De Rock, P., Elwen, S.H., Roux, J-P., Leeney, R.H., James, B.S., Visser, V., Martin, M.J. & T. Gridley, 2019. Predicting Large-Scale Habitat Suitability For Cetaceans Off Namibia Using Minxent. Marine Ecology Progress Series, 619: 149-167.

Desprez, M., 2000. Physical And Biological Impact Of Marine Aggregate Extraction Along The French Coast Of The Eastern English Channel: Short-And Long-Term Post-Dredging Restoration. Ices Journal Of Marine Science, 57: 1428–1438.

De Wet, A. 2013. Factors Affecting Survivorship Of Loggerhead (Caretta Caretta) And Leatherback (Dermochelys Coriacea) Sea Turtles Of South Africa. Msc, Nelson Mandela Metropolitan University.

Dingle, R.V., 1973. The Geology Of The Continental Shelf Between Lüderitz (South West Africa) And Cape Town With Special Reference To Tertiary Strata. J. Geol. Soc. Lond., 129: 337-263.

Drake, D.E., Cacchione, D.A. And H.A. Karl, 1985. Bottom Currents And Sediment Transport On San Pedro Shelf, California. J. Sed. Petr., 55: 15-28.

Dubois, M.J., Putman, N.F. & S.E. Piacenza, 2021. A Global Assessment Of The Potential For Ocean-Driven Transport In Hatchling Sea Turtles. Water, 13: 757.

Duna, O., Clark, B.M., Biccard, A., Hutchings, K., Harmer, R., Mostert, B., Brown, E., Massie, V., Makunga, M., Dlaku, Z. & A, Makhosonke, 2016. Assessment Of Mining-Related Impacts On Macrofaunal Benthic Communities In The Northern Inshore Area Of Mining License area Mpt 25-2011 And Subsequent Recovery. Technical Report. Report Prepared For De Beers Marine By Anchor Environmental Consultants (Pty) Ltd. Report No. 1646/1.

Duncombe Rae, C.M., 2005. A Demonstration Of The Hydrographic Partition Of The Benguela Upwelling Ecosystem At 26°40’s. Afr. J. Mar. Sci., 27(3): 617–628.

Dundee, B.L., 2006. The Diet And Foraging Ecology Of Chick-Rearing Gannets On The Namibian Islands In Relation To Environmental Features: A Study Using Telemetry. Msc Thesis, University Of Cape Town, South Africa.

Dunlop, R.A., Braithwaite, J., Mortensen, L.O. & C.M. Harris, 2021. Assessing Population-Level Effects Of Anthropogenic Disturbance On A Marine Mammal Population. Front. Mar. Sci., 8: 1 12.

Eckert, S.A. & B.S. Stewart, 2001. Telemetry And Satellite Tracking Of Whale Sharks, Rhincodon Typus, In The Sea Of Cortez, Mexico, And The North Pacific Ocean. Environmental Biology Of Fishes, 60: 299–308.

Eckert, S.A., Eckert, K.L., Ponganis, P. & G.L. Kooman, 1989. Diving And Foraging Behavior Of Leatherback Sea Turtles (Dermochelys Coriacea). Canadian Journal Of Zoology 67: 28-34.

Eisenbarth, S. & M. Zettler, 2015. Diversity Of The Benthic Macrofauna Off Northern Namibia From The Shelf To The Deep Sea. Journal Of Marine Systems. 1-10. 10.1016/J.Jmarsys.2015.10.017.

Ekau, W. And H. M. Verheye, 2005. Influence Of Oceanographic Fronts And Low Oxygen On The Distribution Of Ichthyoplankton In The Benguela And Southern Angola Currents. Afr. J. Mar. Sci., 27(3): 629–639.

Ellison, W.T., Racca, R., Clark, C.W., Streever, B. Et Al. 2016. Modelling The Aggregated Exposure And Responses Of Bowhead Whales Balaena Mysticetus To Multiple Sources Of Anthropogenic Underwater Sound. Endang. Species Res., 30: 95–108.

Elwen, S.H., Gridley, T., Roux, J.-P., Best, P.B. And M.J. Smale, 2013. Records Of Kogiid Whales In Namibia, Including The First Record Of The Dwarf Sperm Whale (K. Sima). Marine Biodiversity Records. 6, E45 Doi:10.1017/S1755267213000213.

Elwen, S.H. And R.H. Leeney, 2011. Interactions Between Leatherback Turtles And Killer Whales In Namibian Waters, Including Predation. South African Journal Of Wildlife Research, 41(2): 205-209.

Elwen, S.H. Meÿer, M.A.M, Best, P.B., Kotze, P.G.H, Thornton, M. And S. Swanson, 2006. Range And Movements Of A Nearshore Delphinid, Heaviside's Dolphin Cephalorhynchus Heavisidii A Determined From Satellite Telemetry. Journal Of Mammalogy, 87(5): 866–877.

Elwen, S.H., Best, P.B., Reeb, D. And M. Thornton, 2009b. Near-Shore Diurnal Movements And Behaviour Of Heaviside's Dolphins (Cephalorhynchus Heavisidii), With Some Comparative Data For Dusky Dolphins (Lagenorhynchus Obscurus). South African Journal Of Wildlife Research, 39(2): 143-154.

Elwen, S.H., Best, P.B., Thornton, M., And D. Reeb, 2010. Near-Shore Distribution Of Heaviside's (Cephalorhynchus Heavisidii) And Dusky Dolphins (Lagenorhynchus Obscurus) At The Southern Limit Of Their Range In South Africa. African Zoology, 45(1).

Elwen, S.H., Findlay, K.P., Kiszka, J. & C.R. Weir, 2011. Cetacean Research In The Southern African Subregion: A Review Of Previous Studies And Current Knowledge, African Journal Of Marine Science 32(3)

Elwen S.H., Reeb D., Thornton M. And P.B. Best, 2009a. A Population Estimate Of Heaviside's Dolphins Cephalorhynchus Heavisidii In The Southern End Of Their Range. Marine Mammal Science 25: 107-124.

Elwen, S.H., Tonachella, N., Barendse, J,. Collins, T.J.Q., Best, P.B., Rosenbaum, H.C., Leeney, R.H. And T. Gridley. 2014. Humpback Whales Off Namibia: Occurrence, Seasonality, And A Regional Comparison Of Photographic Catalogs And Scarring. Journal Of Mammalogy, 95 (5): 1064–76. Doi:10.1644/14-Mamm-A-108.

Emanuel, B.P., Bustamante, R.H., Branch, G.M., Eekhout, S. And F.J. Odendaal, 1992. A Zoogeographic And Functional Approach To The Selection Of Marine Reserves On The West Coast Of South Africa. S. Afr. J. Mar. Sci., 12: 341-354.

Emeis, K.-C., Brüchert, V., Currie, B., Endler, R., Ferdelman, T., Kiessling, A., Leipe, T., Noli-Peard, K., Struck, U. And T. Vogt, 2004. Shallow Gas In Shelf Sediments Of The Namibian Coastal Upwelling Ecosystem. Continental Shelf Research, 24: 627-642.

Environmental Evaluation Unit, 1996. Impacts Of Deep Sea Diamond Mining, In The Atlantic 1 Mining License area In Namibia, On The Natural Systems Of The Marine Environment. Environmental Evaluation Unit Report No. 11/96/158, University Of Cape Town. Prepared For De Beers Marine (Pty) Ltd. 370 Pp.

Environmental Impact Assessment Regulations, 2012. Online: nam137363.pdf.

Environmental Management Act 7 of 2004. Online: Environmental Management Act 7 of 2007.

Erbe, C., Reichmuth, C., Cunningham, K., Lucke, K. and Dooling, R., 2016. Communication masking in marine mammals: A review and research strategy. Marine pollution bulletin, 103(1-2), 15-38.

Erbe, C., Marley, S.A., Schoeman, R.P., Smith, J.N., Trigg, L.E. and Embling, C.B., 2019. The effects of ship noise on marine mammals—a review. Frontiers in Marine Science, 6, p.606.

Erongo RED, About Erongo RED - Leading Electricity Distributor in Erongo Region, Namibia.

Erongo Regional Council, 2015.Tourism, Tourism.

FAO, 2008. International Guidelines For The Management Of Deep-Sea Fisheries In The High Seas. Sprfmo-Vi-Swg-Inf01

FAO, 2022. Fishery And Aquaculture Statistics Yearbook 2022.

Fegley, S.R., Macdonald, B.A. And T.R. Jacobsen, 1992. Short-Term Variation In The Quantity And Quality Of Seston Available To Benthic Suspension Feeders. Estuar. Coast. Shelf Sci., 34: 393–412.

Findlay K.P., Best P.B., Ross G.J.B. And V.C. Cockroft. 1992. The Distribution Of Small Odontocete Cetaceans Off The Coasts Of South Africa And Namibia. S. Afr. J. Mar. Sci. 12: 237-270.

Finke, G., Gee, K., Kreiner, A., Amunyela, M. & R. Braby, 2020b. Namibia's Way To Marine Spatial Planning – Using Existing Practices Or Instigating Its Own Approach? Marine Policy 121: 104107.

Finke, G., Gee, K., Gxaba, T., Sorgenfrei, R., Russo, V., Pinto, D., Nsiangango, S.E.,Et Al. 2020a. Marine Spatial Planning In The Benguela Current Large Marine Ecosystem. Environmental Development, 36: 100569.

Finneran, J.J., 2016. Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise (No. TR3026).

Finneran, J.J., E.E. Henderson, D.S. Houser, K. Jenkins, S. Kotecki, & J. Mulsow. 2017. Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III). Technical report by Space and Naval Warfare Systems Center Pacific (SSC Pacific). 183 p

Fossing, H., Ferdelman, T.G. And P. Berg, 2000. Sulfate Reduction And Methane Oxidation In Continental Margin Sediments Influenced By Irrigation (South-East Atlantic Off Namibia). Geochim. Cosmochim. Acta. 64(5): 897–910.

Foulis, A.J., 2013. A Retrospective Analysis Of Shark Catches Made By Pelagic Longliners Off The East Coast Of South Africa And Biology And Life History Of Shortfin Mako Shark, Isurus Oxyrinchus. Msc. Thesis, University Of Kwazulu-Natal, Durban, South Africa. Pp. 117.

Francis, C.D., Ortega, C.P. & A. Cruz, 2009. Cumulative Consequences Of Noise Pollution: Noise Changes Avian Communities And Species Interactions. Current Biology, 19: 1415–1419.

Geomar, 2014. Rv Sonne Fahrtbericht / Cruise Report So233 Walvis Ii: Cape Town, South Africa - Walvis Bay, Namibia: 14.05-21.06.2014. Hoernle, K., Werner, R., Lüter, C (Eds). Helmholtzzentrum Für Ozeanforschung Kiel, Germany: Nr. 22 (N. Ser.), 153 Pp.

Gihwala, K., Biccard, A., Clark, B.M., Brown, E.A., Makhosonke, A., Swart, C. & B. Tshingana, 2018. De Beers Marine Namibia Environmental Monitoring Programme: Mining-Related Impacts In Mining License Area Mpt 25-2011 And Subsequent Recovery. Report Prepared For De Beers Marine Namibia By Anchor Environmental Consultants (Pty) Ltd. Report No. 1800/1.

Gihwala, K., Biccard, A., Clark, B.M., Brown, E.A., Makhosonke, A., Swart, C. & B. Tshingana, 2019. Mining-Related Impacts To Soft Bottom Benthic Habitats And Associated Macrofauna Assemblages In Mining License Area Sasa 2c And Subsequent Recovery. Report Prepared For De Beers Group Of Companies By Anchor Environmental Consultants (Pty) Ltd. Report No. 1800/1.

Goosen, A.J.J., Gibbons, M.J., Mcmillan, I.K., Dale, D.C. And P.A. Wickens, 2000. Benthic Biological Study Of The Marshall Fork And Elephant Basin Areas Off Lüderitz. Prepared By De Beers Marine (Pty) Ltd. For Diamond Fields Namibia, January 2000. 62 Pp.

Government of Namibia, 2004. National Heritage Act 2004. See Part VI, section 57.

Gray, J.S., Aschan, M., Carr, M.R., Clarke, K.R., Green, R.H., Pearson, T.H., Rosenberg, R. & R.M. Warwick, 1988. Analysis Of Community Attributes Of The Benthic Macrofauna Of Frierfjord-Langesundfjord And In A Mesocosm Experiment. Mar. Ecol. Prog. Ser., 46: 151-165.

Gray, J.S., Clarke, K.R., Warwick, R.M. & G. Hobbs, 1990. Detection Of Initial Effects Of Pollution On Marine Benthos E An Example From The Ekofisk And Eldfisk Oilfields, North-Sea. Mar. Ecol. Prog. Ser., 66: 285-299.

Griffiths, M.H., 2002. Life History Of South African Snoek Thyrsites Atun (Pisces: Gempylidae): A Pelagic Predator Of The Benguela Ecosystem. Fishery Bull., Wash. 100(4): 690-710.

Griffiths, M.H., 2003. Stock Structure Of Snoek Thyrsites Atun In The Benguela: A New Hypothesis. Afr. J. Mar. Sci., 25: 383-386.

Griffiths, M.H. & P.C. Heemstra, 1995. A Contribution To The Taxonomy Of The Marine Fish Genus Argyrosomus (Perciformes: Sciaenidae), With Descriptions Of Two New Species From Southern Africa. Ichthyol. Bull., J.L.B. Smith Inst. Ichthyol. No. 65, 40 P

Groeneveld, J.C., G. Cliff, S.F.J. Dudley, A.J. Foulis, J. Santos & S. P. Wintner, 2014. Population Structure And Biology Of Shortfin Mako, Isurus Oxyrinchus, In The South-West Indian Ocean. Marine And Freshwater Research 65:1045–1058.

Hamann, M., Grech, A., Wolanski, E. & J. Lambrechts, 2011. Modelling The Fate Of Marine Turtle Hatchlings. Ecol. Modelling 22: 1515–1521.

Hammar, L., Molander, S., Pålsson, J., Crona Schmidtbauer, J., Carneiro, C., Johansson, T., Hume, D., Kågesten, G., Mattsson, D., Törnqvist, O., Zillén, L., Mattsson, M., Bergström, U., Perry, D., Caldow, C. & J. Andersen, 2020. Cumulative Impact Assessment For Ecosystem- Based Marine Spatial Planning. Science Of The Total Environment, 734: 139024.

Hampton, I., 1992. The Role Of Acoustic Surveys In The Assessment Of Pelagic Fish Resources On The South African Continental Shelf. South African Journal Of Marine Science, 12: 1031-1050.

Hampton, I., 2003. Harvesting The Sea. In: Molloy, F. And T. Reinikainen (Eds), 2003. Namibia's Marine Environment. Directorate Of Environmental Affairs, Ministry Of Environment And Tourism, Namibia, 31-69.

Haney, J.C., Haury, L.R., Mullineaux, L.S. And C.L. Fey, 1995. Sea-Bird Aggregation At A Deep North Pacific Seamount. Marine Biology, 123: 1-9.

Hansen. F.C., Cloete. R.R. And H.M. Verheye, 2005. Seasonal And Spatial Variability Of Dominant Copepods Along A Transect Off Walvis Bay (23ºs), Namibia. African Journal Of Marine Science, 27: 55-63.

Harris, L.R., Nel, R., Oosthuizen, H., Meÿer, M., Kotze, D., Anders, D., Mccue, S. & S. Bachoo, 2018. Managing Conflict Between Economic Activities And Threatened Migratory Species Toward Creating A Multiobjective Blue Economy. Conservation Biology, 32(2): 411-423.

Harris, L.R., Holness, S.D., Kirkman, S.P., Sink, K.J., Majiedt, P. & A. Driver, 2022. National Coastal And Marine Spatial Biodiversity Plan, Version 1.2 (Released 12-04-2022): Technical Report. Nelson Mandela University, Department Of Forestry, Fisheries And The Environment, And South African National Biodiversity Institute. South Africa. 280 Pp.

Hawkins, A.D., Roberts, L. & S. Cheesman, 2014. Responses Of Freeliving Coastal Pelagic Fish To Impulsive Sounds. Journal Of The Acoustical Society Of America, 135: 3101–3116.

Hays, G.C. Houghton, J.D.R., Isaacs, C. King, R.S. Lloyd, C. And P. Lovell, 2004. First Records Of Oceanic Dive Profiles For Leatherback Turtles, Dermochelys Coriacea, Indicate Behavioural Plasticity Associated With Long-Distance Migration. Animal Behaviour, 67: 733-743.

Hazin, F.H.V., Pinheiro, P.B. & M.K. Broadhurst, 2000. Further Notes On Reproduction Of The Blue Shark, Prionace Glauca, And A Postulated Migratory Pattern In The South Atlantic Ocean. Cienca E Cultura 52: 114–120.

Hickey, C., Funnemark, E., & Thomas, M., 2014. The Worldwide Offshore Accident Databank (WOAD). In: DNV GL – Software and Oil & Gas Divisions. The Worldwide Offshore Accident Databank rev4. DNV GL, Høvik, Norway.

Hofmeyr-Juritz, L.H. and Best, P.B., 2011. Acoustic behaviour of southern right whales in relation to numbers of whales present in Walker Bay, South Africa. African Journal of Marine Science, 33(3), pp.415-427.

Holness, S., Kirkman, S., Samaai, T., Wolf, T., Sink, K., Majiedt, P., Nsiangango, S., Kainge, P., Kilongo, K., Kathena, J., Harris, L., Lagabrielle, E., Kirchner, C., Chalmers, R. And M. Lombard, 2014. Spatial Biodiversity Assessment And Spatial Management, Including Marine Protected Areas. Final Report For The Benguela Current Commission Project Beh 09-01.

Holsman, K., Jameal Samhouri, J., Cook, G., Hazen, E., Olsen, E., Dillard, M., Kasperski, S., Gaichas, S., Kelble, C.R., Fogarty, M. & K. Andrews, 2017. An Ecosystem-Based Approach To Marine Risk Assessment, Ecosystem Health And Sustainability, 3: 1, E01256.

Holtzhauzen, J.A., 2000. Population Dynamics And Life History Of Westcoast Steenbras Lithognathus Aureti (Sparidae), And Management Options For The Sustainable Exploitation Of The Steenbras Resource In Namibian Waters. Phd Thesis, University Of Port Elizabeth: 233 Pages.

Holtzhausen, J.A., Kirchner, C.H. And S.F. Voges, 2001. Observations On The Linefish Resources Of Namibia, 1999-2000, With Special Reference To West Coast Steenbras And Silver Kob. South African Journal Of Marine Science 23: 135-144.

Hovland, M., Vasshus, S., Indreeide, A., Austdal, L. And Ø. Nilsen, 2002. Mapping And Imaging Deep-Sea Coral Reefs Off Norway, 1982-2000. Hydrobiol. 471: 13-17.

Howard, J.A.E., Jarre, A., Clark, A.E. And C.L. Moloney, 2007. Application Of The Sequential T-Test Algorithm Or Analyzing Regime Shifts To The Southern Benguela Ecosystem. African Journal Of Marine Science 29(3): 437-451.

Hubert, J., Campbell, J., Van Der Beek, J. G., Den Haan, M. F., Verhave, R., Verkade, L. S. & H. Slabbekoorn, 2018. Effects Of Broadband Sound Exposure On The Interaction Between Foraging Crab And Shrimp – A Field Study. Environmental Pollution, 243: 1923–1929.

Hughes, G. R. 1974. The Sea Turtles Of South East Africa. Phd, University Of Natal.

Hughes, G.R., Luschi, P., Mencacci, R. & F. Papi, 1998. The 7000 Km Journey Of A Leatherback Turtle Tracked By Satellite. Journal Of Experimental Marine Biology And Ecology, 229: 209 - 217.

Hughes, G. & R. Nel, 2014ª. Family Cheloniidae. In: Bates, M.F., Branch, W.R., Bauer, A.M., Burger, M., Marais, J., Alexander, G.J., De Villiers, M.S. (Eds) Atlas And Red List Of The Reptiles Of South Africa, Lesotho And Swaziland. Suricata 1, Sanbi, Pretoria.

Hughes, G. & R. Nel, 2014b. Family Dermochelyidae. In: Bates, M.F., Branch, W.R., Bauer, A.M., Burger, M., Marais, J., Alexander, G.J., De Villiers, M.S. (Eds) Atlas And Red List Of The Reptiles Of South Africa, Lesotho And Swaziland. Suricata 1, Sanbi, Pretoria.

Hui, C,A., 1985. Undersea Topography And The Comparative Distributions Of Two Pelagic Cetaceans. Fishery Bulletin, 83(3): 472-475.

Huisman, 2025. Accessed From Semi Submersibles - Huisman

Institute for Public Policy research, 2021. Namibia Quarterly Economic Review Q" 2021: Special Focus on Tourism, IPPR.

International Finance Corporate (IFC), 2012. IFC's Performance Standards on Environmental and Social Sustainability. Available at: https://www.ifc.org/en/insights-reports/2012/ifc-performance-standards.

Inter-Parliamentary Union (2018) Namibia National Council, IPU PARLINE database: NAMIBIA (National Council), Full text. Accessed: 31/03/2025. Iucn, 2025. The Iucn Red Of Threatened Species. Version 2025-1. Https://Www.Iucnredlist.Org Issn 2307-8235.

Iwc [International Whaling Commission], 2012. Report Of The Scientific Committee. Annex H: Other Southern Hemisphere Whale Stocks Committee 11–23.

Jackson, L.F. Ad S. Mcgibbon, 1991. Human Activities And Factors Affecting The Distribution Of Macro-Benthic Fauna In Saldanha Bay. S. Afr. J. Aquat. Sci., 17: 89-102.

Johnson, C., Reisinger, R., Palacios, D., Friedlaender, A., Zerbini, A., Willson, A., Lancaster, M. , Battle, J., Graham, A., Cosandey-Godin, A., Jacob T., Felix, F., Grilly, E., Shahid, U., Houtman, N., Alberini, A., Montecinos, Y., Najera, E. & S. Kelez, 2022. Protecting Blue Corridors, Challenges And Solutions For Migratory Whales Navigating International And National Seas. Wwf, Oregon State University, University Of California, Santa Cruz, Publisher: Wwf International, Switzerland.

Jones, D.O.B., Gates, A.R. And B. Lausen, 2012. Recovery of deep-water megafaunal assemblages from hydrocarbon drilling disturbance in the Faroe–Shetland Channel. Marine Ecology Progress Series, 461: 71-82

Jonsson, P.R., Hammar, L., Wåhlström, I., Et Al. 2021. Combining Seascape Connectivity With Cumulative Impact Assessment In Support Of Ecosystem-Based Marine Spatial Planning. J Appl Ecol., 58: 576–586.

Kastelein, R.A., Hagedoorn, M., Au, W.W. and de Haan, D., 2003. Audiogram of a striped dolphin (Stenella coeruleoalba). The Journal of the Acoustical Society of America, 113(2), pp.1130-1137.

Kastelein, R.A., Janssen, M., Verboom, W.C. & D., de Haan, 2005. Receiving beam patterns in the horizontal plane of a harbour porpoise (*Phocoena phocoena*). Journal of the Acoustical Society of America, 118(2), 1172–1179.

Kastelein, R. A., & P.J., Wensveen, 2008. Effect of two levels of masking noise on the hearing threshold of a harbour porpoise (*Phocoena phocoena*) for a 4.0 kHz signal. Aquatic Mammals, 34(4), 420-425.

Kanwisher, J.W. & S.H. Ridgway, 1983. The Physiological Ecology Of Whales And Porpoises. Scientific American, 248: 110–120.

Karenyi, N., 2014. Patterns And Drivers Of Benthic Macrofauna To Support Systematic Conservation Planning For Marine Unconsolidated Sediment Ecosystems. Phd Thesis, Nelson Mandela Metropolitan University, South Africa.

Karenyi, N., Sink, K. & R. Nel, 2016. Defining Seascapes For Marine Unconsolidated Shelf Sediments In An Eastern Boundary Upwelling Region: The Southern Benguela As A Case Study. Estuarine, Coastal And Shelf Science 169: 195–206.

Kavanagh, A.S., Nykänen, M., Hunt, W., Richardson, N. & M.J. Jessopp, 2019. Seismic Surveys Reduce Cetacean Sightings Across A Large Marine Ecosystem. Scientific Reports, 9(1): 1-10.

Keen, K., Beltran, R., & Pirotta, E. & D. Costa, 2021. Emerging Themes In Population Consequences Of Disturbance Models. Proceedings Of The Royal Society B: Biological Sciences. 288. 20210325. 10.1098/Rspb.2021.0325.

Kemper, J., Underhill, L.G., Crawford, R.J.M. And S.P. Kirkman, 2007. Revision Of The Conservation Status Of Seabirds And Seals Breeding In The Benguela Ecosystem. In: Kirkman, S.P. (Ed). Final Report Of The Bclme (Benguela Current Large Marine Ecosystem) Project On Top Predators As Biological Indicators Of Ecosystem Change In The Bclme: 325-342. Avian Demography Unit, University Of Cape Town, Cape Town, South Africa

Kendall, M.A. And S. Widdicombe, 1999. Small Scale Patterns In The Structure Of Macrofaunal Assemblages Of Shallow Soft Sediments. Journal Of Experimental Marine Biology And Ecology, 237:127-140.

Kenny, A.J., Rees, H.L., Greening, J. And S. Campbell, 1998. The Effects Of Marine Gravel Extraction On The Macrobenthos At An Experimental Dredge Site Off North Norfolk, U.K. (Results 3 Years Post-Dredging). Ices Cm 1998/V:14, Pp. 1-8.

Kershaw, J.L., Ramp, C.A., Sears, R., Plourde, S., Brosset, P., Miller, P.J.O., Et Al., 2021. Declining Reproductive Success In The Gulf Of St. Lawrence’s Humpback Whales (Megaptera Novaeangliae) Reflects Ecosystem Shifts On Their Feeding Grounds. Glob. Change Biol., 27: 1027–1041.

Kirchner, C.H., 2001. Fisheries Regulations Based On Yield Per Recruit Analysis For The Linefish Silver Kob Argyrosomus Inodorus In Namibian Waters. Fisheries Research, 52: 155–167.

Kirchner, C.H., Sakko, A. And J.I. Barnes, 2000. Estimation Of The Economic Value Of The Namibian Recreational Rock-And-Surf Fishery. South African Journal Of Marine Science 22: 17-25.

Kirkman, S.P., Oosthuizen, W.H., Meÿer, M.A., Kotze, P.G.H., Roux, J-P. & L.G. Underhill, 2007. Making Sense Out Of Censuses And Dealing With Missing Data: Trends In Pup Counts Of Cape Fur Seals Arctocephalus Pusillus Pusillus Between 1972 And 2004. African Journal Of Marine Science, 29: 161–176

Kirkman, S.P., Yemane, D., Oosthuizen, W.H., Meyer, M.A., Kotze, P.G.H, Skrypzeck, H., Vaz Velho, F. And L.G. Underhill, 2012. Spatio-Temporal Shifts Of The Dynamic Cape Fur Seal Population In Southern Africa, Based On Aerial Censuses (1972-2009). Marine Mammal Science, Doi: 10.1111/J.1748-7692.2012.00584.X

Kirkman, S.P., Meyer, M.A. And M. Thornton, 2010. False Killer Whale Pseudorca Crassidens Mass Stranding At Long Beach On South Africa’s Cape Peninsula, 2009. African Journal Of Marine Science 31 (1): 167–70. Doi:10.2989/1814232x.2010.481168.

Kolberg, H., 2015. Namibia’s Important Bird And Biodiversity Areas 2: Na014 Sandwich Harbour. Lanioturdus 48(3): 10-18.

Koper, R.P. and Plön, S., 2012. The potential impacts of anthropogenic noise on marine animals and recommendations for research in South Africa. Johannesburg: Endangered Wildlife Trust.

Koslow, J.A., 1996. Energetic And Life History Patterns Of Deep-Sea Benthic, Benthopelagic And Seamount Associated Fish. Journal Of Fish Biology, 49a: 54-74.

Kyhn, L.A., Wisniewska, D.M., Beedholm, K., Tougaard, J., Simon, M., Mosbech, A., Et Al. 2019. Basin-Wide Contributions To The Underwater Soundscape By Multiple Seismic Surveys With Implications For Marine Mammals In Baffin Bay, Greenland. Mar. Pollut. Bull., 138: 474–490.

Laird, M.C., Hutchings, K., Nalusha, S.H. & B.M. Clark, 2018. Marine Ecology Report For The National Oil Storage Facilities Project, Walvis Bay. Report No. 1790/4 Prepared By Anchor Environmental Consultants (Pty) Ltd And Green Team Consultants Cc For Om'kumoh Aij Jv. 95 Pp.

Lambardi, P., Lutjeharms, J.R.E., Menacci, R., Hays, G.C. And P. Luschi, 2008. Influence Of Ocean Currents On Long-Distance Movement Of Leatherback Sea Turtles In The Southwest Indian Ocean. Marine Ecology Progress Series, 353: 289–301.

Lamberth, S.J., Van Niekerk, L. & K. Hutchings, 2008. Comparison Of, And The Effects Of Altered Freshwater Inflow On, Fish Assemblages Of Two Contrasting South African Estuaries: The Cool-Temperate Olifants And The Warm-Temperate Breede. African Journal Of Marine Science 30: 311-336.

Lane, S.B. And R.A. Carter, 1999. Generic Environmental Management Programme For Marine Diamond Mining Off The West Coast Of South Africa. Marine Diamond Mines Association, Cape Town, South Africa. 6 Volumes.

Large, S.I., Fay, G., Friedland, K.D. & J.S. Link, 2015. Quantifying Patterns Of Change In Marine Ecosystem Response To Multiple Pressures. Plos One 10(3): E0119922. Doi:10.1371/Journal.

Lasiak, T.A., 1981. Nursery Grounds Of Juvenile Teleosts: Evidence From Surf Zone Of King's Beach, Port Elizabeth. South African Journal Of Science 77: 388-390.

Leeney, R.H., Post, K., Hazevoet, C.J. And S.H. Elwen, 2013. Pygmy Right Whale Records From Namibia. African Journal Of Marine Science 35(1): 133-139.

Le Gouvello, D.Z.M., Nel, R. & A.E. Cloete, 2020. The Influence Of Individual Size On Clutch Size And Hatchling Fitness Traits In Sea Turtles. J. Exp. Mar. Biol. Ecol., 527: 151372.

Le Gouvello, D.Z.M., Heye, S., Harris, L.R., Temple-Boyer, J., Gaspar, P., Hart-Davis, M.G., Louro, C. & R. Nel, 2024. Dispersal Corridors Of Neonate Sea Turtles From Dominant Rookeries In The Western Indian Ocean. Ecological Modelling, 487, P.110542.

Le Roux, L., 1998. Research On Deepsea Red Crab After More Than 20 Years Of Exploitation. Namibia Brief, 20: 126-128.

Levin, L.A., 2003. Oxygen Minimum Zone Benthos: Adaptation And Community Response To Hypoxia. Oceanography And Marine Biology: An Annual Review 41: 1-45.

Levin, L.A., Whitcraft, C.R., Mendoza, G.F., Gonzalez, J.P. And G. Cowie, 2009. Oxygen And Organic Matter Thresholds For Benthic Faunal Activity On The Pakistan Margin Oxygen Minimum Zone (700 - 1100 M). Deep-Sea Reserach Ii 56: 449-471.

Levin, L.A., Gage, J.D., Martin, C. And P.A. Lamont, 2000. Macrobenthic Community Structure Within And Beneath The Oxygen Minimum Zone, Nw Arabian Sea, Deep-Sea Res. Pt. Ii, 47: 189– 226.

Levin, P.S., Et Al. 2014. Guidance For Implementation Of Integrated Ecosystem Assessments: A Us Perspective. Ices Journal Of Marine Science, 71:1198–1204.

Loefer, J.K., Sedberry, G.R. & J.C. Mcgovern, 2005. Vertical Movements Of A Shortfin Mako In The Western North Atlantic As Determined By Pop-Up Satellite Tagging. Southeastern Naturalist 4, 237-246.

Longhurst, A. R., 2006. Ecological Geography Of The Sea. 2nd Edition. Academic Press, San Diego. Pp. 560.

Louw, D.C., 2008. Internal Memorandum. Phytoplankton Bloom Along The Namibian Coast. Ministry Of Fisheries & Marine Resources: Directorate Of Resource Management. Date: 10/03/2008.

Ludynia, K., 2007. Identification And Characterisation Of Foraging Areas Of Seabirds In Upwelling Systems: Biological And Hydrographic Implications For Foraging At Sea. Phd Thesis, University Of Kiel, Germany.

Ludynia, K., Kemper, J. & J-P. Roux, 2012. The Namibian Islands' Marine Protected Area: Using Seabird Tracking Data To Define Boundaries And Assess Their Adequacy. Biological Conservation, 156: 136-145.

Luschi, P., Hays, G. C. & F. Papi, 2003a. A Review Of Long-Distance Movements By Marine Turtles, And The Possible Role Of Ocean Currents. Oikos, 103, 293 – 302.

Luschi, P., Lutjeharms, J.R.E., Lambardi, P., Mencacci, R., Hughes, G.R. & G.C. Hays, 2006. A Review Of Migratory Behaviour Of Sea Turtles Off Southeastern Africa. South African Journal Of Science, 102, 51 - 57.

Luschi, P., Sale, A., Mencacci, R., Hughes, G. R., Lutjeharms, J. R. E. & F. Papi, 2003b. Current Transport Of Leatherback Sea Turtles (Dermochelys Coriacea) In The Ocean. Proceedings Of The Royal Society: Biolgical Sciences, 270, 129 - 132.

Maartens, L., 2003. Biodiversity. In: Molloy, F. And T. Reinikainen (Eds). Namibia's Marine Environment. Directorate Of Environmental Affairs, Ministry Of Environment And Tourism, Namibia: 103-135.

Macissac, K., Bourbonnais, C., Kenchington, E.D., Gordon Jr. And S. Gass, 2001. Observations On The Occurrence And Habitat Preference Of Corals In Atlantic Canada. In: (Eds.) J.H.M. Willison, J. Hall, S.E. Gass, E.L.R. Kenchington, M. Butler, And P. Doherty. Proceedings Of The First International Symposium On Deep-Sea Corals. Ecology Action Centre And Nova Scotia Museum, Halifax, Nova Scotia.

Macleod, C.D. And A. D'amico, 2006. A Review Of Beaked Whale Behaviour And Ecology In Relation To Assessing And Mitigating Impacts Of Anthropogenic Noise. Journal Of Cetacean Research And Management 7(3): 211–221.

Macpherson, E. And A. Gordoa, 1992. Trends In The Demersal Fish Community Off Namibia From 1983 To 1990. South African Journal Of Marine Science 12: 635-649.

Marine Traffic, 2025. Accessed from www.marinetraffic.com/en/ais/home

Mate, B.R., Best, P.B., Lagerquist, B.A. And M.H. Winsor, 2011. Coastal, Offshore And Migratory Movements Of South African Right Whales Revealed By Satellite Telemetry. Marine Mammal Science, 27(3): 455-476.

Mate, B.R., Lagerquist, B.A., Windsor, M., Geraci, J. And J.H. Prescott, 2005. Movements And Dive Habits Of A Satellite-Monitoring Longfinned Pilot Whales (Globicephala Melas) In The Northwet Atlantic. Marine Mammal Science 21(10): 136-144.

Matthews, J.P. And N.L. Smit, 1979. Trends In The Size Composition, Availability, Egg-Bearing And Sex Ratio Of The Rock Lobster Jasus Lalandii In Its Main Fishing Area Off South West Africa, 1958-1969. Investl. Rep. Div. Sea Fish. S. Afr., 103: 1-38

Matthews, S.G. And G.C. Pitcher, 1996. Worst Recorded Marine Mortality On The South African Coast. In: Yasumoto, T, Oshima, Y. And Y. Fukuyo (Eds), Harmful And Toxic Algal Blooms. Intergovernmental Oceanographic Commission Of Unesco, Pp 89-92.

Mcalpine, D.F., 2018. Pygmy And Dwarf Sperm Whales: Kogia Breviceps And K. Sima. In Encyclopedia Of Marine Mammals (3rd Ed., Issue June 2018, P936–938).

McDonald, M. A., Calambokidis, J., Teranishi, A. M., & J.A. Hildebrand, 2001. The acoustic calls of blue whales off California with gender data, The Journal of the Acoustical Society of America, 109(4), 1728-173.

McDonald, M.A., Mesnick, S.L. and Hildebrand, J.A., 2006. Biogeographic characterization of blue whale song worldwide: using song to identify populations. Journal of cetacean research and management, 8(1), 55-65.

McDonald, M.A., Hildebrand, J.A. and Wiggins, S.M., 2006. Increases in deep ocean ambient noise in the Northeast Pacific west of San Nicolas Island, California. The Journal of the Acoustical Society of America, 120(2), pp.711-718.

Mchuron, E.A., Schwarz, L.K., Costa, D.P. & M. Mangel, 2018. A State-Dependent Model For Assessing The Population Consequences Of Disturbance On Income-Breeding Mammals. Ecological Modelling, 385: 133- 144.

Mclachlan, A., 1980. The Definition Of Sandy Beaches In Relation To Exposure: A Simple Rating System. S. Afr. J. Sci., 76: 137-138.

Mclachlan, A., 1986. Ecological Surveys Of Sandy Beaches On The Namib Coast. Report No. 13, Institute For Coastal Research, University Of Port Elizabeth, Port Elizabeth, 135 Pp.

McNutt, M.K., Camilli, R., Crone, T.J., Guthrie, G.D., Hsieh, P.A., Ryerson, T.B., Savas, O. and Shaffer, F., 2012. Review of flow rate estimates of the Deepwater Horizon oil spill. Proceedings of the National Academy of Sciences, 109(50), pp.20260-20267.

Mecenero, S., Roux, J-P., Underhill, L.G. And M.N.Bester, 2006. Diet Of Cape Fur Seals Arctocephalus Pusillus Pusillus At Three Mainland Breeding Colonies In Namibia. 1. Spatial Variation. African Journal Of Marine Science 28: 57-71.

Milewski, A., 2025. Namibia: Africa's new oil frontier, Namibia: Africa's new oil frontier – InvestorNews.

Ministry of Education, 2023. EMIS Education Statistics 2023, Namibia. Ministry of Education, Windhoek.

Mining and Energy, 2024. Oil, gas to add N$11.5bn annually to Namibia's GDP, Namibia+-+Mining+and+Energy+-+25+August+2024.pdf [Accessed 14/05/2025].

Ministry Of Fisheries And Marine Resources (MFMR), 2008. Ministry Of Fisheries & Marine Resources: Directorate Of Resource Management. Monthly Marine Environmental Update. March 2008. No. 03/2008. Compiled By C.H. Bartholomae.

Ministry Of Fisheries And Marine Resources (MFMR), 2019. National Framework For Marine Spatial Planning In Namibia. Ministry Of Fisheries And Marine Resources, Windhoek: Namibia.

Ministry Of Fisheries And Marine Resources (MFMR), 2021. Current Status Report: Knowledge Baseline For Marine Spatial Planning In Namibia. Second Edition. MFMR, Windhoek: Namibia.

Ministry Of Fisheries And Marine Resources (MFMR), 2021. Annual Report 2020/2021. MFMR, Windhoek: Namibia.

Ministry Of Fisheries And Marine Resources, 2022. Monitoring And Evaluation Strategy For Marine Spatial Planning In Namibia. Windhoek: Namibia.

Ministry of Health and Social Services, 2014. The Namibian Demographic and Health Survey 2013. ICF International, Windhoek.

Ministry of Industrialisation and Trade, 2024. Draft National Informal Economy, Startups and Entrepreneurship Development Policy, DRAFT NATIONAL INFORMAL ECONOMY_STARTUPS_ENTERPRENEURSHIP POLICY_DECEMBER 2023 (1).pdf.

Modde, T., 1980. Growth And Residency Of Juvenile Fishes Within A Surf Zone Habitat In The Gulf Of Mexico. Gulf Research Reports 6: 377-385.

Moldan, A.G.S., 1978. A Study Of The Effects Of Dredging On The Benthic Macrofauna In Saldanha Bay. South African Journal Of Science, 74: 106-108.

Molloy, F. And T. Reinikainen (Eds), 2003. Namibia's Marine Environment. Directorate Of Environmental Affairs, Ministry Of Environment And Tourism, Namibia, 160 Pp.

Montagna, P.A. And D.E. Harper, Jr., 1996. Benthic Infaunal Long-Term Response To Offshore Production Platforms In The Gulf Of Mexico. Can. J. Fish. Aquat. Sci., 53: 2567-2588.

Montealegre-Quijano, S. & C.M. Vooren, 2010. Distribution And Abundance Of The Life Stages Of The Blue Shark Prionace Glauca In The Southwest Atlantic. Fisheries Research 101: 168–179.

Monteiro, P.M.S. And A.K. Van Der Plas, 2006. Low Oxygen Water (Low) Variability In The Benguela System: Key Processes And Forcing Scales Relevant To Forecasting. In: Shannon, V., Hempel, G., Malanotte-Rizzoli, P., Moloney, C. And J. Woods (Eds). Large Marine Ecosystems, Vol. 15, Pp 91-109.

Morant, P.D., 2006. Environmental Management Programme Report For Exploration/Appraisal Drilling In The Kudu Gas Production Licence No 001 On The

Continental Shelf Of Namibia. Prepared For Energy Africa Kudu Limited. Csir Report Csir/Nre/Eco/2006/0085/C.

Morant, P.D., 2013. Environmental Management Plan For The Proposed Marine Phosphate Prospecting In The Outeniqua West License area On The Eastern Agulhas Bank, Offshore Mossel Bay. Prepared For Diamond Fields International Ltd. Csir/Cas/Ems/Er/2013/0000/A, Pp266.

Moura, J.F., Acevedo-Trejos, E., Tavares, D.C., Meirelles, A.C.O., Silva, C.P.N., Oliveira, L.R., Santos, R.A., Wickert, J.C., Machado, R., Siciliano, S. & A. Merico, 2016. Stranding Events Of Kogia Whales Along The Brazilian Coast. Plos One, 11(1): 1–15.

Namibia Investment Centre, 2025. About Namibia, Infrastructure. Accessed 15/05/2025.

Namibian Broadcasting Corporation, 2024. Erongo records increase in crime, Erongo records increase in crime | nbc. Accessed 15/05/2025.

Namibia Statistics Agency, 2014. Erongo 2011 Census Regional Profile, p19dptss1rt6erfri0a1k3q1mrhm.pdf.

Namibia Statistics Agency, 2021. Namibia Multidimensional Poverty Index (MPI) Report 2021, Namibia Multidimensional Poverty Index (MPI) Report 2021 | OPHI 15/05/2025.

Namibia Statistics Agency, 2022. Census of Business Establishments Erongo Regional Profile 2019/21, PUBLICATIONS - Namibia Statistics Agency.

Namibia Statistics Agency, 2024. Erongo, Erongo – Namibia Statistics Agency | Census Dissemination.

Namibia Statistics Agency, 2024. 2023 Population and Housing Census, 2023-Population-and-Housing-Census-Main-Report-28-Oct-2024.pdf.

Namibia Statistics Agency, 2024a. Annual National Accounts, 2023. NSA, Windhoek.

Namibia Statistics Agency, 2024b. 2023 Population and Housing Census: Labour Force Report. NSA, Windhoek

Namibia Statistics Agency, 2025. Erongo Region Census Tables, Windhoek.

Namport, 2019. Integrated Annual Report 2018.

Namport, 2025. Integrated Annual Report 2023.

Namport, 2025. Welcome to the Port of Walvis Bay, Welcome to the Port of Walvis Bay - Namibian Ports Authority.

NamPower, NamPower - Powering the Nation and beyond.

NamWater, About Us | NamWater Ltd.

National Planning Commission, 2021. Namibia's Second Voluntary National Review Report on the Implementation of the Sustainable Development Goals Towards Agenda 2030. Office of the President, National Planning Commission, Windhoek.

Nelson, G., 1989. Poleward Motion In The Benguela Area. In: Poleward Flows Along Eastern Ocean Boundaries. Neshyba Et Al. (Eds) New York; Springer: 110-130 (Coastal And Estuarine Studies 34).

Nelson G. And L. Hutchings, 1983. The Benguela Upwelling Area. Prog. Oceanogr., 12: 333-356.

National Planning Commission (NPC). (2011). Namibia Index of Multiple Deprivation 2011. Windhoek, Namibia: Government of the Republic of Namibia.

National Planning Commission (NPC). (2015). Namibia Poverty Mapping Report. Macroeconomic Planning Department. Windhoek, Namibia: Government of the Republic of Namibia.

Netto, S.A., Fonseca, G. & F., Gallucci, 2010. Effects Of Drill Cuttings Discharge On Meiofauna Communities Of The Shelf Break In The Southwest Atlantic. Environ. Monit. Assess., 167: 49–63.

Newman, G.G. And D.E. Pollock, 1971. Biology And Migration Of Rock Lobster Jasus Lalandii And Their Effect On Availability At Elands Bay, South Africa. Investl. Rep. Div. Sea Fish. S. Afr., 94: 1-24.

Nicol, S., Bowie, A., Jarmon, S., Lannuzel, D., Meiners, K.M., Et Al. 2010. Southern Ocean Iron Fertilization By Baleen Whales And Antarctic Krill. Fish And Fisheries, 11: 203–209.

Nieukirk, S.L., Mellinger, D.K., Moore, S.E., Klinck, K., Dziak, R.P. & J. Goslin, 2012. Sounds From Airguns And Fin Whales Recorded In The Mid-Atlantic Ocean, 1999–2009. Journal Of The Acoustical Society Of America, 131: 1102–1112.

Nmp [Namibian Marine Phosphates], 2012. Environmental Impact Assessment Report For The Marine Component: Proposed Recovery Of Phosphate Enriched Sediments From The Marine License area No. 170 Off Walvis Bay Namibia. Prepared For Namibian Marine Phosphate (Pty) Ltd. J Midgley And Associates, Enviro Dynamics, Csir.

NOAA (National Marine Fisheries Service, Office of Protected Resources). (2018). 2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts

NOAA (National Ocean Service, Office of Response and Restoration). (2023). Small diesel spills (500–5,000 gallons). U.S. Department of Commerce.

NOAA (National Marine Fisheries Service, Office of Protected Resources). (2024). 2024 Update to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 3.0): Underwater and In-Air Criteria for Onset of Auditory Injury and Temporary Threshold Shifts

NPC (National Planning Commission), 2021. Namibia Multidimensional Poverty Index (MPI) Report 2021. Windhoek, Namibia.

Nrc, 2005. Marine Mammal Populations And Ocean Noise, Determining When Noise Causes Biologically Significant Effects. The National Academy Press, Washington, Dc.

Olivier, J., 1992. Aspects Of The Climatology Of Fog In The Namib. Sa Geographer 19(2): 107-125.

Olivier, J., 1995. Spatial Fog Distribution Pattern In The Namib Using Meteosat Images. J. Arid Environments 29: 129-138.

Oosthuizen W.H., 1991. General Movements Of South African (Cape) Fur Seals Arctocephalus Pusillus Pusillus From Analysis Of Recoveries Of Tagged Animals. S. Afr. J. Mar. Sci., 11: 21-30.

OSPAR Commission. (2009). Overview of the impacts of anthropogenic underwater sound in the marine environment. OSPAR Commission. Retrieved from https://qsr2010.ospar.org/media/assessments/p00441_Noise_background_document.pdf

Oyadele, O and Amulungu F., 2025. Contributing Factors of Women's Participation in Namibia's Labour Force. The International Journal of Business & Management, 13(3). https://www.internationaljournalcorner.com/index.php/theijbm/article/view/174186.

Parkins, C.A. And J. G. Field, 1997. A Baseline Study Of The Benthic Communities Of The Unmined Sediments Of The De Beers Marine Sasa Grid. Unpublished Report To De Beers Marine, October 1997, Pp 29.

Parkins, C.A. And J.G.Field, 1998. The Effects Of Deep Sea Diamond Mining On The Benthic Community Structure Of The Atlantic 1 Mining License area. Annual Monitoring Report – 1997. Prepared For De Beers Marine (Pty) Ltd By Marine Biology Research Institute, Zoology Department, University Of Cape Town. Pp. 44.

Parry, D.M., Kendall, M.A., Pilgrim, D.A. And M.B. Jones, 2003. Identification Of Patch Structure Within Marine Benthic Landscapes Using A Remotely Operated Vehicle. J. Exp. Mar. Biol. Ecol., 285– 286: 497–511.

Payne, A.I.L. And R.J.M. Crawford, 1989. Oceans Of Life Off Southern Africa. Vlaeberg, Cape Town, 380 Pp.

Penney, A.J., Krohn, R.G. And C.G. Wilke. 1992. A Description Of The South African Tuna Fishery In The Southern Atlantic Ocean. Iccat Col. Vol. Sci. Pap. Xxix(1) : 247-253.

Penney, A.J., Pulfrich, A., Rogers, J., Steffani, N. And V. Mabille, 2007. Project: Behp/Cea/03/02: Data Gathering And Gap Analysis For Assessment Of Cumulative Effects Of Marine Diamond Mining Activities On The Bclme Region. Final Report To The Bclme Mining And Petroleum Activities Task Group. December 2007. 410pp.

Penry, G.S., 2010. Biology Of South African Bryde's Whales. Phd Thesis. University Of St Andrews, Scotland, Uk.

Pirotta, E., Booth, C.G., Costa, D.P., Et Al. 2018. Understanding The Population Consequences Of Disturbance. Ecol Evol., 8: 9934–9946. Https://Doi.Org/10.1002/Ece3.4458.

Pitcher, G.C., 1998. Harmful Algal Blooms Of The Benguela Current. Ioc, World Bank And Sea Fisheries Research Institute Publication. 20 Pp.

Plön, S., 2004. The Status And Natural History Of Pygmy (Kogia Breviceps) And Dwarf (K. Sima) Sperm Whales Off Southern Africa. Phd Thesis. Department Of Zoology And Entomology (Rhodes University), P. 551.

Pollock, D.E. And L.V. Shannon, 1987. Response Of Rock-Lobster Populations In The Benguela Ecosystem To Environmental Change – A Hypothesis. South African Journal Of Marine Science 5, 887-899.

Popper, A.N., Hawkins, A.D., Fay, R.R., Mann, D.A., Bartol, S., Carlson, T.J., Coombs, S., Ellison, W.T., Gentry, R.L., Halvorsen, M.B. and Løkkeborg, S., 2014. Sound exposure guidelines. In ASA S3/SC1. 4 TR-2014 sound exposure guidelines for fishes and sea turtles: A technical report prepared by ANSI-accredited standards committee S3/SC1 and registered with ANSI (pp. 33-51). Cham: Springer International Publishing.

Potter, I.C., Beckley, L.E., Whitfield, A.K., Lenanton, R.C.J., 1990. Comparisons Between The Roles Played By Estuaries In The Life Cycles Of Fishes In Temperate Western Australia And Southern Africa. Environmental Biology Of Fishes 28: 143-178.

Potts, W.M., Sauer, W.H.H., Henriques, R., Sequesseque, S., Santos, C.V. And P.W. Shaw. 2010. The Biology, Life History And Management Needs Of A Large Sciaenid Fish, Argyrosomus Coronus In Angola. African Journal Of Marine Science 32 (2): 247 — 258.

Pulfrich, A., 2015. Invertebrate Macrofaunal Communities Of The Beaches North Of Swakopmund. Baseline Field Survey Report. Prepared For Gecko Namibia, August 2015. Pp30.

Pulfrich, A. And A.J. Penney, 1999. The Effects Of Deep-Sea Diamond Mining On The Benthic Community Structure Of The Atlantic 1 Mining License area. Annual Monitoring Report – 1998. Prepared For De Beers Marine (Pty) Ltd By Marine Biology Research Institute, Zoology Department, University Of Cape Town And Pisces Research And Management Consultants Cc. Pp 49.

Putman, N.F. & K.L. Mansfield, 2015. Direct Evidence Of Swimming Demonstrates Active Dispersal In The Sea Turtle “Lost Years”. Curr. Biol., 25: 1221–1227.

Putman, N.F., Verley, P., Shay, T.J. & K.J. Lohmann, 2012. Simulating Transoceanic Migrations Of Young Loggerhead Sea Turtles: Merging Magnetic Navigation With An Ocean Circulation Model. J. Exp. Biol., 215: 1863–1870.

Putman, N.F. & E. Naro-Maciel, 2013. Finding The ‘Lost Years’ In Green Turtles: Insights From Ocean Circulation Models And Genetic Analysis. Proc. R. Soc. Biol., 280.

Putman, N.F., Seney, E.E., Verley, P., Shaver, D.J., Lopez-Castro, M.C., Cook, M., Et Al., 2020. Predicted Distributions And Abundances Of The Sea Turtle ‘Lost Years’ In The Western North Atlantic Ocean. Ecography, 43: 506–517.

PRDW, 2019. Proposed Offshore Exploration Well Drilling In Pel82, Walvis Basin, Namibia. Oil Spill And Drilling Discharge Modelling Specialist Study, Prestedge Retief Dresner Wijnberg (Pty) Ltd Consulting Port And Coastal Engineers, 83 Pp.

Ramil, F. & M. Gil, 2015. Walvis Ridge Seamounts Benthic Fauna. Workshop For Preliminary Results Of The Assessment Of Resources And Vulnerable Marine Ecosystems Survey In The Seafo Convention Area. (12/02/2015 - 13/02/2015. Swakopmund (Namibia)).

Rengura, R., 2024. Erongo Region's tourism industry bounces back, Erongo Region's tourism industry bounces back | nbc.

Ripple, W.J., Estes, J.A., Schmitz, O.J., Constant, V., Kaylor, M.J., Lenz, A., Motley, J.L., Self, K.E., Taylor, D.S. & C. Wolf, 2016. What Is A Trophic Cascade?. Trends In Ecology & Evolution, 31(11):.842-849.

Robinson, N., Anders, D., Bachoo, S., Harris, L., Hughes, G., Kotze, D., Maduray, S., Mccue, S., Meyer, M., Oosthuizen, H., Paladino, F. & P. Luschi, 2019. Satellite Tracking Of Leatherback And Loggerhead Sea Turtles On The Southeast African Coastline. Indian Ocean Turtle Newsletter, 28: 5pp.

Roel, B.A., 1987. Demersal Communities Off The West Coast Of South Africa. South African Journal Of Marine Science 5: 575-584.

Rogers, A.D., 1994. The Biology Of Seamounts. Advances In Marine Biology, 30: 305–350.

Rogers, A.D., 2004. The Biology, Ecology And Vulnerability Of Seamount Communities. Iucn, Gland, Switzerland. Available At: Www.Iucn.Org/Themes/ Marine/Pubs/Pubs.Htm 12 Pp.

Rogers, A.D., Clark, M.R., Hall-Spencer, J.M. And K.M. Gjerde, 2008. The Science Behind The Guidelines: A Scientific Guide To The Fao Draft International Guidelines (December 2007) For The Management Of Deep-Sea Fisheries In The High Seas And Examples Of How The Guidelines May Be Practically Implemented. Iucn, Switzerland, 2008.

Rogers, J., 1977. Sedimentation On The Continental Margin Off The Orange River And The Namib Desert. Unpubl. Ph.D. Thesis, Geol. Dept., Univ. Cape Town. 212 Pp.

Rogers, J. And J.M. Bremner, 1991. The Benguela Ecosystem. Part Vii. Marine-Geological Aspects. Oceanogr. Mar. Biol. Ann. Rev., 29: 1-85.

Roman, J. & J.J. Mccarthy, 2010. The Whale Pump: Marine Mammals Enhance Primary Productivity In A Coastal Basin. Plos One 5(10): E13255. Doi:10.1371/

Romer, G.S., 1988. Fishes. In: Mclachlan A. (Ed,). Ecological Surveys Of Sandy Beaches Of The Namib Coast. Institute For Coastal Research Report No. 13. University Of Port Elizabeth.

Rose, B. & A. Payne, 1991. Occurrence And Behavior Of The Southern Right Whale Dolphin Lissodelphis Peronii Off Namibia. Marine Mammal Science 7: 25-34.

Rosenbaum, H.C., Pomilla, C., Mendez, M., Leslie, M.S., Best, P.B., Findlay, K.P., Minton, G., Ersts, P.J., Collins, T., Engel, M.H., Bonatto, S., Kotze, P.G.H., Meÿer, M., Barendse, J., Thornton, M., Razafindrakoto, Y., Ngouessono, S., Vely, M. And J. Kiszka, 2009. Population Structure Of Humpback Whales From Their Breeding Grounds In The South Atlantic And Indian Oceans. Plos One, 4 (10): 1-11.

Ross, G.J.B., 1979. Records Of Pygmy And Dwarf Sperm Whales, Genus Kogia, From Southern Africa, With Biological Notes And Some Comparisons. Annals Of The Cape Province Museum (Natural History) 11: 259-327.

Roux, J-P., Best, P.B. And P.E. Stander. 2001. Sightings Of Southern Right Whales (Eubalaena Australis) In Namibian Waters, 1971-1999. J. Cetacean Res. Manage. (Special Issue). 2: 181-185.

Roux, J-P., Brady, R. And P.B. Best, 2011. Southern Right Whales Off Namibian And Their Relationship With Those Off South Africa. Paper Sc/S11/Rw16 Submitted To Iwc Southern Right Whale Assessment Workshop, Buenos Aires 13-16 Sept. 2011.

Roux, J-P., Brady, R. And P.B. Best, 2015. Does Disappearance Mean Extirpation? The Case Of Right Whales Off Namibia. Marine Mammal Science, 31 (3): 1132–52. Doi:10.1111/Mms.12213.

Rowat, D., 2007. Occurrence Of The Whale Shark (Rhincodon Typus) In The Indian Ocean: A Case For Regional Conservation. Fisheries Research, 84: 96-101.

Rowat, D. & M. Gore, 2007. Regional Scale Horizontal And Local Scale Vertical Movements Of Whale Sharks In The Indian Ocean Off Seychelles. Fisheries Research 84: 32–40.

Savage, C., Field, J.G. And R.M. Warwick, 2001. Comparative Meta-Analysis Of The Impact Of Offshore Marine Mining On Macrobenthic Communities Versus Organic Pollution Studies. Mar Ecol Prog Ser., 221: 265-275.

Scott, R., Biastoch, A., Roder, C., Stiebens, V.A. & C. Eizaguirre, 2014. Nano-Tags For Neonates And Ocean-Mediated Swimming Behaviours Linked To Rapid Dispersal Of Hatchling Sea Turtles. Proc. R. Soc. B, 281: 20141209.

Seakamela, S.M., Kotze, P.H.G., Mccue, S.A., De Goede, J., Lamont, T., Pieterse, J., Smith, M. & T. Anthony, 2022. 25. Mortality Event Of Cape Fur Seals In South Africa During 2021. In: Kirkman, S.P., Huggett, J.A., Lamont, T. & T. Haupt (Eds.) Oceans And Coasts Annual Science Report 2021. Department Of Forestry, Fisheries And The Environment, P28.

Seakamela, S.M., Kotze, P.H.G., Mccue, S.A. & S. Benjamin, 2022. 23. The First Satellite Tracking Of Movements Of Long-Finned Pilot Whales In South Africa. In: Kirkman, S.P., Huggett, J.A., Lamont, T. & T. Haupt (Eds.) Oceans And Coasts Annual Science Report 2021. Department Of Forestry, Fisheries And The Environment, P26.

Seiderer, L.J. And R.C. Newell, 1999. Analysis Of The Relationship Between Sediment Composition And Benthic Community Structure In Coastal Deposits: Implications For Marine Aggregate Dredging. Ices Journal Of Marine Science, 56: 757–765.

Shannon, L.J., C.L. Moloney, A. Jarre And J.G. Field, 2003. Trophic Flows In The Southern Benguela During The 1980s And 1990s. Journal Of Marine Systems, 39: 83 - 116.

Shannon, L.V., 1985. The Benguela Ecosystem. Part 1. Evolution Of The Benguela, Physical Features And Processes. Oceanogr. Mar. Biol. Ann. Rev., 23: 105-182.

Shannon, L.V. And F.P. Anderson, 1982. Application Of Satellite Ocean Colour Imagery In The Study Of The Benguela Current System. S. Afr. J. Photogrammetry, Remote Sensing And Cartography, 13(3): 153-169.

Shannon L.V. And S. Pillar, 1985. The Benguela Ecosystem Iii. Plankton. Oceanography And Marine Biology: An Annual Review, 24: 65-170.

Shannon, L.V. And M.J. O'toole, 1998. Bclme Thematic Report 2: Integrated Overview Of The Oceanography And Environmental Variability Of The Benguela Current Region. Unpublished Bclme Report, 58pp

Shaughnessy P.D., 1979. Cape (South African) Fur Seal. In: Mammals In The Seas. F.A.O. Fish. Ser., 5, 2: 37-40.

Sherley, R.B., Ludynia, K., Dyer, B.M., Lamont, T., Makhado, A.B., Roux, J.-P., Scales, K.L., Underhill, L.G. & S.C. Votier, 2017. Metapopulation Tracking Juvenile Penguins Reveals An Ecosystem-Wide Ecological Trap. Current Biology 27: 563-568.

Shillington, F. A., Peterson, W. T., Hutchings, L., Probyn, T. A., Waldron, H. N. And J. J. Agenbag, 1990. A Cool Upwelling Filament Off Namibia, South West Africa: Preliminary Measurements Of Physical And Biological Properties. Deep-Sea Res., 37 (11a): 1753-1772.

Siciliano, S., De Moura, J.F., Barata, P.C.R., Dos Prazeres Rodrigues D., Moraes Roges, E., Laine De Souza, R., Henrique Ott P. & M. Tavares, 2013. An Unusual Mortality Of Humpback Whales In 2010 On The Central-Northern Rio De Janeiro Coast, Brazil. Paper To International Whaling Commission Sc63/Sh1

Simmons, R.E., Barnes, K.N. Jarvis, A.M. And A. Robertson, 1999. Important Bird Areas In Namibia. Research Discussion Paper No. 31. Dea Of Met, 68pp.

Simmons, R.E., Brown, C.J. And J. Kemper, 2015. Birds To Watch In Namibia: Red, Rare And Endemic Species. Ministry Of Environment And Tourism And Namibia Nature Foundation, Windhoek

Sink, K., Holness, S., Harris, L., Majiedt, P., Atkinson, L., Robinson, T., Kirkman, S., Hutchings, L., Leslie, R., Lamberth, S., Kerwath, S., Von Der Heyden, S., Lombard, A., Attwood, C., Branch, G., Fairweather, T., Taljaard, S., Weerts, S., Cowley, P., Awad, A., Halpern, B., Grantham, H. And T. Wolf, 2012. National Biodiversity Assessment 2011: Technical Report. Volume 4: Marine And Coastal Component. South African National Biodiversity Institute, Pretoria.

Sink, K.J., Van Der Bank, M.G., Majiedt, P.A., Harris, L.R., Atkinson, L.J., Kirkman, S.P. And N. Karenyi (Eds), 2019. South African National Biodiversity Assessment 2018 Technical Report Volume 4: Marine Realm. South African National Biodiversity Institute, Pretoria. South Africa.

SINTEF, 2021. SINTEF Offshore Blowout Database. In: SINTEF Projects. https://www.sintef.no/en/projects/2021/sintef-offshore-blowout-database/.

Skern-Mauritzen, M., Kirkman, S.P., Olsen, E.J.S., Bjørge, A., Drapeau, L., Mëyer, M., Roux, J.-P., Swanson, S. & W.H. Oosthuizen, 2009. Do Inter-Colony Differences In Cape Fur Seal Foraging Behaviour Reflect Large-Scale Changes In The Northern Benguela Ecosystem? African Journal Of Marine Science, 31: 399–408.

Slabbekoorn, H., Dalen, J., De Haan, D., Winter, H.V., Radford, C., Ainslie, M.A., Heaney, K.D., Van Kooten, T., Thomas, L. & J. Harwood, 2019. Population-Level

Consequences Of Seismic Surveys On Fishes: An Interdisciplinary Challenge. Fish And Fisheries 20(4): 653-685.

Slabbekoorn, H. & W. Halfwerk, 2009. Behavioural Ecology: Noise Annoys At Community Level. Current Biology, 19: R693–R695.

SLR, 2022. Proposed 3D seismic survey in PEL 90, Orange Basin, Namibia: Final Environmental Impact Assessment Report and Environmental & Social Management Plan (Rev. 3, SLR Project No. 733.20072.00002). Prepared for Harmattan Energy Limited.

Smale, M.J., Roel, B.A., Badenhorst, A. And J.G. Field, 1993. Analysis Of Demersal Community Of Fish And Cephalopods On The Agulhas Bank, South Africa. Journal Of Fisheries Biology 43:169-191.

Smith, G.G And G.P. Mocke, 2002. Interaction Between Breaking/Broken Waves And Infragravity-Scale Phenomena To Control Sediment Sediment Suspension And Transport In The Surf Zone. Marine Geology, 187: 320-345.

Snelgrove, P.V.R. And C.A. Butman (1994). Animal-Sediment Relationships Revisited: Cause Versus Effect. Oceanography And Marine Biology: An Annual Review, 32: 111-177.

Southall, B. L., Bowles, A. E., Ellison, W. T., Finneran, J. J., Gentry, R. L., Green, C. R., Kastak, D., Ketten, D. R., Miller, J. H., Nachtigall, P. E., Richardson, W. J., Thomas, J. A., & Tyack, P. L. (2007). Marine mammal noise exposure criteria. Aquatic Mammals, 33(4), 411–521.

Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P. and Tyack, P.L., 2019. Marine mammal noise exposure criteria: updated scientific recommendations for residual hearing effects. Aquatic Mammals, 45(2), pp.125-232.

Spooner, E., Karnauskas, M., Harvey, C.J., Kelble, C., Rosellon-Druker, J., Kasperski, S., Lucey, S.M., Andrews, K.S., Gittings, S.R., Moss, J.H., Gove, J.M., Samhouri, J.F., Allee, R.J., Bograd, S.J., Monaco, M.E., Clay, P.M., Rogers, L.A., Marshak, A., Wongbusarakum, S., Broughton, K. & P.D. Lynch, 2021. Using Integrated Ecosystem Assessments To Build Resilient Ecosystems, Communities, And Economies, Coastal Management, 49:1, 26-45, Doi: 10.1080/08920753.2021.1846152

Sprfma, 2007. Information Describing Seamount Habitat Relevant To The South Pacific Regional Fisheries Management Organisation.

Stage, J. & C.H. Kirchner, 2005. An Economic Comparison Of The Commercial And Recreational Linefisheries In Namibia. African Journal Of Marine Science 27, 577-584.

Steffani, N., 2007a. Biological Baseline Survey Of The Benthic Macrofaunal Communities In The Atlantic 1 Mining License area And The Inshore Area Off Pomona For The Marine Dredging Project. Prepared For De Beers Marine Namibia (Pty) Ltd. Pp. 42 + Appendices.

Steffani, N., 2007b. Biological Monitoring Survey Of The Macrofaunal Communities In The Atlantic 1 Mining License area And The Inshore Area Between Kerbehuk And

Bogenfels. 2005 Survey. Prepared For De Beers Marine Namibia (Pty) Ltd. Pp. 51 + Appendices.

Steffani, N., 2009a. Biological Monitoring Surveys Of The Benthic Macrofaunal Communities In The Atlantic 1 Mining License area And The Inshore Area – 2006/2007. Prepared For De Beers Marine Namibia (Pty) Ltd. (Confidential Report) Pp. 81 + Appendices.

Steffani, N., 2009b. Assessment Of Mining Impacts On Macrofaunal Benthic Communities In The Northern Inshore Area Of The De Beers Ml3 Mining License area - 18 Months Post-Mining. Prepared For De Beers Marine. Pp. 47 + Appendices.

Steffani, N., 2009c. Baseline Study On Benthic Macrofaunal Communities In The Inner Shelf Region And Assessment Of Mining Impacts Off Chameis. November 2009. Prepared For Namdeb. Pp. 45 + Appendices.

Steffani, C.N., 2010a. Assessment Of Mining Impacts On Macrofaunal Benthic Communities In The Northern Inshore Area Of The De Beers Mining License area 3 – 2010 . Prepared For De Beers Marine (South Africa). Pp 30 + Appendices.

Steffani, N., 2010b. Biological Monitoring Surveys Of The Benthic Macrofaunal Communities In The Atlantic 1 Mining License area – 2008. Prepared For De Beers Marine Namibia (Pty) Ltd. Pp 40 + Appendices.

Steffani, N., 2010c. Benthic Grab Monitoring Survey In The Atlantic 1 Mining License area – 2009. Prepared For De Beers Marine Namibia (Pty) Ltd. Pp 40 + Appendices.

Steffani, N., 2011. Environmental Impact Assessment For The Dredging Of Marine Phosphate Enriched Sediments From Mining License area No. 170. Specialist Study No. 1c: Marine Benthic Specialist Study For A Proposed Development Of Phosphate Deposits In The Sandpiper Phosphate License area Off The Coast Of Central Namibia. Prepared For Namibian Marine Phosphate (Pty) Ltd. November 2011. 72 Pp.

Steffani, C.N., 2012. Assessment Of Mining Impacts On Macrofaunal Benthic Communities In The Northern Inshore Area Of The Ml3 Mining License area - 2011. Prepared For De Beers Marine (South Africa), July 2012, 54pp.

Steffani, C.N. And A. Pulfrich, 2004a. Environmental Baseline Survey Of The Macrofaunal Benthic Communities In The De Beers Ml3/2003 Mining License area. Prepared For De Beers Marine South Africa, April 2004., 34pp.

Steffani, N. And A. Pulfrich, 2004b. The Potential Impacts Of Marine Dredging Operations On Benthic Communities In Unconsolidated Sediments. Specialist Study 2. Specialist Study For The Environmental Impact Report For The Pre-Feasibility Phase Of The Marine Dredging Project In Namdeb's Atlantic 1 Mining License area And In The Nearshore Areas Off Chameis. Prepared For Pisces Environmental Services (Pty) Ltd, September 2004.

Steffani, C.N. And A. Pulfrich, 2007. Biological Survey Of The Macrofaunal Communities In The Atlantic 1 Mining License area And The Inshore Area Between Kerbehuk And Lüderitz 2001 – 2004 Surveys. Prepared For De Beers Marine Namibia, March 2007, 288pp.

Steffani, N., Sedick, S., Rogers, J. & M.J. Gibbons, 2015. Infaunal Benthic Communities From The Inner Shelf Off Southwestern Africa Are Characterised By Generalist Species. Plos One 10(11): E0143637. Doi:10.1371/Journal.Pone.0143637.

Terblanche, N., 2025. Chevron Expands Footprint in Namibia with PEL 82 acquisition, Chevron expands footprint in Namibia with PEL 82 acquisition – News Stand.

The Brief, 2025. Namibia's informal sector growth potential limited —AfDB, Namibia's informal sector potential limited —AfDB.

The Namibian, 2022. Namibia to promote artisanal fisheries and aquaculture, Namibia to promote artisanal fisheries and aquaculture – Trade Forward Southern Africa.

Thom, I., 2023. Will Namibia become a major deepwater oil producer?, Accessed Wood Mackenzie.

Thomisch, K., 2017. Distribution Patterns And Migratory Behavior Of Antarctic Blue Whales. Reports On Polar And Marine Research 707: Pp194. Doi:10.2312/Bzpm_0707_2017

Thomisch, K., Boebel, O', Clark, C.W., Hagen, W., Spiesecke, S., Zitterbart, D.P. And I. Van Opzeeland, 2016. Spatio-Temporal Patterns In Acoustic Presence And Distribution Of Antarctic Blue Whales Balaenoptera Musculus Intermedia In The Weddell Sea. Doi: 10.3354/Esr00739.

Timonin, A.G., Arashkevich, E.G., Drits, A.V. And T.N. Semenova, 1992. Zooplankton Dynamics In The Northern Benguela Ecosystem, With Special Reference To The Copepod Calanoides Carinatus. In: Payne, A.I.L., Brink, K.H., Mann, K.H. And R. Hilborn (Eds). Benguela Trophic Functioning. S. Afr. J. Mar. Sci. 12: 545–560.

Tyack, P.L., Zimmer, W.M.X., Moretti, D., Southall, B.L., Claridge, D.E., Durban, J.W., Clark, C.W., Et Al., 2011. Beaked Whales Respond To Simulated And Actual Navy Sonar, 6(3). Doi:10.1371/Journal.Pone.0017009

Uirab, S., 2024. Demand for Health Care Services in Erongo Growing, Demand for health care services in Erongo growing | nbc. Accessed 01/04/2025.

UNICEF, 2017. Children and the Namibian Budget: Basic Education, Budget Brief Education.pdf.

United Kingdom Kome Office, 2021. Namibia: Women fearing gender-based violence, NAM CPIN Women fearing GBV. Accessed 15/05/2025.

United Nations Development Programme (UNDP), 2022. Human Development Report 2021/2022: Uncertain Times, Unsettled Lives – Shaping our Future in a Transforming World (Overview). New York: UNDP.

United Nations Development Programme (UNDP), 2025. Namibia, Specific country data | Human Development Reports.

United Nations Namibia, 2020. Human Development Report 2020 and Namibia National Human Development Report 2019 Launch, Human Development Report 2020 and Namibia National Human Development Report 2019 Launch | United Nations in Namibia.

Utne-Palm, A.C., Salvanes, A.G.V., Currie, B., Kaartvedt, S., Nilsson, G.E., Braithwaite, V.A., Stecyk, J.A.W., Hundt, M., V.D. Bank, M., Flynn, B., Sandvik, G.K., Klevjer, T.A., Sweetman, A.K., Brüchert, V., Pittman, K., Peard, K.R., Lunde, I.G., Strandabø, R.A.U. & M.J. Gibbons, 2010. Trophic Structure And Community Stability In An Overfished Ecosystem. Science, 329: 333-336.

Van Dalfsen, J.A., Essink, K., Toxvig Madsen, H., Birklund, J., Romero, J. And M. Manzanera, 2000. Differential Response Of Macrozoobenthos To Marine Sand Extraction In The North Sea And The Western Mediterranean. Ices J. Mar. Sci., 57: 1439–1445.

Van Der Bank, M.G., Utne-Palm, A.C., Pittman, A., Sweetman, A.K., Richoux, N.B., Brüchert, V. & M.J. Gibbons, 2011. Dietary Success Of A 'New' Key Fish In An Overfished Ecosystem: Evidence From Fatty Acid And Stable Isotope Signatures. Mar. Ecol. Prog. Ser. 428: 219-233.

Villegas-Amtmann, S., Schwarz, L.K., Gailey, G., Sychenko, O. & D.P. Costa, 2017. East Or West: The Energetic Cost Of Being A Gray Whale And The Consequence Of Losing Energy To Disturbance. Endangered Species Research, 34: 167-183.

Villegas-Amtmann, S., Schwarz, L.K., Sumich, J.L. & D.P. Costa, 2015. A Bioenergetics Model To Evaluate Demographic Consequences Of Disturbance In Marine Mammals Applied To Gray Whales. Ecosphere, 6(10): Art183.

Visser, G.A., 1969. Analysis Of Atlantic Waters Off The Coast Of Southern Africa. Investigational Report Division Of Sea Fisheries, South Africa, 75: 26 Pp.

Waldron, F.W., 1901. On The Appearance And Disappearance Of A Mud Island At Walfish Bay. Trans. S. Afr. Phil. Soc., 11(1): 185-194.

Ward, L.G., 1985. The Influence Of Wind Waves And Tidal Currents On Sediment Resuspension In Middle Chesapeake Bay. Geo-Mar. Letters, 5: 1-75.

Wärtsilä, 2025. Accessed From Offshore Support Vessels (Osvs)

Warwick, R.M., Goss-Custard, J.D., Kirby, R., George, C.L., Pope, N.D. And A.A. Rowden, 1991. Static And Dynamic Environmental Factors Determining The Community Structure Of Estuarine Macrobenthos In Sw Britain: Why Is The Severn Estuary Different? J. Appl. Ecol., 28: 329–345.

Wearne, K. & L.G. Underhill, 2005. Walvis Bay, Namibia: A Key Wetland For Waders And Other Coastal Birds In Southern Africa. Wader Study Group Bull. 107: 24–30.

Weather Atlas, 2025. Accessed From Https://Www.Weather-Atlas.Com/En/Namibia/Walvis-Bay-Climate.

Weeks, S., Currie, B. And A. Bakun, 2002. Massive Emissions Of Toxic Gas In The Atlantic. Nature, 415: 493-494.

Weeks, S.J., Currie, B., Bakun, A. And K.R. Peard, , 2004. Hydrogen Sulphide Eruptions In The Atlantic Ocean Off Southern Africa: Implications Of A New View Based On Seawifs Satellite Imagery. Deep-Sea Res. I, 51:153-172.

Weir, C.R., 2011. Distribution And Seasonality Of Cetaceans In Tropical Waters Between Angola And The Gulf Of Guinea. African Journal Of Marine Science 33(1): 1-15.

Weir, C.R., Collins, T., Carvalho, I. And H.C. Rosenbaum, 2010. Killer Whales (Orcinus Orca) In Angolan And Gulf Of Guinea Waters, Tropical West Africa. Journal Of The Marine Biological Association Of The U.K. 90: 1601– 1611.

Whitehead, H., 2002. Estimates Of The Current Global Population Size And Historical Trajectory For Sperm Whales. Marine Ecology Progress Series, 242: 295-304.

World Bank, 2024. World Bank Group in Namibia. World Bank, Windhoek.

World Health Organization, 2024. Health Data Overview for the Republic of Namibia, Namibia.

Yates, M.G., Goss-Custard, J.D., Mcgrorty, S.M., Lakhani, Dit Durrell, S.E.A., Levit, Clarke, R.T., Rispin, W.E., Moy, I., Yates, T., Plant, R.A. And A.J. Frost, 1993. Sediment Characteristics, Invertebrate Densities And Shorebird Densities On The Inner Banks Of The Wash. J. Appl. Ecol., 30: 599– 614.

Zajac, R.N., Lewis, R.S., Poppe, L.J., Twichell, D.C., Vozarik, J., And M.L. Digiacomo-Cohen, 2000. Relationships Among Sea-Floor Structure And Benthic Communities In Long Island Sound At Regional And Benthoscape Scales. J. Coast. Res., 16: 627– 640.

Zettler, M.L., Bochert, R. & F. Pollehne, 2009. Macrozoobenthos Diversity In An Oxygen Minimum Zone (Omz) Off Northern Namibia. Marine Biology 156: 1949-1961

Zettler, M.L., Bochert, R. & F. Pollehne, 2013. Macrozoobenthic Biodiversity Patterns In The Northern Province Of The Benguela Upwelling System. African Journal Of Marine Science 35(2): 283-290

Zeybrandt, F. And J.I. Barnes, 2001. Economic Characteristics Of Demand In Namibia's Marine Recreational Shore Fishery. South African Journal Of Marine Science, 23: 145-156.

Zoutendyk, P., 1992. Turbid Water In The Elizabeth Bay Region: A Review Of The Relevant Literature. Csir Report Emas-I 92004.

Zoutendyk, P., 1995. Turbid Water Literature Review: A Supplement To The 1992 Elizabeth Bay Study. Csir Report Emas-I 95008.

ERM

DETAILED CURRICULUM VITAE OF EAP

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Her fields of expertise include environmental permitting and management consulting to local and IFC standards in countries including South Africa, Mozambique, Kenya, Equatorial Guinea, and Angola. Additionally, Stephanie has experience in closure planning and costing, environmental auditing, due diligence, feasibility studies and environmental risk assessments.

In addition, Stephanie has experience in closure planning and costing, environmental auditing, due diligence, feasibility studies, and environmental risk assessments. She has successfully managed projects for clients in diverse sectors such as oil and gas (upstream and downstream), power utilities, renewable energy, industrial, mining, and transport.

Her focus and specialization revolve around the South African context, and she has led large-scale, multi-disciplinary, and complex projects for prominent companies including TotalEnergies, Shell, Impact Africa, Shearwater, ENI, ExxonMobil, Equinor, Sasol, Anglo suite, ENGIE, and others.

EXPERIENCE: 15+ years' experience in environmental permitting, environmental management and project management.

LINKEDIN: https://www.linkedin.com/in/stephanie-gopaul-79473172

EMAIL: Stephanie.gopaul@erm.com

EDUCATION

- Masters in Environmental Management, University of the Free State, South Africa, 2012
- BSc. Environmental and Engineering Geology, University of KwaZulu Natal, South Africa, 2005
- Water Quality Monitoring Short Course - GCS
- Environmental Impact Assessment Training– Metamorphosis Environmental Consultants;
- Intermediate/ Advanced Excel (ExecuTrain);
- Conflict resolution (Elsie Van Der Merwe)
- Project Management- University of the Free State;
- Hazardous Waste Course- IWMSA (Institute of Waste Management of Southern Africa)
- Environmental Managers as Leaders, Managers and Change Masters- University of the Free State;
- First Aid- Titan Medical; and
- Defensive Driving Course- MasterDrive.

LANGUAGES

- English, native speaker

FIELDS OF COMPETENCE

- Category A and B permitting (including Environmental Impact Assessments/ Basic Assessments)
- Environmental Management Programmes
- Environmental Audits and Due Diligence
- Compliance Audits
- Waste Management Licenses
- Integrated Water Use License Applications
- Integrated Water and Waste Management Plans
- Environmental legal assessments

- Environmental compliance monitoring
- Mining and prospecting right applications
- Public / stakeholder consultation and participation
- Mine closure and closure cost estimations

KEY INDUSTRY SECTORS

- Diversified Energy
- Offshore
- Manufacturing
- Chemicals
- Mining

AWARDS AND RECOGNITION

- 2023: Global Recognition Award related to Client excellence (ExxonMobil).
- 2022: Global Recognition Award related to delivery on Key Client account (Shell upstream).
- 2019: Global Recognition Award related to delivery on Key Client account (ENI), ENI African Account Manager, supported CPD growth into Africa (delivery and sales).

KEY PROJECTS

ExxonMobil Rovuma LNG Midstream project, Mozambique, 2023

Project Manager and EAP

ExxonMobil's Rovuma LNG Project in Mozambique was redesigned with ESG in mind – lowering emissions through engineering and technology selection, reducing security risks by offshoring operations, investing in biodiversity and local communities. ExxonMobil's efforts ceased due to local insurgency, COVID pandemic and Force Majoue in the country and they took the opportunity to redesign the plant, including an option for CCS, potential to significantly reduce emissions as well as reduce reliance on the workforce. The current scope and includes work includes:

1. Environmental Design Basis for the Area 4 midstream plant.
2. Review of the contractor's Waste Management Philosophy
3. Review of the contractor's Noise Management Philosophy
4. Review of the contractor's Environmental Design Basis
5. Review of a contractor's Acorn's Gap Analysis of the Area 4 Project
6. Regulatory review of the Combines Cycle Power Plant
7. Early Authorities Engagement (including impact screening) as part of an imminent update to the EMP
8. Compilation of a Permitting Action Tracker for the midstream and Upstream Components
9. Updates to 16 contractors Environmental Management Plans & 10 Socio-economic Management Plans

Noble/ Chevron EIA Amendment re the Aseng gas Monetisation Project, Equatorial Guinea, 2023

Project Manager

Noble Energy EG Ltd., a Chevron Company, intended to expand the Alen and Aseng deepwater gas facilities in Blocks O and I, off the east coast of Bioko Island, Equatorial Guinea. The supplemental EIA process was undertaken to comply with the environmental licensing requirements of the Republic of Equatorial Guinea, to describe the environmental baseline conditions of the Project area and to recommend mitigation measures for Project activities as warranted for the Project.

Sasol Expert Responding Affidavit on Review Application for Offshore Exploration Project, Block ER236 of the East Coast of South Africa, 2022

Project Manager and EAP

Various applicants lodged a review application in the High Court of South Africa, against the Environmental Authorisation held by ENI and Sasol for offshore exploration in Block ER236 of the East Coast of South Africa. Duties as a project manager and EAP included preparing an expert affidavit in response to the review and co-ordinating the inclusion of the opinions of marine fauna experts, oil and gas subject matter experts, an underwater noise modelling expert, and a climate change expert. This also included collaboration with the clients, client's attorneys and the expert legal council.

Coega LNG Exclusion Zone Quantified Risk Assessment, South Africa, TotalEnergies; 2021

Project Manager

Stephanie managed the team to support TotalEnergies carry out a Quantitative Risk Assessment (QRA) in order to inform a series of proposed exclusion zones for the TOTAL Coega LNG (Liquefied Natural Gas) concept which TOTAL has proposed to the South Africa Department of Mineral Resources and Energy.

Environmental Impact Assessment for Offshore Exploration Drilling, South Africa, ENI, 2019

Project Consultant

Contributing to the drafting of a Scoping and EIA Report and the management of specialists for an exploration drilling project, offshore South Africa.

Additional support on this project included addressing appeal comments in collaboration with the ENI team and their appointed legal consultants.

Gas to Power EIA, South Africa, ACED, 2021

Environmental Assessment Practitioner

Stephanie was the Environmental Assessment Practitioner (EAP) for the EIA for this Gas to power facility, Saldanha Bay in the Western Cape, South Africa

Darling Wind Power EMPr- Darling 1B Wind Energy facility in the Western Cape

EAP

Amendment of the EMPr and layout plan associated with an Environmental Authorisation obtained in 2021.

Environmental and Social Screening Assessment, South Africa, ENGIE, 2020, Project Manager and reviewer

Directed and reviewed an Environmental and Social Screening (ESS) of the seven pre-selected sites. The purpose if the work was for early identification of any potential high risk environmental or social sensitivities associated with the project development at and around the proposed sites. This can be accomplished by the development of high-level pre-feasibility investigations to determine any potential environmental and social impacts that may inhibit the successful development of these projects in terms of the environmental permits and authorizations required at each of the sites.

Goldfields Solar PV EIA, South Africa, ENEL Greenpower, 2017- 2019

Project Consultant

Gold Fields in collaboration with Enel Green Power proposed a 40MW Solar PV Plant at the South Deep Gold Mine near Westonaria, Gauteng. My project responsibilities included compilation of the financial provisioning for closure and drafting certain sections of the EIA.

Shell Gess Programme, Shell, South Africa, 2013 - ongoing

Project Manager

Responsibilities included managing various (ERM has been awarded over 400 to date) Shell Gess projects including Remediation Orders, Section 24G Rectification Processes, Environmental Licensing, Environmental Audits and Waste Management Licenses in terms of specialists co-ordination, public consultation, client liaison, report compilation and all financial aspects. List of selected Projects include:

1. Basic Assessment for the Construction of the Aerodrome Service Station;
2. Decommissioning Basic Assessment for Shell infrastructure at the AEL Modderfontein Site;
3. Bayhead Road Compliance Motivation;
4. Breede Valley Decommissioning Basic Assessment and ECO Audits;
5. Davenport Service Station Compliance Audit;
6. Combined Transport Section 30 Application;
7. Five Star Service Station Compliance Audit;
8. Glebe Service Station Compliance Audit and ECO;
9. Key Delta Basic Assessment Process and ECO Audit;
10. Assegai Motors Environmental Audit and EMP;
11. Bailey and Maile EMP;
12. Mondi Basic Assessment Process and ECO Audit;
13. Montrose Service Station ECO Audit;
14. Ntokozweni EMP and ECO Audit;
15. Philani Valley EMP and ECO Audit;

16. Masakhane Basic Assessment Process and ECO Audit;
17. Beverly Service Station Basic Assessment Process;
18. Diepsloot Basic Assessment Process;
19. Alberton Water Use License;
20. Bargain Wholesalers EMP;
21. Quatro EMP;
22. Summit Road Basic Assessment Process;
23. Wilie Street Basic Assessment Process;
24. Cosmo City Basic Assessment Process;
25. Caledon Depot Basic Assessment;
26. Witbank WULA;
27. Mvoti Service Station WULA;
28. Umfula Motors Basic Assessment Process;
29. Update of Dom Pedro EMP;
30. De Beers Kleinsee Decommissioning Basic Assessment Process;
31. AEL Modderfontein Decommissioning Basic Assessment Process;
32. Three Sisters Screening;
33. Western Cape Sites Screening;
34. Project Black Rhino Screening and AEL;
35. Section 24G Screening Assessment for over 200 Shell sites.

Victoria Louw

Principal Consultant

Vicky Louw (Nee Stevens) is a Principal Environmental Consultant in ERM with over 15 years of experience in the field of environmental consultancy. Vicky has extensive experience with the Project Management, Coordination and compiling of Environmental Impact Assessments (EIAs) and Environmental Management Plans (EMPs) for developments occurring in the marine and coastal zone. She has also supported the marine permitting and management plans for subsea cables, dredging and coastal discharges. Maximising the success of delivery, she has coordinated many environmental disciplines, while liaising closely with the client, project teams, authorities and stakeholders.

Recent key experience in includes project manager/ marine lead for the following Projects:

- The installation of the 2Africa cable system in Nigeria, Senegal, Gabon, Seychelles, Angola, Egypt and São Tomé and Príncipe.
- The development of oil and gas fields for Halfdan North and Valdemar, offshore Denmark
- An exploration well off the coast of KwaZulu-Natal.

EXPERIENCE: 18 years' experience in EIAs & EMPs for developments occurring in the marine and coastal zone

LINKEDIN: https://www.linkedin.com/in/victoria-louw-0656121b

EMAIL: vicky.louw@erm.com

EDUCATION

- MSc (Physical Oceanography), University of Cape Town (UCT), South Africa, 2005
- BSc (Hons) (Environmental and Geographical Science), UCT, 2002
- BSc (Zoology and Environmental & Geographical Science), UCT, 2001

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- South African Council for Natural Scientific Professions (Pr.Sci.Nat. No: 400170/17)
- Member of the IAIA SA association

LANGUAGES

- English, native speaker

FIELDS OF COMPETENCE

- Project Management and Compilation of EIAs and EMPs for offshore Oil & Gas exploration, development, production and decommissioning projects
- Project Management and Compilation of EIAs and EMPs for subsea cable projects
- Providing engineers with advice and guidance to ensure environmental compliance
- Environmental permitting reviews according to World Bank and IFC requirements
- Coastal Waters Discharge Permits
- Marine specialist and oceanographic studies
- Environmental monitoring of dredging operations
- Liaising with authorities, stakeholders, interested & affected parties and clients

KEY INDUSTRY SECTORS

- Offshore Oil & Gas exploration, development, production and decommissioning activities
- Marine Ports and developments
- Dredging Operations
- IFC Permitting reviews

PUBLICATIONS

- Stevens, V, Waldron, H, Brundrit. G and Harcourt-Baldwin, J (2005) The Threat and Cascade Method of Estuarine Health Assessment, South African Marine Science Symposium
- Stevens, V, Waldron, H, Brundrit. G and Harcourt-Baldwin, J (2005) The Threat and Cascade Method of Estuarine Health Assessment - A Logical Sequence from Human Impact to Biological Degradation via System Physics and Chemistry, Land Ocean Interactive Zone Conference

KEY PROJECTS

Permit Feasibility Study for a subsea cable installation in SA, Confidential 2024

Marine Lead

Responsible for the permit feasibility study for two potential subsea cable landings in South Africa.

Scoping and ESIA Study, DP World Maputo, 2023

ESIA Review

Responsible for technical review of the ESIA Report and associated specialist studies for a port expansion project in Maputo.

Supplementary EIA Report, Confidential, 2023

Marine Lead and Project Manager

Responsible for project management and the drafting of a Supplementary EIA Report for the Aseng Gas Monetization (ASGM) Project in Equatorial Guinea.

Environmental Impact Assessment (EIA) Reports for 2 Africa Subsea Cable System, ASN, 2021

Marine Lead and Project Manager

Responsible for project management and the drafting of a Scoping and EIA Reports and the management of specialists for a subsea cable system for multiple countries in West and East Africa.

EIA Report for an Offshore Development, Denmark, Confidential Client, 2020

Environmental Lead

Reviewing and contributing to the drafting of an EIA Report. ESPOO Notification and the Natura 2000 Appropriate Assessment Screening Report for the Valdemar Development, offshore Denmark.

Environmental Compliance Audits for the Drilling and Seismic EMPr for Block 11B/12B for TEPSA, South Africa, 2020

Audit Lead

Reviewed the environmental compliance audit and compiled the close out report for the Block 11B/12B.

EIA Report for an Offshore Development, Denmark, Confidential Client, 2020

Environmental Lead

Reviewing and contributing to the drafting of an EIA Report. ESPOO Notification and the Natura 2000 Appropriate Assessment Screening Report for the Halfdan North Development, offshore Denmark.

Environmental Compliance Audit and Close Out Report for the Deep Water Durban Exploration Right for Exxon Mobil, South Africa, 2020

Reviewed the environmental compliance audit and compiled the close out report for the Deep Water Durban Exploration Right.

Environmental Compliance Audit Report for the Transkei-Algoa Exploration Right for Exxon Mobil, South Africa, 2020

Reviewed the environmental compliance audit for the Transkei-Algoa Exploration Right.

Environmental Compliance Audit of the ER236 Exploration Right for Eni South Africa B.V, South Africa, 2020

Reviewer

Reviewed the environmental compliance audit for the ER236 Exploration Right

Environmental Compliance Audit Report for the Tugela South Exploration Right for Exxon Mobil, South Africa, 2020

Reviewer

Reviewed the environmental compliance audit for the Tugela South Exploration Right.

Health, Safety, Security and Environment (HSSE) review of offshore Angola operations as part of a transaction process, Confidential Client, 2020

Reviewer

Reviewed the HSSE documents, on the behalf of the client, with the primary purpose to access the regulatory compliance status of the Assets.

ESDD Review of the ESIA for a Port Development in Mozambique, Confidential Client, 2020

Reviewer

Reviewed the ESIA, on the behalf of the client, with the primary purpose to check if national requirements and lender requirements are both adequately considered.

Offshore Nigeria, Confidential Client, 2019

Marine Lead

Contribution to the environmental and social baseline assessment of offshore Oil & Gas assets, offshore Nigeria.

EIA Appeal Response, South Africa, ENI, 2019-2020

Marine Lead

Contributing to the drafting of appeal responses against the Environmental Authorisation.

Coastal Water Discharge Permit, South Africa, Burgan Cape Terminals, 2019 to 2020

Marine Lead

Contributing to the Coastal water Discharge Permit application for a proposed reverse osmosis desalination plant and associated infrastructure, Port of Cape Town. Review of the Environmental Management Programme for CCT.

Environmental Red Flags Study Madagascar, CPCS, 2019

Marine Lead

Contributing to an Environmental Red Flags Study for the Madagascar Cabotage Project Madagascar and conducting ground trothing on site.

Legal Register and Permitting Report, Offshore Namibia, Exxonmobil, 2019

Project Manager

Responsible for the management of the subcontractor

Legal Register, Nigeria, Confidential, 2019

Project Consultant

Responsible for the compilation of a legal register for occupational health and safety laws applicable to the film industry in Nigeria.

Environmental and Social Baseline Update, Offshore Angola , Confidential Client, 2019

Project Manager

Update of the environmental and social baseline for a proposed offshore Oil & Gas development, offshore Angola.

EIA Report for METISS Subsea Cable System to be Landed in KwaZulu-Natal, South Africa, ASN, 2018 to 2020

Marine Lead and Project Manager

Responsible for project management and the drafting of a Scoping and EIA Report and the management of specialists for a subsea cable system, KwaZulu-Natal, South Africa.

EIA Report for Noble Energy's Alen Gas Export Pipeline, Equatorial Guinea, Noble Energy, 2018

Marine Lead and Project Manager

Responsible for project management and the drafting of an EIA Report for the installation of an offshore natural gas export pipeline.

EIA Report for IOX Subsea Cable System to be Landed in East London, South Africa, IOX, 2018

Marine Lead and Project Manager

Responsible for project management and the drafting of a Scoping and EIA Report and the management of specialists for a subsea cable system, East London, South Africa.

ESIA Report for Offshore Exploration Drilling, Kenya, ENI, 2018

Marine Lead

Contributing to the drafting of a pre-ESIA and ESIA Report for an offshore exploration drilling project, offshore Kenya.

Update of the EIA Report for the proposed 3D Seismic Survey for Petroleum Exploration Licence 39 Exploration Programme., Shell, 2018

Marine Lead

Responsible for the drafting of the update of the EIA Report for a 3D seismic survey in the western portion of the PEL 39 Licence Area.

EIA Report for Marine Shallow Seismic Acquisition in the Marine III licence area in the Republic of Congo, NewAge, 2017 to 2019

Project Manager and Marine Lead

Responsible for the Project Management and drafting of an EIA Report for a shallow marine seismic survey project offshore Congo.

EIA Report for Offshore Exploration Drilling, South Africa, ENI, 2017 to 2019

Marine Lead and Project Manager

Contributing to the drafting of a Scoping and EIA Report and the management of specialists for an exploration drilling project, offshore South Africa.

EIA Report for Offshore Seismic Survey Blocks W, S and EG21, Equatorial Guinea, KOSMOS, 2019

Marine Lead

Contributing to the drafting of an EIA Report for a seismic survey project in offshore Bioko Equatorial Guinea waters.

EIA Report for Offshore Seismic Survey Block 11, Equatorial Guinea, ExxonMobil, 2019

Project Manager

Responsible for the drafting of an EIA Report for a seismic survey project offshore Bioko Island, Equatorial Guinea.

The EIA Report compilation included an evaluation of the relevant legal and regulatory requirements; determination of the environmental (biological and physical) and social conditions; determination of potential impacts; and creation of a comprehensive mitigation and management plan.

Update of EIA Report for Block I to Include Offshore Drilling, Equatorial Guinea, Noble Energy, 2017

Project Manager and Marine Lead

Responsible for the drafting of an EIA Report for additional offshore drilling activities in Block I, Equatorial Guinea.

The EIA Report compilation included an evaluation of the relevant legal and regulatory requirements; determination of the environmental (biological and physical) and social conditions; determination of potential impacts; and creation of a comprehensive mitigation and management plan.

Environmental and Social Due Diligence for an Offshore Platform, Norway, Confidential Investment Client, 2016

Marine Environment Lead

Project managed and undertook the desk-based component and write-up of an ESDD to international standards of an offshore platform for a client looking to invest in the project.

Review of the EIA of BUA Refinery and Petrochemical Project Ibeno, Nigeria, Confidential Client, 2019

Reviewer

Reviewed the ESIA, on the behalf of the client, with the primary purpose to see that national requirements and lender requirements are both adequately considered.

EIA Report for Offshore Seismic Survey Block B, Equatorial Guinea, ExxonMobil, 2017

Marine Lead

Contributing to the assessment of seismic noise on marine mammals and turtles for an Environmental Impact Assessment offshore Bioko Island, Equatorial Guinea.

Summary Paper, IPIECA, 2017

Project Manager

Compilation of a summary document that outlines the areas of existing good practice and management measures that are currently implemented by the oil and gas industry in the marine environment to reduce potential impacts on Biodiversity & Ecosystem Services (BES) from specific aspects and dependencies.

Dredging Specialist, Mozambique, Client Confidential , 2017

Marine Environmental Advisor

Compiling an Environmental Management Plan for the dredging operations inside Palma Bay, Mozambique.

EIA for Offshore Exploration Drilling, Equatorial Guinea, ExxonMobil, 2017

Marine Lead

Contributing to the drafting of an EIA Report for an offshore exploration drilling project offshore Bioko Island, Equatorial Guinea. The EIA Report compilation included an evaluation of the relevant legal and regulatory requirements; determination of the environmental (biological and physical) and social conditions; determination of potential impacts; and creation of a comprehensive mitigation and management plan.

EIA Onshore and Offshore Mozambique, Sasol, 2017

Project Co-ordinator and Marine Lead

Project co-ordinator and Marine Lead of Scoping Study, Specialist studies, and the ESIA for the proposed offshore Oil & Gas Development.

Environmental Advisor, Cape Town, South Africa, Client Confidential, 2017

Marine Environmental Advisor

Providing advice and assistance to the client in terms of their marine environmental permitting (Coastal Waters Discharge Permits).

EIA, offshore Tanzania, BG, 2016

Marine Lead

Marine Lead for the Environmental Impact Statement for two proposed Block-Wide Offshore Drilling projects.

Marine Environmental Specialist, Multiple Gas to Power Projects, Confidential Client, 2015

Marine Specialist

Coastal effluent and associated marine impacts advisor for multiple gas to power projects.

Environmental Management Programme for 3D Seismic Data Acquisition on the East Coast of South Africa, Schlumberger, 2015

Environmental Consultant

Composition and authorization of 3D Marine Seismic Environmental Management Programme.

Environmental Impact Study for 2D Seismic Data Acquisition in the Benguela and Namibe Basins, offshore Angola, GXT Technology, 2015

Project Manager

Project management and composition of 2D Marine Seismic Survey Environmental Impact Study.

EIA Scoping Study, offshore Ghana, Confidential Client, 2015

Project Manager

Project management and composition of Scoping Study for the proposed offshore Oil & Gas development.

Multi-products Pipeline Screening Study and EIA, Ethiopia & Djibouti, BlackRhino, 2015

Marine Lead and Advisor

Marine advisor for the screening study for the Environmental and Social Impact Assessment (ESIA) in Ethiopia and Djibouti for the BlackRhino MOGS (BRM) multi-products fuel pipeline from Djibouti to Awash in Ethiopia.

Rapid Cumulative Assessment, Tema Port Upgrade and Expansion, Ghana, APMT, 2015

Report Writer

Composition of a Rapid Cumulative Assessment for the upgrade and expansion of Tema Port in Ghana.

EPA Compliance Review EIA Report and Environmental Management Plan Review for Tema Port Upgrade and Expansion, Ghana, APMT, 2015

Environmental Advisor

Reviewed the EIA and Environmental Authorisation for the expansion and upgrade of the Tema Port in Ghana. Provided the client with advice regarding the implementation of the mitigation measures stipulated in the relevant reports and IFC compliance.

Coastal Waters Discharge Permit, Port Elizabeth, South Africa, Shell, 2015

Project Manager

Assisted Shell with their Coastal Water Discharge Permit application for the Dom Pedro Jetty.

Andy's truck Stop Basic Assessment, Port Elizabeth, South Africa, Shell, 2015

Environmental Consultant

Composition and authorization of a Basic Assessment for Andy's Truck Stop.

KEY PROJECTS BEFORE JOINING ERM

Environmental feasibility and screening study for barging of construction materials, Kenya, Tullow Oil, 2015

Senior Consultant

Assisted with an environmental feasibility and screening study for the location of a port on Lake Turkana.

EIR and EMP Review for Tanker Farm & Berth and Fuel Transfer Pipeline, South Africa, Oil & Gas Client, 2015

Environmental Advisor

Reviewed the EIRs and EMPs that were conducted in 2013 for the development of a tanker farm, tanker berth and associated new fuel transfer pipeline in Walvis Bay. Provided engineers with advice regarding design and implementation of the mitigation measures stipulated in the relevant reports.

Environmental Advisor for A Power Plant, Ghana, Oil & Gas client, 2015

Environmental Advisor

Provided engineers with advice regarding design and implementation of the mitigation measures stipulated in the relevant reports.

Metolong Dam Water Supply Programme, Lesotho UNIK, 2014

Environmental Control Officer

Environmental Control Officer services for Metolong Dam Water Supply Programme in Lesotho.

Lender's Technical Adviser for Kuvaninga gas Engine Power Plant, Mozambique, Power Client, 2015

Environmental Auditor

IFC Environmental permitting review of the construction of a power plant in Mozambique.

Botanical Constraints Study for Proposed Liquefied Natural Gas (LNG) Onshore Terminal, Saldanha, South Africa, PetroSA, 2014

Project Manager

Management of Botanical Constraints Study for Proposed LNG Onshore Terminal, Saldanha, Western Cape.

Environmental Advisor, WorleyParsons Engineers, 2015

Environmental Advisor

Assisting WorleyParsons Engineers with environmental authorisations for multiple projects.

Amendment to an Existing Environmental Authorisation - Final Amendment EIA Report. Proposed Well Stimulation of Three Wells in the F-O Gas Field, Offshore Mossel Bay, SA, PetroSA, 2013 - 2015

Project Management and Senior Marine Environmental Consultant

Project management and compilation of an EIA of the proposed hydraulic fracturing of wells, in the F-O Gas Field, offshore South Africa. Management of all the specialist studies associated with the EIA.

Environmental Advisor, Koeberg Nuclear Power Station, South Africa, Eskom, 2014

Marine Environmental Advisor

Providing advice and assistance to the client in terms of their marine environmental permitting (Coastal Waters Discharge Permits and EMPs). Compiling an Environmental Management Plan for the dredging operations inside the intake basin at Koeberg.

Compiling terms of reference for specialist assessments associated with the Coastal Waters Discharge Permits.

Environmental Statements, Oil & Gas clients, UK, 2012

Marine Environmental Consultant

Writing multiple reports on the results of the 2012 post construction survey of the Noord Stream pipeline, in the Baltic Sea. Compiling noise assessments of the impact of seismic guns on marine mammals and fish in the North Sea. Managing and writing multiple PON15B applications. Scoping assessment for an Oil & Gas development in Shetland.

Environmental Statements, Oil & Gas clients, UK, 2012

Project Manager and Marine Environmental Consultant

Project management and compilation of multiple decommissioning environmental statements in the North Sea. Reviewing Oil Pollution Emergency Plans (OPEP).

Environmental Baseline Report, Oil & Gas client, Qatar, 2012

Project Manager and Marine Environmental Consultant

Project management and writing and editing and of an Environmental baseline for an offshore oil development in the Arabian Gulf, Qatar.

Environmental Statements, Oil & Gas client, UK, DONG, 2012

Marine Environmental Consultant

Editing and assisting in the management and compilation of an Environmental statement for the Glenrothes and Cragganmore condensate developments in the west of Shetland.

PON15B, Oil & Gas clients, UK, 2011

Marine Environmental Consultant

Writing environmental descriptions and chemical justifications for multiple PON15Bs.

Environmental Statement for the Sweep (Carrack), UK Shell, 2011

Marine Environmental Consultant

Writing, editing and managing the compilation of an Environmental Statement for the Sweep (Carrack).

Environmental Statement, Endeavour, 2011

Marine Environmental Consultant

Writing, editing and assisting in the compilation and management of an Environmental Statement for the West Rochelle offshore condensate development.

Scoping Report, Oil & Gas client, UK, 2011

Marine Environmental Consultant

Editing and assisting in the compilation of a scoping report for decommissioning an offshore Oil & Gas structure.

Environmental Statements, ConcoPhillips, UK, 2011

Marine Environmental Consultant

Writing, editing and assisting in the compilation of two Environmental Statements for the Katy and Enochdhu offshore Oil & Gas developments.

Environmental Statement, Oil & Gas client, UK, 2011

Marine Environmental Consultant

Writing, editing and assisting in the compilation of an Environmental Statement for the decommissioning of a gas field. Preparing materials and participating in a comparative assessment workshop.

Environmental Statements, Nexen Petroleum UK Limited, UK, 2010

Writing, editing and assisting in the compilation of 2 Environmental Statements for the Blackbird and Golden Eagle Developments.

Environmental Statement, BG Norge, UK, 2010

Writing the accidental release of hydrocarbons and mitigation measures sections of an Environmental Statement for the Knarr gas development. Formatting and reviewing document.

Environmental Monitoring of Dredging And Dredge Spoil Disposal in Cape Town Harbour. (Transnet, South African Dredging Surveys, Rohde Nielson), SA, Transnet, 2007 - 2010

Marine Environmental Consultant

Implementing and maintaining real time monitoring of the environmental impact of dredging in Cape Town harbour. Implementing and maintaining monitoring of the dumping of the dredge spoil from the Cape Town harbour at the dump site. Analysis and processing of all the data collected. Reporting to the client on the environmental impact of the dredging in Cape Harbour and at the dumpsite. Real time plume tracking of the dredge spoil at the dumpsite.

Cooling Water Discharge Assessment, Koeberg Nuclear Power Station, Eskom, SA, 2009

Marine Specialist

A desktop review of the environmental impact of the discharge of cooling water from a nuclear power plant off the west coast of South Africa was conducted.

EIA for Offshore Oil & Gas Exploration Drilling in Block 16, Angola, Maersk, 2009

Marine Environmental Consultant

Assisted in compiling an EIA of offshore drilling for Oil & Gas in Angola.

Seismic survey by Sonangol in Block 3/05a, Angola, Sonangol, 2008

Marine Environmental Consultant

Assisted in the compiling of the environmental impact of Seismic surveying in Angola.

A Physical Oceanography Environmental Profile for Beira, Mozambique, ERM, 2007

Marine Specialist

Preparation of an environmental baseline description for a proposed transportation of coal in Beira, Mozambique.

Joane Foucher

Consulting Director

Joane is Consulting Director at ERM France, in Paris office. She is part of Southern Europe Capital Project Delivery Team, acting as Project Manager, Environmental Lead and Team Leader for France.

The vast majority of the projects she has been involved in are in the Oil & Gas industry: for various segments (E&P, Refining, LNG,…), in main Project development phases (Conceptual, FEED, EPC), both Onshore and Offshore, in multiple geographies. She has managed and contributed to numerous ESIAs across different geographies and has experience with international standards.

EXPERIENCE: +20 years' experience in Health, Safety and Environmental Services

LINKEDIN: https://www.linkedin.com/in/joane-foucher-29430b256/

EMAIL: joane.foucher@erm.com

EDUCATION

- Engineer graduated from ENSIL (Ecole Nationale Supérieure d'Ingénieurs de Limoges), specialized in environment, France, 2001
- Technical Diploma of the Orsay University (Diplôme Universitaire de Technologie) specialized in chemistry, France, 1998

LANGUAGES

- French, native speaker
- English, fluent

FIELDS OF COMPETENCE

- Project Management
- Environmental design
- Engineering
- Environmental Impact Assessment

- Atmospheric Dispersion
- Best Available Techniques
- Carbon footprint
- Compliance with international environmental standards (e.g., IFC PS)
- Safety design: active & passive fire protection / fire & gas detection / escape, evacuation and rescue / hazardous area classification

KEY INDUSTRY SECTORS

- Oil and Gas
- Renewables and CCUS
- Chemicals & fertilizers

KEY PROJECTS

Environmental & Social scoping for LNG infrastructure project in Morocco (confidential, on-going)

Project Manager and Lead environmental for an E&S scoping study in accordance with international standards as part of the due diligence and transaction structuring process for a LNG infrastructure project in Morocco consisting in an import and regassification terminal alongside its associated downstream gas transport / distribution infrastructure.

Program Manager and technical assistance for environmental screenings, Environmental Impact Assessment (TotalEnergies E&P Denmark, since 2021)

Support for delivering environmental impact assessment reports or screening reports for various activities on existing offshore assets (new platforms and pipelines, workovers, drillings). Acting as project manager and Environmental Lead.

Support to ESIA on a CO_2 pipeline project crossing 6 countries in Europe (confidential, on-going)

Support for reviewing scoping and ESIA reports for Danish and French trunklines on a CO_2 highway pipeline project crossing 6 countries in Europe.

Environmental and Social Due Diligence for a Gas Development Project in Morocco (onshore, offshore) (Confidential, 2023)

Project Manager and Lead environmental for an ESDD including site visit, reporting and ESAP aligned with IFC and EP4.

Environmental and Social monitoring for a thermal plant in Togo (confidential, 2023)

Project Manager and Lead environmental for an E&S monitoring during construction period including site visit, reporting and ESAP aligned with IFC and EP4.

Project Manager for Biodiversity studies on O&G infrastructures (offshore and onshore) (confidential, 2022 - 2024)

Realization of different types of biodiversity studies (diagnosis, Biodiversity Action plans) on various O&G infrastructures (offshore assets, onshore upstream or downstream sites) in Denmark, Tunisia, France, Nigeria and Brazil.

IFC benchmark study in the O&G Sector (confidential, 2022)

Project manager and Environmental Lead for a benchmark study based on IFC Standards for an O&G project in Papua New Guinea: preparation of an IFC based questionnaire to lead the benchmark study, participating in interviews with peers, review of IFC benchmark report.

Technical assistance for Tunnels and associated infrastructures Early Works ESIA, Guinea (confidential, 2021)

Technical assistance as Environmental Lead for the realization of an Environmental and Social Impact Assessment Study for the construction of tunnels and associated infrastructures as part of railway development early works in Guinea.

Project Manager for socio-economic and environmental studies for Offshore Wind Farm in Normandie, France (confidential, 2021-2022)

Project Manager for the realization of socio-economic and environmental studies to support the application to a call for tender for an offshore wind farm in France.

Environmental Lead for ESIA review against World Bank Standard (confidential, 2021)

Review of an ESIA for a pumping water transfer station project in Tunisia to perform a gap analysis against World Bank E&S Standards.

Project Manager for ESIA studies, Seismic and Drilling in Oman (confidential, 2021)

Project Manager for the realization of Environmental & Social Impact Assessment Study for a seismic acquisition survey and exploration drilling campaign, onshore Oman. The scope also includes the Environmental and social baseline studies, as well as scoping report.

Project Manager for ESIA study, Drilling campaign offshore Malaysia (confidential, 2021)

Project Manager for the realization of Environmental & Social Impact Assessment Study for an exploration drilling campaign, offshore Malaysia. The scope also included ENVID, scoping, social baseline and fishery study, underwater noise modelling, drill cuttings and mud modelling as well as oil spill modelling.

Project Manager for Environmental Studies of Gorm Reconfiguration Project (TotalEnergies E&P Denmark, 2021)

Project Manager for the environmental studies to be conducted as part of Gorm Reconfiguration Project: ENVID, scoping and Environmental & Social Impact Assessment Study of the Project, screening reports for various fields, update of existing ESIA on other fields. The scope also includes the Net Environmental Benefit Analysis and Comparative Assessment of the decommissioning options.

Project Manager for Social Acceptability study of carbon capture & Storage Project in Dunkirk, France (confidential, 2021)

Project Manager for the social acceptability study of carbon capture and storage Project in Dunkirk (France).

Facilitating citizen committee for the project in 2022 and 2023.

Project Manager for ESHIA studies, Seismic acquisition in Sao Tome é Principe (confidential, 2020)

Project Manager for the realization of two Environmental, Social & Health Impact Assessment Studies for a seismic acquisition survey in Sao Tome é Principe and JDZ.

Technical Assistance for the Environmental Risk Assessment Studies of North Sea Platforms in Denmark (Total E&P Denmark, 2020)

Environmental Lead for the Environmental Risk Assessment study of the Halfdan A and Halfdan North Platforms in accordance with Total's methodology.

KEY PROJECTS PRIOR TO JOINING ERM

HSE Design Engineer at Technip (2008 – 2020), Engineering Company. Involved in various engineering projects, mainly in the Oil & Gas industry, main experience described hereafter:

Lead environmental engineer for a LNG liquefaction plant project, onshore Mozambique (EPC, confidential, 2020)

Establishment of environmental aspects register, participation to ENVID study, stack height determination, marine dispersion study scope of work.

Sponsoring of newly hired lead environmental engineer for a condensate platform development project, offshore United Arab Emirates (FEED, confidential, 2019)

Technical support to new hired lead environmental engineer; follow-up of the marine & atmospheric dispersion studies, focal point for HSEIA.

Lead environmental engineer for a FPSO project, offshore Israël (EPC, confidential, 2018)

Definition of environmental philosophy applicable to the project based on local regulations, Client specifications and codes & standards. Establishment of environmental inventories (gaseous emissions, liquid effluents, solid waste) and waste management report. Estimation of carbon footprint of the project. Implementation of avifauna protection patent on the project.

Lead environmental engineer for a refinery modernization project, UK (conceptual, confidential, 2017)

Definition of environmental philosophy, establishment of environmental inventories and Best Available Techniques Assessment report.

Focal point HSE for a project of ocean thermal energy (renewables), Offshore France (Martinique) (conceptual, confidential, 2016)

Coordination of various HSE activities: HAZID, biofouling, critical analysis on safety engineering documents.

Focal point HSE for the expansion of a refinery, Irak (FEED, confidential, 2015)

Coordination of HSE activities including safety engineering, environmental & noise as well as risk quantification.

Lead safety engineer for the development of an integrated wellhead platform project, offshore Denmark (EPC, confidential, 2012-2014)

Definition of philosophies and strategies, Fire & Gas detection studies (including follow-up of mapping studies), ATEX risk analysis, follow-up of escape, evacuation & rescue equipment procurement (lifeboats, escape chutes, man overboard boat).

Safety engineer for a rehabilitation and adaptation of a refinery, Algeria (EPC, confidential, 2011)

In charge of fire protection studies: active fire protection philosophy, fire water demand calculation note, fire protection and personnel protection drawings, network hydraulic study, early works and ties-in on existing network, safety equipment specification and follow-up of safety equipment procurement.

Safety engineer for a project of gas treatment facilities (new units), onshore Qatar (EPC, confidential, 2010)

In charge of fire protection studies: job specification for design, firewater demand calculation note, fire fighting layouts and Piping &Instruments Diagrams.

Safety engineer for a project of distillate hydrocracking unit implementation within a refinery, Saudi Arabia (EPC, confidential, 2009)

In charge of fire protection studies: fire water demand calculation note, deluge system hydraulic and arrangement calculation notes, fire protection and personnel protection drawing, line list, firewater Piping &Instruments Diagrams.

Safety engineer for a project of sulfuric acid production plant, Tunisia (EPC, confidential, 2008)

In charge of safety concept, hazardous area classification, active fire protection, personnel protection, safety equipment specification. Follow-up of safety equipment procurement.

Consultant for Sof Conseil (2001 – 2008) involved in various missions, mainly in the Oil & Gas industry:

- Environment: Environmental Impact Assessment studies for regulatory operating permits, Health Impact Assessment studies (including atmospheric dispersion modeling), Environmental Management Plans (waste, chemicals, oil spills)
- Safety: Risk analysis (Quantitative Risk Assessment, safety studies for SEVESO II regulatory operating permit), HAZOP, HAZID
- Functional Safety: SIL reviews, reliability studies and calculations
- Organization: implementation of Quality and Environment Management Systems to obtain ISO 9001 and ISO 14001 certifications.

ERM

STAKEHOLDER ENGAGEMENT PLAN

PREPARED FOR

Chevron Namibia Exploration Limited II

IN COLLABORATION WITH

Stakeholder Engagement Plan

Offshore Drilling Activities in Namibia in PEL 82

DATE
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Stakeholder Engagement Plan

Offshore Drilling Activities in Namibia in PEL 82

0775081

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ACRONYMS AND ABBREVIATIONS

Acronym	Description
AoI	Area of Influence
BID	Background Information Document
CEO	Chief Executive Officer
CNEL	Chevron Namibia Exploration Limited II
E&S	Environmental and Social
EBSA	Ecologically or Biologically Significant Marine Area
ECC	Environmental Clearance Certificate
EIA	Environmental Impact Assessment
EMA	Environmental Management Act
EPs	Equator Principles
ERC	Erongo Regional Council
ERM	Environmental Resources Management
ESIA	Environmental and Social Impact Assessment
FGD	Focus Group Discussion
GBV	Gender Based Violence
GM	Grievance Mechanism
IFC	International Finance Corporation
KPI	Key Performance Indicator
MAFWLR	Ministry of Agriculture, Fisheries, Water and Land Reform
MEFT	Ministry of Environment, Forestry and Tourism
MET	Ministry of Environment and Tourism
MFMR	Ministry of Fisheries and Marine Resources
MIME	Ministry of Industry, Mines and Energy
MWT	Ministry Works and Transport
NADF	Non-aqueous Drilling Fluid
NamPort	Namibia Ports Authority
NGO	Non-Governmental Organisation
NTS	Non-technical Summary
OIC	Oil Industry Contractor
PEL	Petroleum Exploration License
PS	Performance Standard
SEP	Stakeholder Engagement Plan

1. INTRODUCTION

1.1 OVERVIEW

This document is the Stakeholder Engagement Plan (SEP) and Community Grievance Mechanism for the Chevron Namibia Exploration Limited II (CNEL) offshore hydrocarbon exploration program within Petroleum Exploration License (PEL) 82 (hereafter “the project”). The project is located in the Walvis Basin, Namibia.

This SEP has been developed by Environmental Resources Management Southern Africa (Pty) Ltd (“ERM”) and Urban Dynamics (based in Namibia) in support of CNEL. This SEP has been prepared according to the requirements of the Namibian Environmental Management Act 7 of 2007 and associated regulations such as the Environmental Impact Assessment Regulations. It has also been developed to align with Chevron’s internal policies and procedures.

1.2 OBJECTIVES OF STAKEHOLDER ENGAGEMENT

A stakeholder is defined as any individual or group potentially affected by a project, interested in a project or who can themselves affect the project. The main objectives of stakeholder consultation / engagement are as follows:

- Identify all those affected by or who can affect the project to strive to include them in the engagement process.
- Understand the views of stakeholders and make sure that they adequately understand the positive and negative impacts of the proposed project.
- Inform stakeholders throughout the Environmental and Social Impact Assessment (ESIA) process, including local benefits and partner opportunities.
- Build relationships and trust through supporting open dialogue and engagement with stakeholders. Establish transparency in activities being undertaking and build trust with stakeholders.
- Engage with all stakeholders, including vulnerable and marginalised groups, by having an inclusive approach to consultation and participation. This may include the use of differential measures to maximise effective participation of vulnerable stakeholders.
- Manage expectations and concerns by providing a mechanism for stakeholders to engage with the project about their concerns and expectations and provide a mechanism for receiving, documenting and addressing comments received.

1.3 DOCUMENT STRUCTURE

In addition to this introductory section, the remainder of the document is structured as follows:

- Section 2, Legal Framework: Describes the applicable Namibian legislation, international standards and corporate policies and procedures that frame consultation discussions for the project;
- Section 3, Principles of Stakeholder Engagement: Presents the engagement principles of the project;

- Section 4, Context for Stakeholder Engagement: Provides an overview of the socio-economic context of the project area, summarises previous engagement activities;
- Sections 5, Stakeholder Identification and Analysis: Identifies and analyses project stakeholders and vulnerable groups;
- Section 6, Stakeholder Engagement Activities: Presents the proposed engagement programme for the project for all phases;
- Section 7, Engagement tools and resources: Identifies which tools and resources will be used to engage with different stakeholder groups;
- Section 8, Community Grievance Mechanism: Describes the process by which CNEL will receive, and address stakeholder grievances related to the project and its associated activities;
- Section 9, Organisational Capacity: Summarises the roles and responsibilities associated with stakeholder engagement and grievance management within CNEL; and
- Section 10, Reporting, Monitoring and Evaluation: Provides an overview of the necessary tracking, monitoring, reporting requirements, and evaluation measures to oversee and document the implementation of the SEP and Grievance Mechanism (GM).

It is noted that the SEP is a 'living document' that will be updated and adjusted annually (at a minimum) during the project's construction and operation in order to account for ongoing stakeholder engagement activities, changing stakeholder interests and changes in the project.

2. LEGAL FRAMEWORK

2.1 NATIONAL REGULATIONS

Stakeholder engagement related to the ESIA process in Namibia is primarily guided by the stipulations set out in the Environmental Management Act (EMA) 7 of 2007 and associated regulations such as the Environmental Impact Assessment Regulations. The EMA sets out requirements for public consultation based on the rights of the public to be informed as early as possible of any development project which may impact them, be included in decision making regarding project design, and be empowered to provide comment on potential development projects. Additionally, the Act specifies in Section 36 that a public hearing may be carried out as part of the environmental impact assessment process prior to a final decision being made by the Environmental Commissioner regarding an application, if it is deemed necessary by the Commissioner (Environmental Management Act 7 of 2004).

Sections 21-24 of the Environmental Impact Assessment (EIA) Regulations provides further details on the public consultation process required (Environmental Impact Assessment Regulations, 2012):

- A project must give notice of the public consultation process using site notices, written communication to neighbours and authorities as well as potentially interested and affected parties, and advertisements once per week for two consecutive weeks in at least two widely circulated newspapers;
- Public notices / communication should include details of the application / project to which the consultation is associated, the nature and location of the project, details of where further information on the application / project can be obtained, how to communicate with the project;
- All interested and affected parties must be recorded on a register by the project. Interested and affected parties include all persons who have submitted written comments or attended meetings during the public consultation, all persons who have requested to be added to the register following public consultations, and all organs of state that have jurisdiction in respect to the planned activities of the project;
- All registered interested and affected parties are entitled to provide written comment on the application, including comments on scoping reports, EIA reports, and any amendments to such reports; and
- All comments received from registered interested and/or affected parties must be recorded by the project in the reports that are submitted as part of the application.

2.2 COPORATE POLICIES AND PROCEDURES

The Stakeholder Focus Area (SFA) is one of the six Focus Areas in Chevron’s Operational Excellence Management System (OEMS). SFA outlines how we engage stakeholders to foster trust, build relationships, and promote two-way dialogue to manage potential impacts and create business opportunities. The company is committed to working with stakeholders in a socially responsible and ethical manner to ensure respect for human rights. Further commitments include:

- Building and maintaining relationships with all external stakeholders (including governments and communities);
- Identifying and assessing stakeholder issues; and
- Developing and implementing issue management plans, stakeholder engagement plans, and social impact management plans.

The Stakeholder Engagement and Issues Management (SEIM) Process, which operationalises the SFA, is a framework for identifying, assessing, and managing social risks and impact across asset lifecycle. The Process helps the Company to understand and address the concerns of stakeholders with a goal of building trust and fostering positive relationships.

3. PRINCIPLES OF STAKEHOLDER ENGAGEMENT

The key principles guiding the project's approach to stakeholder engagement are as follows:

- Transparent: process, objectives and criteria communicated openly to stakeholders;
- Credible: building confidence and trust through honouring commitments and sharing relevant information in a timely manner;
- Respectful: engagements prioritized and conducted in a culturally appropriate manner;
- Collaborate: to work cooperatively with stakeholders to find solutions that meet common interests;
- Responsive: to stakeholder concerns and in disseminating feedback on their inputs;
- Proactive: to act in anticipation of the need for information or potential issues;
- Fair: to conduct all engagements impartially without bias and treat stakeholders fairly, and their issues and concerns are afforded fair consideration;
- Accessible: engagements and information disclosed in a language and form accessible to stakeholders and without cost to them engage in language; and
- Inclusive: engagements that are appropriate for all identified.

4. CONTEXT FOR STAKEHOLDER ENGAGEMENT

To develop an effective SEP, it is necessary to understand the context in which the project is set. This section provides high level contextual socio-economic information of the project and summarises previous stakeholder engagement prior to identifying stakeholders that may be directly or indirectly affected by the project (positively and negatively) as a basis of tailoring the subsequent engagement plan to the needs of different stakeholder groups.

The project will entail an offshore hydrocarbon exploration program within PEL 82 in blocks 2112B and 2212A. PEL 82 is located approximately 163 km north-west of Walvis Bay. Walvis Bay will be used a logistics base for the project. Given that much of the project activities will be occurring in deepwater and the project is restricted to exploration drilling and testing, the number and type of stakeholders that may be impacted by the project is limited.

4.1 SOCIO-ECONOMIC CONTEXT

The main impact of the project will be experienced in coastal towns namely Walvis Bay, Swakopmund and Henties Bay. These towns are the main socio-economic centres of the coast of the Erongo Region, host the bulk of Namibia's coastal population and provide the base for the fishing, logistics, tourism and offshore exploration industries. Walvis Bay and Swakopmund settlements are experiencing rapid, migration-driven population growth. The Erongo Region as a whole has a high percentage of working age residents. This underscores the region's role as an economic hub, attracting labour for port, fishing, mining and logistics activities. Henties Bay has an older population reflecting its attraction as a retirement and seasonal settlement.

Namibia's rich mineral base and small population of about 3 million gives it a World Bank classification of a lower-middle-income country. Political stability and social policies, such as public spending on pensions and welfare grants since Independence in 1990, have reduced poverty.

However, socio-economic inequalities inherited from the past apartheid system remain extremely high and structural constraints to growth have hampered job creation. Economic advantage remains in the hands of a relatively small segment of the population, and the large income disparities have led to a dual economy - a highly developed modern sector co-existing with an informal subsistence-oriented one. The duality of the labour market, combined with slow job creation and low primary-sector productivity, results in very high unemployment.

Poverty levels and the cost of living are high and thus the quality of life for many are not in unison with the country's macro-economic indicators. The economy grew between 2010 and 2015 by an average of 5.3% per annum, but since 2016, it has not come out of recession.

Primary industry (agriculture, extractives) contribution to Gross Domestic Product in Namibia is on the increase while the contributions of secondary (meat and other food processing, beverages, mineral processing, electricity generation and construction) and tertiary industries (public sector, retail and wholesale, transport and services sectors) are on the decrease.

Namibia and the Erongo Region record high literacy rates. School attendance in Erongo is better than in Namibia on average with 4% of the population in the region having never attended school compared to 9.7% nationally. Within the region, Walvis Bay and Swakopmund show slightly higher levels of secondary and tertiary attainment than the regional average, reflecting their urbanised nature and the presence of private and technical training institutions.

The majority of Namibians make use of public health services (82%), with the remaining 18% accessing private healthcare through medical insurance schemes. Access to healthcare is considered good, with 76% of the population on average living within 10 km of a healthcare facility. However, in rural areas, on average, each primary healthcare facility serves a population of 5,780 people while each district hospital serves 58,825 people. This has resulted in overcrowding and long wait times. In response, many people travel significant distances to attend clinics and hospitals in areas far from their homes that are perceived to be less crowded and provide better services. The public health system in Namibia is facing challenges from a shortage of qualified professionals as well as high staff turnover.

Access to infrastructure and services varies widely across Namibia with a clear rural-urban divide. Those living in urban centres have greater access to grid electricity, water, sanitation, waste management services etc. The towns in the project Area of Influence (AoI) tend to have decent access to infrastructure and service. However, this access does not always extend to the surrounding rural areas.

5. STAKEHOLDER IDENTIFICATION AND ANALYSIS

5.1 STAKEHOLDER IDENTIFICATION

The following categories of external stakeholders have been identified as being of interest for the project:

- National, Regional, and Local Authorities;
- Traditional Authorities;
- Affected Communities, including vulnerable groups;
- Civil Society and Community Associations;
- Onshore Business Community;
- Commercial Marine Users; and
- Media.

Table 5-1 lists the stakeholders that have been identified for the project. This list will continue to be developed and refined as the project progresses through its lifecycle.

A stakeholder database has been developed that includes various details for individual stakeholders such as:

- Stakeholder category;
- Name of the organization;
- Individual name and position in the organisation;
- Contact information - email address, telephone number; and
- Responses received.

This database is a live document and will continue to be updated as and when new stakeholders are identified or stakeholder details change. The database will be maintained by CNEL for the duration of the project.

TABLE 5-1 SUMAMRY OF EXTERNAL PROJECT STAKEHOLDERS

Category	Stakeholder	Relationship to Project
Authorities	• Ministry of Industry, Mines and Energy (MIME) • Ministry of Environment and Tourism (MET) • Ministry of Agriculture, Fisheries, Water and Land Reform (MAFWLR) • Ministry Works and Transport (MWT) • Namibia Ports Authority (NamPort) • Erongo Regional Council (ERC) • Municipality of Henties Bay • Municipality of Swakopmund • Municipality of Walvis Bay	• The MIME is responsible for promoting and regulating the development and use of Namibia's mining and hydrocarbon resources. The Ministry issues licenses for petroleum exploration and production. • The Ministry of Environment and Tourism is responsible for issues relating to the environment including the EIA process and will comment on the EIA report. • The Ministry of Agriculture, Fisheries, Water and Land Reform deals with sensitive issues in the marine environment that could be impacted by project activities. • The Ministry of Works and Transport oversees maritime affairs through its Department of Transport. • The Nambian Ports Authority (Namport) a public entity associated with the Ministry of Works and Transport, manages the ports of Walvis Bay and Lüderitz and is responsible for protecting the environment within harbor areas under the National Ports Authority Act. • The Erongo Regional Council is responsible for decentralized governance and is mandated to plan and develop the region in a sustainable manner by establishing, managing and controlling settlement areas focusing on core services. Local Government may also have a role in issuing permits and processing applications associated with the project. They may also have a role in monitoring the implementation of project commitments included in an Environmental and Social Management Plan (ESMP). • Municipal Administrations (which govern cities) are responsible, in general, for: promoting the economic and social development of the Municipality, the quality of life of citizens, basic public services such as education, health, culture, sports, recreation and tourism, water and energy supply, basic sanitation and waste management, as well as the road network, the energy network and public lighting, building maintenance and wastewater management, civic and community education of citizens, social welfare services, parking, traffic and public transport.
Traditional Authorities	Topnaar Traditional Authority	Traditional authorities represent their communities' interests in local decision making.
Potentially Affected Communities	Walvis Bay communities close to onshore Area of Influence (AoI)	This category includes households and social support services (i.e. schools, healthcare facilities and places of worship) within the AoI that will potentially be impacted by or interested in the project. Positive benefits associated with employment may be experienced by some in this stakeholder category.
Civil Society, Non-Governmental Organizations and Community Associations	• Community associations (including fishing and tourism) • Civil society groups and Non-Governmental Organizations (NGOs) (including conservation, workers,	Local community associations/ organizations and NGO's that engage in and are supportive of livelihood activities ensuring the needs of communities are being met. These groups can collaborate with the project to support the realization of socio-economic benefits and livelihood compensations (where necessary) plans are effective. Furthermore, the groups can influence the project directly or through public opinion. There are a large number of active NGO's in the Erongo Region associated with environmental and biodiversity conservation.

Category	Stakeholder	Relationship to Project
	youth, justice, policing etc.)	
Onshore Businesses and Business Associations	Businesses that are operational within the onshore AoI.	Businesses may experience disruptions to their operations, especially during construction of the project due to changes in road conditions / access, dust, noise etc. Some businesses may benefit in terms of service provisions.
Commercial Marine Users	Commercial fisheries, cargo, passenger transport, oil and gas logistics, and other marine users are in operation near the offshore AoI.	This includes any business engaged in commercial activities in the buffer zones of the offshore and nearshore components of the project who may face temporary disruptions to commercial activities during project construction.
Media	Local newspapers, radio, television, social media.	Local media will be used for the communication of project-related information and has the potential to raise positive or negative awareness about the project. Newspapers will be used to advertise public meetings as part of the public participation process.

5.1.1 VULNERABLE GROUPS

Vulnerable people or groups are those who may be more adversely affected by project impacts by virtue of characteristics such as their gender, gender identity, religion, physical or mental disability, ethnicity, literacy and employment status. Vulnerable individuals and/or groups may include but are not limited to, people living below the poverty line, single-headed households, migrant workers and refugees.

To create an inclusive engagement process, it is important to identify individuals and groups who may find it more difficult to participate and those who may be directly and differentially or disproportionately affected by the project because of their disadvantaged or vulnerable status.

TABLE 5-2 below provides an overview of the groups that may be considered vulnerable in the project area and need to be particularly considered in the engagement plan in order to facilitate access and provide them with the opportunity to engage in informed discussion about the project.

TABLE 5-2 POTENTIALLY VULNERABLE GROUPS

Vulnerable Group	Description of the Group
Single parent households	Single parents may be less able to access stakeholder meetings due to caring responsibilities.
Elderly and retired individuals	Elderly individuals may find it difficult to access meetings about the project and have their voices heard.
Low-income households	These households might face more barriers to expressing any issues they may have with the project.
Physically and/or mentally disabled	Those who have physical and/or mental disabilities may find it difficult to access meetings / information about the project and have their voices heard.

5.2 STAKEHOLDER ANALYSIS

It is not practical, and not necessary, to engage with all stakeholder groups with the same level of intensity all the time. Analysing and prioritising stakeholders is important to determine appropriate engagement methods for different stakeholders. It also helps identify which stakeholders need to be prioritised during latter stages of the ESIA process. It is important to keep in mind that the project development situation is dynamic and that both stakeholders and their interests might change over time, in terms of level of relevance to the project and the need to actively engage at various stages. Stakeholder analysis should, therefore, be revisited throughout the project lifecycle.

For each stakeholder category identified in Section 5 above, the following needs to be considered:

1. Level of influence that they may exert over the project:

- High – Stakeholder is highly influential and has significant ability to stop or disrupt the project or cause extensive damage to its reputation.

- Medium – Stakeholder has a moderate influence and considerable capacity to stop or disrupt the project and cause damage to its reputation.
- Low – Stakeholder is considered to have limited influence and little capacity to stop or disrupt the project or cause damage to its reputation.

2. Level of interest that they may have in the project:

- High – Project is of high interest to stakeholder.
- Medium – Project is of moderate interest to the stakeholder.
- Low – Project is of little or negligible interest to the stakeholder.

3. Level of impact that they may experience as a result of the project:

- High – Stakeholder is considered to be highly sensitive to potential project impacts and may experience significant changes in their health, wellbeing and livelihoods as a result of the project.
- Medium – Stakeholder is considered to be moderately sensitive to potential project impacts and may experience some changes in their health, wellbeing and livelihoods as a result of the project.
- Low – Stakeholder is not considered to be sensitive to the potential project impacts and is unlikely to experience any changes in their health, wellbeing and livelihood as a result of the project.

Once the above criteria have been decided for each stakeholder category, the matrix below (Figure 5-1) can be used to determine the engagement approach to be adopted. Varying engagement approaches are necessary, depending on the level of impact and influence that each stakeholder has in regard to the project. Approaches to engagement are further described in TABLE 5-3. The analysis also needs to consider which stakeholder categories may find it more difficult to participate in consultation activities owing to their marginalized or vulnerable status (such as disabled or elderly people).

As the level of influence and importance in the project may change over time, there is a need to review and, where necessary, update this information on a regular basis.

FIGURE 5-1 STAKEHOLDER ANALYSIS MATRIX

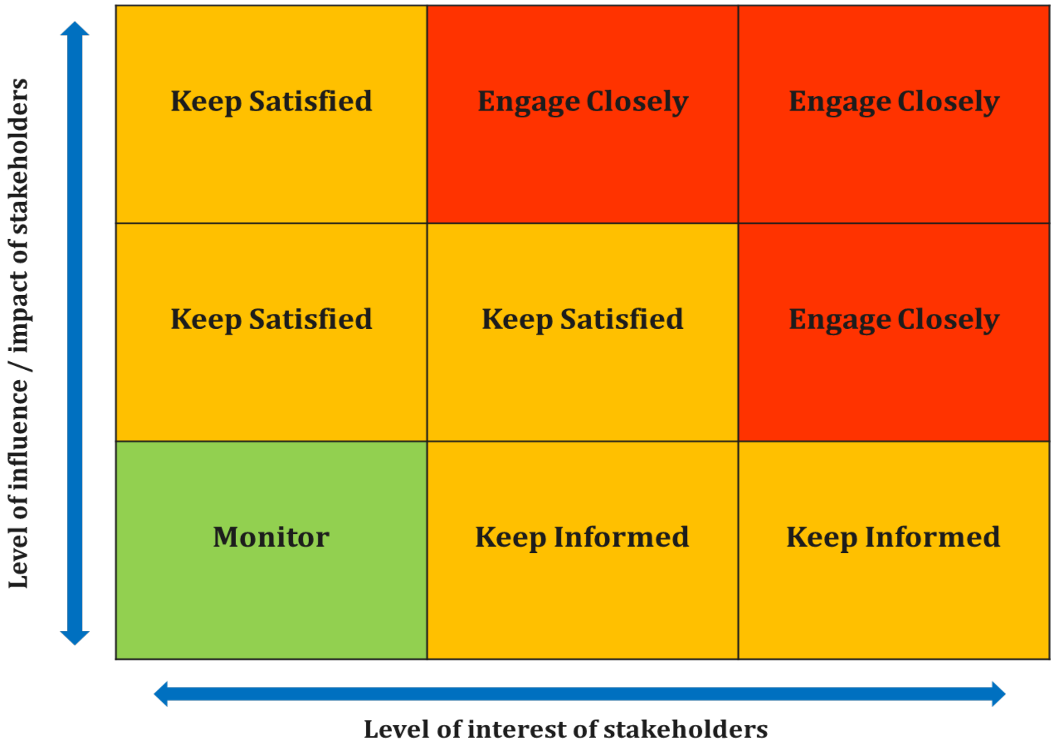


TABLE 5-3 ENGAGEMENT APPROACHES

Approach to Engagement	Frequency and Type of Engagement Activities
Engage closely	Stakeholders are directly engaged throughout the ESIA process. Communication is two-way and is likely to revolve around the conduct of direct, in-person or virtual meetings to discuss the project, facilitate dialogue and ensure that relevant information and feedback from stakeholders is considered in the ESIA process.
Keep satisfied	Stakeholders are directly and indirectly engaged throughout the ESIA process. Communication is predominantly one-way and revolves around the distribution of written information (e.g. information leaflets) via email, post or by hand. Stakeholders are encouraged to respond with written or verbal feedback and comments. Where appropriate, and at the stakeholder's request, there may be more direct contact.
Keep informed	Stakeholders are engaged with indirectly throughout the ESIA process. Communication is one-way and revolves around the distribution of written information (e.g. information leaflets) via email, post or by hand. Stakeholders are free to respond with written or verbal feedback or comments if they wish.
Monitor	There are no deliberate plans to engage with these stakeholders throughout the EISA process. However, their interest in and opinions of the project are monitored (e.g. through the receipt of correspondence and online, including social media, activities) to identify any change in perceptions and the potential need for engagement, as appropriate.

Using the approach and frequency of engagement activities set out in Table 5-4 together with the outcomes of the stakeholder analysis, recommended levels of engagement have been assigned to project stakeholder groups. This approach recognises that stakeholder engagement is multi-faceted, and that the approach to engagement is not uniform across stakeholders.

Priority should be given to stakeholders that are highly influential, including those that are both supportive and unsupportive of the project.

TABLE 5-4 STAKEHOLDER ANALYSIS RESULTS

Stakeholder	Impact Level	Influence Level	Interest Level	Engagement Approach
Ministry of Industries, Mines and Energy	Medium	High	High	Engage Closely
Ministry of Environment and Tourism	Medium	High	High	Engage Closely
Ministry of Agriculture, Fisheries, Water and Land Reform	Medium	High	High	Engage Closely
Ministry Works and Transport	Low	Medium	Medium	Keep Satisfied
Namibia Ports Authority	High	Medium	Medium	Keep Satisfied
Erongo Regional Council	Low	Medium	High	Engage Closely
Municipality of Henties Bay	Low	Low	High	Keep informed
Municipality of Swakopmund	Low	Low	High	Keep informed
Municipality of Walvis Bay	Medium	Medium	High	Engage Closely
Topnaar Traditional Authority	Low	Low	High	Keep Informed
Potentially Affected Communities	Low	Low	High	Keep Informed
Civil Society and Community Associations	Low	Medium	Medium	Keep Satisfied
Onshore Businesses and Associations	Low	Low	Medium	Keep Informed
Commercial Marine Users	High	Medium	High	Engage Closely
Media	Low	Low	Low	Monitor

6. STAKEHOLDER ENGAGEMENT ACTIVITIES CARRIED OUT TO DATE

6.1 SUMMARY OF SCOPING PHASE STAKEHOLDER ENGAGEMENT

The scoping phase of stakeholder engagement aimed at facilitating disclosure of the latest project details, the Draft Scoping Report (including Non-Technical Summary) and obtaining information to identify the expectations of interested and potentially affected parties in relation to the project.

Stakeholder engagement during the Scoping Phase included engagements in municipal areas where onshore components of the project are to be located (Walvis Bay). This process included formal engagement with:

- Community members living in close proximity to proposed project site;
- Municipal / regional planning and implementation authorities including the appropriate line ministries; and
- The business community who use the resource or are dependent on the resource that may be impacted by the project.

Prior to the engagements, a Background Information Document (BID) was prepared (English, Afrikaans and Oshivambo) for distribution with invitations to the meetings. All stakeholders identified within the project stakeholder database were invited to attend a meeting and were supplied with the BID as well as access (via a website link) to the Draft Scoping Report and Non-Technical Summary. The meeting date, venues, and basic project information were published in advertisements in two newspapers that are widely circulated in the local area. These advertisements ran for two consecutive weeks prior to the meetings.

A public meeting was held on 12 June 2025 in Walvis Bay to ensure easy access to the meeting within the areas where people live and work. This was the first project public meeting held as part of the scoping phase for the project. A PowerPoint presentation was prepared for use in the meeting to facilitate information sharing and discussion regarding the project and the ESIA process. The meeting was led by Urban Dynamics and representatives from ERM and CNEL were also present. The project team was introduced to the stakeholders. CNEL provided an overview of the company and project and ERM explained the ESIA process and preliminary findings from the scoping phase. Comments and suggestions raised by stakeholders were recorded and included in the meeting minutes and in the updated Scoping Report. Evidence of the meetings included signed registers and photographs.

Key concerns and questions raised, and responses given are summarized in Table 6-1. These concerns and questions have been incorporated into the ESIA approach.

On 3 July 2025, a dedicated online meeting was also held during the scoping phase to engage with a representative from the Ministry of Fisheries and Marine Resources (MFMR) that could not attend the public meeting. MFMR is included within the Ministry of Agriculture, Fisheries, Water and Land Reform. The meeting was facilitated by Urban Dynamics Africa on behalf of CNEL. Representatives from CNEL and ERM were also present. During the meeting, the project team was introduced and CNEL provided an overview of the company and the project. ERM provided an overview of the ESIA process and the potential environmental and social impacts that have been identified as part of scoping. The questions raised and responses given during this online meeting are summarized in Table 6-2.

Further ESIA phase public meetings are expected to be held in October 2025 to provide project updates, explain preliminary ESIA findings, and gather stakeholder feedback to inform the final ESIA report.

6.1.1 KEY ISSUES RAISED BY STAKEHOLDERS

The below Table 6-1 and Table 6-2 provide a summary of the discussions held during the two engagements conducted as part of the scoping phase of the project.

TABLE 6-1 SUMMARY OF QUESTIONS RAISED DURING THE SOCPING PHASE PUBLIC MEETING

Question/Concern	Response
Community Member: What are the procedures that the youth should follow in order to take part in this industry, and what job opportunities are available? This was not explained in your presentation.	CNEL: At this stage, we are still in the exploration phase, which unfortunately does not come with many direct employment opportunities yet. However, there are potential opportunities within support services. We encourage young people to find out what skills are required by local companies that might be contracted to support the project. For entrepreneurs and business owners, it's also a good idea to explore how to become a supplier or service provider to third-party contractors working with us. Information about available opportunities is often only displayed at the sub-contractors' notice boards in Walvis Bay. It's important for community members to actively visit these notice boards to check for updates and opportunities. Additionally, if you are looking to upskill, you should first research what skills are needed by the companies working on the project or within the wider industry, both locally and internationally. That way, you can focus your training efforts in areas that are in actual demand. Additionally, we work closely with Petrofund, which offers scholarships for students who want to study in fields related to the oil and gas industry. We also recommend attending events such as the Oil and Gas Youth Summit planned for 25 – 26 July, where more information will be shared about future opportunities and how to get involved. There is a cost to it but also opportunities to volunteer to gain access to the event.
Community Member: I want to know, where does local content actually start? We often feel left out once the project begins. Where are these opportunities advertised, and how can we access them?	CNEL: Opportunities for local participation are typically advertised directly by the sub-contractors or third-party contractors who work on the project. These are usually made available through notices posted at their offices or notice boards. It is therefore important for local businesses and interested individuals to actively monitor these spaces and engage with the sub-contractors directly to find out about available opportunities.
Community Member: How is local content defined? Does it include companies that are locally registered even if the owners are not Namibian? How exactly is it defined?	CNEL: Namibia has several official instruments guiding local content, including the Local Content Policy and the Petroleum and Energy Act. These documents provide the specifications on what qualifies as local content. For example, the local content policy defines a Namibian company as one that has at least 51% local ownership Chevron maintains a database of local companies that have formally expressed their interest in providing services, and third-party contractors are able to consider the companies listed on that database. Chevron also has an open-door policy, allowing any interested local company to approach us and present their profiles and capabilities
NGO: Regarding marine life, how will the drilling, machinery, and chemicals used in this project affect marine ecosystems and the communities living along the coast?	CNEL: Chevron will use a non-aqueous drilling fluid (NADF) system, also known as drilling muds, that is biodegradable and has lower toxicity and bioaccumulation potential. ERM is currently undertaking a full ESIA, which includes identifying sensitive marine areas, modelling potential impacts and recommending appropriate mitigation measures.

Question/Concern	Response
	A mitigation example includes Chevron delaying the start of a previous seismic project in another block to be outside of the June to November whale migration season. t We will continue studying the potential impacts to ensure they are avoided where possible or reduced to the lowest practical level. While PEL 82 is located offshore approximately 257 km northwest of Walvis Bay, we recognise the importance of protecting marine ecosystems throughout the project area.
Media: PEL 82, was acquired by Chevron, does it mean they own the Walvis- basin area. Is Gemsbok prospect the license area?	CNEL: No, Chevron holds exploration rights over two specific blocks within PEL 82, specifically blocks 2112B and 2212A, which are part of the Walvis Basin. These blocks were previously part of the Galp portfolio and include a relatively small portion of the basin. 'Gemsbok prospect' refers to a specific prospect well within the license area; each well within the area has its own name.
Media: Based on the ESIA process diagram, you indicated we are currently in the scoping phase. Will a full Environmental and Social Impact Assessment (ESIA) be required, and is that why we are here now at the scoping phase (the second step)?	CNEL: Yes, a full ESIA is required. Urban Dynamics: We are busy with the scoping phase currently.
Media: We have an Oil Industry Contractor (OIC) list, and there are three local companies that provide offshore oil and marine services. Will Chevron use one of these existing providers, or will a new company be brought in to do this work?	CNEL: We are likely to use one of the existing local companies, but final decision has not yet been made at this stage. The actual work is some time away and new players may enter the market before then. It will be assessed closer to the time.
Community Member: We have noticed that when these new industries begin operations, they often don't engage directly with schools, where the future workforce is being prepared. These are new industries for our country, and we need to make sure that our children are given the right information and guidance early on, so that when they finish school, they can pursue courses and careers aligned with the demands of these industries. Please make an effort to engage with schools and provide them with clear information about potential job opportunities and the skills or technical expertise required by the industry.	CNEL: Thank you for your contribution. Chevron is aware of the serious challenges faced by communities in Namibia, including the lack of access to water, food insecurity, and unemployment. This is why we are part of NAMPOA (Namibian Petroleum Operators Association), where petroleum industry players come together to work on addressing these social challenges in a coordinated way. We don't believe in just providing short-term solutions; we want to focus on building skills and creating meaningful, long-term opportunities for people. While we are still in the early exploration phase, which means job opportunities are currently limited, we know that there will be a need for various skills as the project develops. These may include general workers, engineers, support staff, and specialised skills like welding and potentially even underwater work. We acknowledge that preparation needs to start now, and your recommendation about engaging directly with schools to build awareness and interest in these opportunities is valuable. We will take this suggestion forward and ensure it is considered as we continue planning our community engagement and skills development initiatives.

Question/Concern	Response
Community Member: What qualification do you need to get involved in Oil industry?	CNEL: It's important to research the skills required by the various companies involved in the industry and seek employment through them. If you already have a qualification, you can attend specific courses to upskill yourself for offshore work. Community Member: emphasised the importance of up skilling for young people to access opportunities in this industry. She shared her personal example of how she has prepared herself for potential offshore or oil and gas related work by obtaining: A Welding qualification; Work experience in welding; Health and Safety certificates; Medical fitness examinations required for offshore work; A valid passport to be able to travel to South Africa for specialised offshore training courses; and An up-to-date CV detailing her qualifications, skills, and work experience. CNEL: We are one of the presenting sponsors of the Youth in Oil and Gas Summit here in Walvis Bay being held in July. We encourage you to find more information on their social media platforms.
Community Member: Where is Chevron's office in Walvis Bay so that we can visit and get first-hand information about available opportunities? Events like conferences on oil and gas—how can we attend those if we're unemployed and don't have the means to participate?	CNEL: We will discuss this with the organizers of the upcoming Youth Summit in July, to explore what opportunities can be made available for more youth to get involved — including as volunteers.
Community Member: I think it is better for Chevron to do their own short listing and not the third-party contractors.	CNEL: Noted

TABLE 6-2 SUMMARY OF QUESTIONS RAISED DURING MFMR MEETING DURING THE SCOPING PHASE ENGAGEMENTS

Question/Concern	Response
UD: invited MFMR representative to provide insights based on her experience in similar projects.	MFMR: noted a trend of declining attendance at project meetings, possibly due to changes in public behaviour following COVID-19. She suggested that focus group meetings might be more effective for stakeholder engagement. She also mentioned that invites to meetings sometimes get lost in the process. MFMR pointed out that while she receives some project information through Ministry of Environment, Forestry and Tourism (MEFT) sub-committees, she often does not receive supplementary invitations or background documents directly. She recommended that hard copies be sent to the Executive Director's Office and soft copies directly to her. This approach will allow her to review data, consolidate feedback with colleagues, and prepare combined reports efficiently.
MFMR: raised a concern that the map presented during the session did not clearly indicate whether the boundary of PEL 82 overlaps with or lies near any Ecologically or Biologically Significant Marine Areas (EBSAs), particularly in relation to known sensitive zones along the Namibian coast. MFMR requested that this be clarified to better assess any potential interaction between the license area and environmentally sensitive marine habitats, such as whale migration routes or productive feeding areas.	ERM: acknowledged the concern and confirmed that the project team will review and improve the mapping. A more detailed and clearly labelled map will be included in the Scoping Report to accurately show the relationship between the PEL 82 boundary and nearby EBSA areas.
ERM: asked what more could be done by consultants to effectively reach and engage industry stakeholders, particularly those in the fisheries sector, during the public consultation process. ERM acknowledged that Urban Dynamic, as the consultant responsible for public engagement, has complied with the requirements of the Namibian environmental impact assessment (EIA) Regulations — including placing newspaper notices, sending stakeholder emails, and displaying physical notices. However, she noted that despite these efforts, industry stakeholders are often under- represented and requested input from the Ministry on how consultation processes could be strengthened to ensure these key	MFMR: acknowledged that the consulting team complied with the public consultation requirements outlined in the Environmental Management Act and associated regulations. MFMR noted that participation in general public meetings for offshore projects is often limited, particularly among sector stakeholders such as the fishing industry. This is largely due to the meetings' focus on socio-economic benefits—such as employment opportunities—rather than technical matters relevant to industry groups. MFMR encouraged that consultants adopt additional engagement methods to strengthen participation and recommended the following: • Conduct focused group discussions with key industry stakeholders. • Engage clustered stakeholder groups, including vulnerable communities, cooperatives, and fishing associations. • Explore tailored engagement approaches beyond general community meetings.

Question/Concern	Response
	MFMR also pointed out the need for the Ministry to update its stakeholder database, particularly for cooperatives and fishing associations, to reflect recent leadership changes.
UD: asked MFMR to share insights based on her experience within the Ministry regarding whether any environmental issues or concerns have been observed after Environmental Clearance Certificates (ECCs) have been issued for offshore exploration projects.	MFMR: indicated that, generally, the Ministry did not receive significant complaints about negative impacts from offshore exploration activities and typically grants consent for ECCs, provided that the required notification timelines for starting and completing activities are respected. MFMR further explained that the fishing industry seldom have objections but that stakeholders involved in aquaculture activities, are often more sensitive towards potential impacts on their industry. A specific incident was discussed regarding the death of dolphins near Lüderitz, which attracted public concern on social media. MFMR confirmed that although offshore activities were ongoing at the time, these operations were not located near the affected area, and an investigation found no direct link between the activities and the dolphin deaths. MFMR emphasized the importance of early engagement with the Ministry, especially for projects near EBSAs. While the EBSA framework is not legally binding, it supports improved coastal and marine management through recommended zoning. MFMR also noted that compared to Namibia, South Africa applies stricter environmental scrutiny and tends to receive more objections to similar offshore projects.

7. STAKEHOLDER ENGAGEMENT PLAN

7.1 ESIA PHASE STAKEHOLDER ENGAGEMENT

Full details of the engagement process for the ESIA phase (and subsequent project phases) will be provided in the updated Stakeholder Engagement Plan (SEP). A complete list of stakeholders has been identified through engagements and a desktop review and are documented in a stakeholder database which will be included in the final project SEP. They will be analysed based on their level of impact and interest in the project. Stakeholder identification and analysis is an on-going process through the ESIA phase and life of the project.

As part of the application process for the Environmental Clearance Certificate, public meetings will be held by CNEL to inform the public about the project and the preliminary findings of the ESIA. A public meeting was scheduled for 2nd October 2025. Feedback from stakeholders will then be incorporated into the Final ESIA Report prior to submission to the Environmental Commissioner.

The following are some of the important messages that will need to be communicated to stakeholders when the ESIA Report is publicly disclosed:

- Background of the project;
- Project description and location;
- Project activities;
- Potential benefits and negative impacts posed by the project;
- Proposed measures to manage and mitigate negative impacts and to enhance positive ones;
- Process that will be followed to engage with stakeholders;
- Recording issues and concerns related to the project;
- Grievance Mechanism; and
- Planning engagement activities related to the resettlement, compensation and livelihoods restoration processes.

Once the report is submitted to the Environmental Commissioner the Commissioner may take appropriate actions to assist with the review. This may include consultation with relevant institutions and authority structures, public consultations, and/or a public hearing per the provisions of the Environmental Management Act 7 of 2007. The Environmental Commissioner will inform the project of decisions made to undertake further public consultation. CNEL will support with the process where required.

Engagement activities to be undertaken during the ESIA phase are summarised in Table 7-1.

TABLE 7-1 ESIA PHASE ENGAGEMENT ACTIVITIES

Engagement Activity	Objective	Methods	Timing	Stakeholder
Notification of non-technical summary (NTS) and ESIA	To encourage stakeholders to review documents	• Notification letters • Radio broadcasts	Start of public	General public, including civil service, local

Engagement Activity	Objective	Methods	Timing	Stakeholder
report availability at Public Meeting	and submit comments	• Newspaper adverts • Flyers • Notice boards	consultation period	administrations and community members
Dissemination of NTS	Inform stakeholders about the project in an accessible format which is easy to understand.	• Online (CNEL website) in English). • Hard copies in English at CNEL offices and at public meeting.	Start of public consultation period	All stakeholders
Collection of public comments	Gather feedback and concerns from stakeholders	• Online via CNEL's website • Submitting hard copies via mail or through a responsible institution • Placing hard copies of comments in a comment submission box which will be placed at public meeting venue • Telephone	During consultation period	Civil service, local administrations and community members
Dissemination of full ESIA document	Provide detailed project information	• Online (CNEL website) in English • Hard copies in English at CNEL offices and at public space in Walvis Bay	End of consultation period	Technical reviewers, civil service and local administrations
Update the SEP	Update the SEP to reflect current project status, stakeholder concerns and disclosure requirements	• Internal review • Stakeholder feedback integration into SEP • Alignment with regulatory requirements	Within 1 month after consultation ends	All stakeholders

7.2 PRE-MOBILIZATION PHASE ENGAGEMENT

Following the issuing of the Environmental Clearance Certificate, the project will move into the pre-mobilization phase during which project planning will continue. Engagement to keep stakeholders updated on project activities and managing stakeholder expectations will take place during this Phase. Stakeholder engagement activities may include:

- Provide project updates to stakeholders when required;

- Receive, respond to and monitor grievances received;
- Maintain stakeholder database, stakeholder engagement log and grievance log;
- Revise stakeholder mapping to accommodate changes in the project and social dynamics; and
- Review and assess stakeholder participation in order to revise, if necessary, the frequency, means and format of engagement to meet accessibility and participation requirements of all stakeholders.

Project Updates

It is important that stakeholders continue to have a good understanding of the project activities. Engagement meetings will, therefore, be undertaken during the pre-mobilization phase as needed. All planned formal and informal engagements should be used as an opportunity to identify and register any new stakeholders and to gather their feedback and concerns.

CNEL will therefore continue to provide feedback and provide updates to stakeholders regarding the progression of planning for mobilization commencement, as well as any other pertinent information to be disclosed.

The meetings will play an important role in communicating relevant project information (such as start dates for drilling campaigns) with communities and other stakeholders as well as disseminate information on employment, local content and the grievance management. Engagement activities to be undertaken during pre-mobilisation are summarised in Table 7-2.

TABLE 7-2 PRE-MOBILIZATION ENGAGEMENT ACTIVITIES

Engagement Activity	Objective	Methods	Timing	Stakeholder
Provide project updates to stakeholders	Strive for stakeholders to be well-informed about project status and activities	Updates through newspaper articles, library, town halls, social media, website, etc	As required	All stakeholders including local administrations, fishing, port authorities, associations, community members, and any new stakeholders
Inform stakeholders about the Grievance Redress Mechanism	Provide accessible ways to submit any grievances that may occur during the project.	Through project updates (e.g. newspapers, social media, website)	Prior to mobilization	All stakeholders including local administrations, fishing, port authorities, associations, community members, and any new stakeholders
Receive, respond to and monitor grievances received	Address stakeholder concerns and grievances effectively	Grievance mechanism. Receiving grievance telephonically,	Ongoing	All stakeholders including local administrations, fishing, port authorities,

Engagement Activity	Objective	Methods	Timing	Stakeholder
		electronically, in person, etc. More information given in Section 5.		associations, community members, and any new stakeholders
Maintain stakeholder database, stakeholder engagement log and grievance log	Maintain accurate and up-to-date stakeholder records	Stakeholder and grievance database management. More information of grievance collection methods in Section 5.	Ongoing	All stakeholders
Revise stakeholder mapping, review and assess stakeholder participation, update SEP	Adapt to changes in project and social dynamics and support inclusive and accessible engagement	Monitor new stakeholders, update stakeholder identification and analysis strategies, conduct a feedback analysis, revise engagement frequency and format	Ongoing	All stakeholders including local administrations, fishing, port authorities, associations, community members, and any new stakeholders

7.3 MOBILIZATION, DRILLING AND TESTING PHASE ENGAGEMENT

Keeping stakeholders updated on project activities, marine exclusion zones, employment / procurement opportunities, managing stakeholder expectations and responding to grievances will take place during these phases. Activities include:

- Provide project updates to stakeholders when required;
- Receive, respond to and monitor grievances received;
- Maintain stakeholder database, stakeholder engagement log and grievance log;
- Revise stakeholder mapping to accommodate changes in the project and social dynamics; and
- Review and assess stakeholder participation in order to revise, if necessary, the frequency, means and format of engagement to meet accessibility and participation requirements of all stakeholders.

Project Updates

CNEL will implement proactive and structured engagement with affected stakeholders. Engagement should take place frequently (as and when required based on project activities). Targeted engagement with specific stakeholder groups will be required, for instance, when exclusion zones are to be enforced or removed.

Engagement will be focused on informing and updating community members and stakeholders about the project mobilization, drilling, and testing activities and schedule, including anticipated delays or changes, and procurement and employment opportunities, as well as the potential impacts that can be expected to occur along with the measures planned to mitigate these.

These engagements may include:

- Targeted face-to-face information disclosure meetings with environmental permitting authorities and other key regulatory authorities such as local government, and the Namibian Ports Authority if required; and
- Community meetings for updates and information sharing on topics of concern such as disruptions to fishing activities and other marine traffic.

Information dissemination tools will continue to be used to support the above activities. For example, notice boards and email updates are an accessible way for communicating changes to stakeholders concerning project design, progress on meeting social and environmental management commitments, details of upcoming project activities and or changes to schedule. The project website will also be updated on a regular basis.

Monitor Contractors

Unmanaged or poorly handled engagement with communities by contractors can present a risk to the project. It may result in inconsistent or contradictory messages or conflicting commitments from the contractor and project representatives, which can give rise to unmet expectations.

CNEL will liaise with and monitor contractors to so that any interactions taking place between contractor workforce and stakeholders are consistent with the standards, core principles and procedures for undertaking, recording and documenting stakeholder engagement.

Stakeholder Database and Engagement Log

In order to ensure all stakeholders affected by project construction are identified and engaged, CNEL will regularly update the stakeholder database, stakeholder engagement log and SEP, and assess and revaluate risks associated with stakeholders, as necessary, based on information gathered through regular engagements and grievance management.

Any new stakeholders that may have developed an interest in the project should be monitored, and strategies developed for engaging them. CNEL will have designated responsible personnel tracking information on new stakeholders or changing stakeholder issues / risks, which arise through their stakeholder interactions.

Review and Respond to Grievances

Unresolved stakeholder grievances can quickly escalate and lead to unforeseen work stoppages and delays. It will, therefore, be important during the mobilization, drilling, and testing phases to respond quickly and effectively to grievances, and regularly engage with stakeholders to anticipate where stakeholder issues or concerns may arise before they do.

Designated responsible personnel will log and respond to all grievances and resolve locally those that can be managed in the immediate term and report and escalate more complex issues to the project management, as appropriate.

Engagement activities to be undertaken during mobilization, drilling, and testing are summarised in Table 7-3.

TABLE 7-3 MOBILIZATION, DRILLING, AND TESTING PHASE ENGAGEMENT ACTIVITIES

Engagement Activity	Objective	Methods	Timing	Stakeholder
Provide project updates to stakeholders	Keep stakeholders informed about mobilisation and drilling activities and opportunities	Updates via stakeholder engagement representative (e.g. face-to-face, community meetings, notice boards, and the project website)	As required	All stakeholders
Monitor subcontractors' social performance	Strive for consistent and appropriate engagement by ensuring subcontractors understand not to engage with stakeholders	Liaison and monitoring to align with SEP standards	Ongoing	Subcontractors
Receive, respond to and monitor grievances	Address stakeholder concerns effectively and prevent escalation	Grievance logging, response, escalation to management if needed	Ongoing	All stakeholders
Maintain stakeholder database, engagement log and grievance log	Track stakeholder interactions and risks	Regular updates to logs and database, risk assessment	Ongoing	All stakeholders
Conduct targeted engagement meetings to disclose the project and record feedback and concerns about the project with port authorities, fishing associations.	Inform stakeholders about mobilisation, drilling impacts and mitigation.	Face-to-face meetings, focus groups	As required	Port authorities, fishing associations
Revise stakeholder identification and analysis, review and assess stakeholder participation, update SEP	Adapt to changes in project and social dynamics and support inclusive and accessible engagement	Monitor new stakeholders, update mapping strategies, conduct a feedback analysis, revise engagement frequency and format	Ongoing	New and existing stakeholders

7.4 DEMOBILIZATION PHASE ENGAGEMENT

Upon completion of drilling and testing activities the project will be demobilized. Stakeholder engagement will be scaled back at this phase and will focus on targeted stakeholders that will likely be impacted. The program of engagement will be further refined near to the start of demobilization. Activities may include:

- Stakeholder engagements related to demobilization;
- Provide project updates if there is a change or any specific demobilization activities occurring;
- Receive, respond to and monitor grievances received;
- Maintain stakeholder database, stakeholder engagement log and grievance log; and
- Revise stakeholder mapping to accommodate changes in the project and social dynamics.

7.5 SPECIAL MEASURES FOR VULNERABLE GROUPS

For stakeholder engagement to be both inclusive and effective, special attention must be given to enabling vulnerable groups to receive information, be able to raise concerns and have those concerns addressed. The following strategies are recommended:

Culturally Appropriate and Accessible Meeting Locations

To overcome barriers related to distance and travel, in-person meetings should be held within or near the communities themselves. Preferred venues could include local town halls, community centres, or other accessible public spaces.

Inclusive Planning and Representation

Engagement planning should involve representatives from vulnerable groups to support the adequate consideration of their perspectives and needs. This may include organising separate group discussions (e.g. for the elderly) or using facilitators who are trusted by and familiar with these groups. The timing of meetings should reflect when individuals are available to attend, considering both employment and duties in the home.

Flexible and Adaptive Approaches

Recognising that vulnerable groups may face unique constraints (e.g., mobility, caregiving responsibilities, or social stigma), engagement methods should be flexible. This could include the use of audio and visual materials for those who speak a variety of languages.

8. ENGAGEMENT TOOLS AND RESOURCES

This section describes the information dissemination tools that can be used during the implementation of the SEP.

Communicating information and engaging with stakeholders in a manner that is accessible is key to the success of an engagement program. Various communication methods will be used to facilitate engagement during the project. The level and purpose of engagement will determine the methods and channels.

Project stakeholders' literacy levels and education levels may vary, and careful consideration must be given to the target audience when preparing engagement materials. Table 8-1 below outlines tools and methods for engagement and information dissemination and guidelines for preparing engagement materials.

TABLE 8-1 TOOLS AND METHODS FOR ENGAGEMENT

Communication Channel	Objective	Target Stakeholders	Additional Guidance
One on one formal meetings (in-person/ online)	To disseminate project information, respect cultural protocol, build stakeholder relationships, understand concerns, and reinforce two-way dialogue.	Government ministries, local authorities, port authorities, fishing associations	Prior to formal meetings CNEL should communicate with local authorities/ associations to inform them of the proposed meeting and the meeting objectives. They can play a key part in relaying the details of the meeting to the relevant stakeholders as necessary. However, CNEL should also communicate meeting details using additional methods to strive to make all relevant stakeholders aware.
Public meetings	To disseminate project information to large groups at one time, build stakeholder relationships, and understand high-level concerns and reinforce two-way dialogue.	Communities	At least one weeks' notice should be given to stakeholders ahead of a community meeting. Consideration should be given to accessibility of the meeting venues and it may be necessary to arrange transportation for individuals and groups, such as elderly or disabled people. Display posters/ newspaper adverts for a public meeting must be developed using simple language and as much visual representation as possible. Public meetings are useful as a starting point for engagement, but may exclude the expression of certain viewpoints, particularly those held by vulnerable groups or others who might be unwilling to express their perspectives in such a formal setting. Therefore, depending on the objective of the meeting, smaller follow-up Focus

Communication Channel	Objective	Target Stakeholders	Additional Guidance
			Group Discussions (FGDs) may be required.
Focus Group Discussions (FGDs)	To disseminate project information to small stakeholder groups, often with a common interest, build stakeholder relationships, understand concerns, and develop management measures / livelihood restoration measures.	Communities, special interest groups (e.g. fishing association/ cooperative members)	Focus group discussions can also be an effective mechanism through which to engage vulnerable groups. Prior to holding focus group discussions, consideration should be given to language requirements, whether a representative from the technical team is required to provide input and answer questions, whether a female representative is required to engage women groups. At least one week's notice should be given to stakeholders ahead of a focus group discussion.
Letters, Email, Website updates	To disseminate project information, make announcements, provide project updates, the engagement programme and schedule, construction schedule, contact details for CNEL, and information on the grievance mechanism.	Government ministries, local authorities, port authorities, fishing associations, civil society, local media	Communications must be prepared using simple, non-technical language, include maps where appropriate, include the contact details for relevant project personnel, and information on the grievance mechanism.
Non-technical summaries / project update flyers	To disseminate project information, make announcements, provide project updates, the engagement program, mobilization and drilling schedule, contact details for the project personnel and information on the grievance mechanism.	All stakeholders.	Summary documents and information flyers should be prepared using simple, non-technical language, and include maps and graphical representations. Summaries / flyers should always include the contact details for relevant project personnel and information on the grievance mechanism.
Media (newspaper)	To make project announcements and inform stakeholders of upcoming meetings.	All stakeholders	CNEL should coordinate press releases in consultation with relevant authorities.

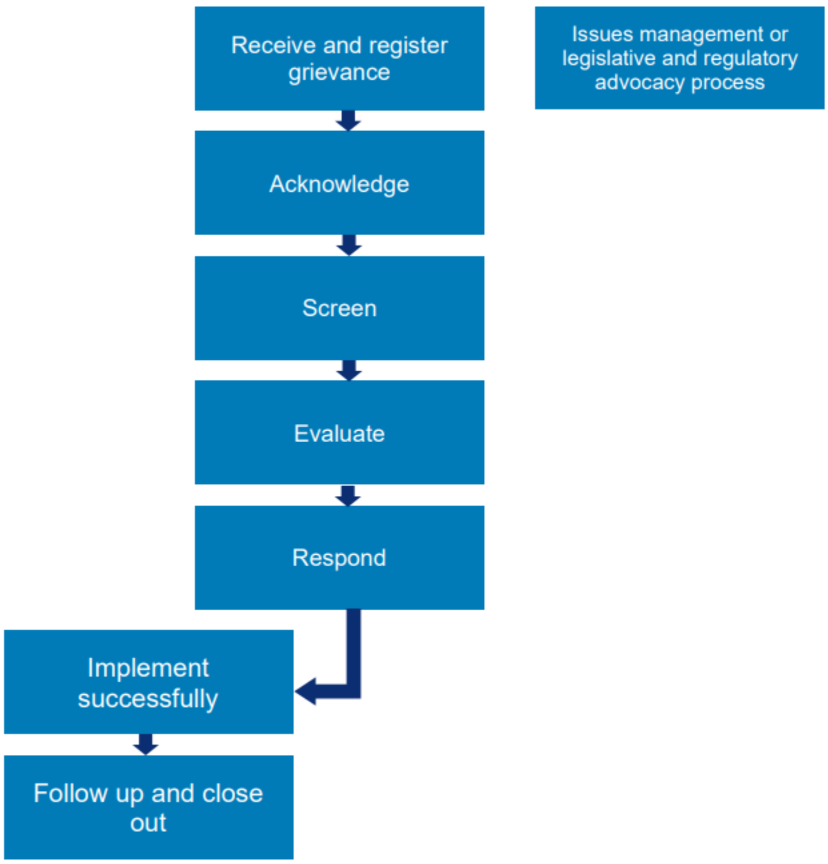
9. GRIEVANCE MECHANISM

Grievances are complaints or comments (or questions/suggestions) concerning the way in which a project is being implemented.

Grievances can encompass minor concerns as well as serious or long-term issues. They might be felt and expressed by a variety of parties including individuals, groups, communities, entities, or other parties affected or interested in the social or environmental impacts of the project. It is essential to have a robust and credible mechanism to systematically handle and resolve any complaints that might arise in order that they do not escalate and present a risk to operations or the reputation of the company (nationally or internationally). If well-handled, an effective GM can help foster positive relationships and build trust with stakeholders.

CNEL has established a grievance mechanism procedure (2025) to define the process to managing stakeholder concerns and complaints in alignment with the Chevron Operational Excellence Stakeholder Engagement and Issues Management Process and the Chevron Human Rights Policy. CNEL's existing 2025 GM will be applicable to the project and the same grievance mechanism process described in the GM and summarized in Figure 9-1, will be followed.

FIGURE 9-1 CNEL GRIEVANCE MECHANSIM PROCESS



Source: CNEL, 2025

Corporate Affairs, under the oversight of the Namibia Country Manager, will administer the GM by providing resources to handle correspondence, coordinate internal resolutions, manage a log, and report (both internally and externally).

The recommended timeline for the different steps in the GM execution are:

- Register grievances within 48 hours of receiving the grievance
- Acknowledge grievances within 72 hours of receiving the complaint including the
- invalid/out of scope grievances.
- Screen and assign level within 96 hours. Closure and response to the grievance will ideally be:
  - Level 1: provide pre-approved standard response within 1 week along with acknowledgement
  - Level 2: evaluate and address grievance within 4 weeks of receiving grievances
  - Level 3: identify the gap within the existing management processes and/or procedures. Work with the relevant teams to close the gaps in existing procedure for repeated, multiple, widespread complaints within 60 days.
- Any grievance that remains outstanding after 60 days will be elevated and monitored irrespective of the project/operations/area that might have been the origin for the grievance.
- If the grievance takes more than 30 days, the complainant will be provided weekly update on the progress and approximate time, it may take to address it.
- Any grievance that is elevated to legal system, will be handled by the law function and taken out of the grievance register.

9.1 RECEIVING A GRIEVANCE

Stakeholders can submit grievances through several methods, including:

- In-person, through letters or in the designated location or regular postal service or electronically.
- Physical grievance dropbox location:
  - Office located at the shorebase
- Electronic:
  - Through e-mail address monitored by Corporate Affairs advisor.
- Traditional means of collecting grievance:
- Letter that can be sent to the Chevron office in Windhoek
- Face-to-face in any external stakeholder meetings (please note generic comments will not be considered a grievance, but a specific issue or grievance raised in these meetings will be handled as a grievance and addressed accordingly)

The locations of the physical grievance boxes will be subject to a quarterly review initially, and will be supplemented by additional locations, if necessary.

Corporate Affairs is responsible for ensuring that any personnel and contractors that could potentially receive claims will be knowledgeable about the grievance mechanism process and ready to accept feedback. Corporate Affairs will stress that there will be no costs or retribution associated with lodging grievances.

9.2 PUBLICIZING THE PROCEDURE

The grievance mechanism procedure will be publicized and communicated in a manner appropriate to the scope and nature of the project, and in a manner appropriate to the audience (i.e., method of delivery, language, etc.). CNEL will publicize and communicate the process to those most likely to use/administer it: local communities, authorities, and contractors. Notification will include:

- A summary of the procedure and how it can/should be used;
- Details of the process, such as who is responsible for receiving and responding to grievances, and any external parties that can receive grievances from communities;
- What type of response can be expected and when stakeholders can expect a response
- Safeguards in place to maintain confidentiality.

CNEL's Grievance Mechanism does not replace existing Namibia legal processes, or CNEL administrative processes already in use. In addition, the GM does not impede access to other judicial or administrative remedies that might be available under domestic law or through existing arbitration procedures, or substitute for feedback mechanisms provided through collective agreements.

CNEL Corporate Affairs, under the oversight of the Namibia Country Manager, will administer the GM by providing resources to handle correspondence, coordinate internal resolutions, manage a log, and report (both internally and externally).

CNEL's Grievance Mechanism will be appended to the full SEP which will be appended to the ESIA.

9.3 REGISTERING AND ACKNOWLEDGING A GRIEVANCE

Grievances will be logged in the Grievance Register within two days of receiving the grievance. A member of the CNEL team will be assigned to each grievance when they are logged and will be responsible for:

- Defining and implementing resolution actions.
- Investigating the grievance.
- Consulting relevant departments or persons within the organization.
- Making sure resolution actions are completed.
- Tracking progress of individual grievances.
- Aggregating and forwarding feedback to Complainants.
- Documenting resolution actions.
- Gaining necessary approvals from, and reporting to, management.

While no response is necessary for anonymous grievances, these will be logged and reported with other grievances to facilitate continuous improvement.

The Corporate Affairs advisor will formally acknowledge a grievance within five working days of the submission of the grievance, informing the Complainant that CNEL's objective is to respond within twenty working days. Written feedback is preferred so that a record of correspondence is retained and recorded.

If grievance is considered out-of-scope for the grievance mechanism (see section 4.2.3 on screening), the Corporate Affairs advisor should draft a response for signature by the Country Manager explaining why it is out-of-scope and providing any guidance of where to go to get the issue addressed (if possible). In cases where another entity (e.g. the government or a contractor) should be responsible for handling the grievance, CA will share the grievance with the appropriate government stakeholder (unless the grievance could result in potential reprisal) and inform the Complainant that the grievance has been shared with the appropriate body/person.

9.4 SCREENING A GRIEVANCE

Each grievance will be screened from Level 1 to 3, per definitions provided in Table 9-1, to determine the appropriate response. “Routine” issues will be managed through the grievance mechanism. “Potentially Significant” grievances will be flagged and managed via the Issues Management/Legislative and Regulatory Advocacy Process.

TABLE 9-1 GRIEVANCE SCREENING

Category	Grievance Description	Type	Approach
Pre-screening	A grievance is a “valid” inquiry when it is asserted in good faith and something Chevron wishes to address. This level also includes grievances that are out-of-scope	Valid or out-of-scope	Progress to further screening
Level 1	A grievance for which there is already a management-approved response.	Routine	Inform appropriate management and then utilize approved answers to handle response.
Level 2	Grievances characterized by being a one-time situation, local in nature, and that will not impact Chevron’s reputation.	Routine	Define response plan and craft draft response for management and Law approval.
Level 3	Repeated, widespread, or high-profile grievances that may result in a negative impact on Chevron’s business activities or reputation. Level 3 feedback may indicate a gap in a management plan or	Potentially significant	Prioritize Issues Management/ Legislative and Regulatory Advocacy Process (specifically the Enterprise Topic List), engage appropriate internal

Category	Grievance Description	Type	Approach
	procedure, or that a serious breach in policy or law may have occurred. Level 3 grievances would also include safety or human rights issues, physical or economic displacement and resettlement, and matters that may present legal issues.		stakeholders and define appropriate management strategy. This process has within it requirements to consult with Law.

9.5 EVALUATE AND RESPOND TO A GRIEVANCE

The Corporate Affairs advisor will lead the grievance evaluation, which could include collecting relevant documents, making site visits, consulting appropriate internal staff, contacting external stakeholders, and other activities. Evaluation findings will be used to document decision making process and inform proposed remedy.

Before responding to the Complainant, Corporate Affairs will complete the following:

- Level 1 Grievances – Corporate Affairs informs the country manager and then utilizes recently approved answers to respond to Complainant. Response requires approval from the country manager.
- Level 2 Grievances – Corporate Affairs in collaboration with the project define a plan for grievance response and crafts the draft response for country manager approval.
- Level 3 Grievances:
  - The Corporate Affairs advisor works directly with the country manager and other departments to define plan for grievance response, then drafts a response.
  - In the case of sensitive grievances, CNEL may engage an external organization or third party (e.g., NGOs) in a joint investigation or allow for the participation of a Community Action Council, or other community structure, to demonstrate transparency in the process being taken to resolve the issue. Level 3 grievance responses need to be approved by the General Manager, CA, Africa, Eastern Mediterranean and Middle East.

Once the response has been approved, the Corporate Affairs advisor will take final, approved language and respond formally using appropriate communication vehicles in the appropriate languages.

Corporate Affairs advisor is responsible for ensuring all information on the grievance is documented and actions tracked in the Grievance Register.

9.6 CLOSE OUT A GRIEVANCE

If the Complainant accepts the proposed resolution, the agreed actions are implemented. The Corporate Affairs advisor is responsible for assigning action parties, actions, and deadlines to implement the resolution. These are recorded in the Grievance Register with any supporting documentation. If necessary, monitoring arrangements will be put in place to verify implementation.

After resolution, the grievance should be formally closed out. This includes requesting the Complainant sign a completion form to document satisfaction with resolution actions, documenting actions taken, and closing out in the Grievance Register.

A Grievance Recording Form template and Grievance Register template are included in the appendices of the CNEL Grievance Mechanism Procedure .

10. ORGANISATIONAL CAPACITY

This section outlines the organisational capacity required to implement the SEP and manage the GM.

Table 10-1 presents the specific roles and responsibilities associated with implementation of the SEP and GM

TABLE 10-1 ROLES AND RESPONSIBILITIES FOR SEP AND GRIEVANCE MECHANISM

Role	Responsibility / Accountability
CNEL Project Director or Country manager	• Overall accountability for Project implementation, including external stakeholder engagement and grievances. • Responsible for reporting to the CNEL Chief Executive Officer (CEO).
Representative(s) responsible for stakeholder engagement (Corporate Affairs)	• Custodian of stakeholder engagement. • Responsible for identifying and engaging with external stakeholders. • Responsible for collaborating with relevant department heads if their input is required for stakeholder engagement. • Responsible for recording all engagement activities and proposed actions. • Responsible for delivering on actions with the relevant department heads if their input is required. • Responsible for reporting on stakeholder engagement activities and actions to Project Director. • Responsible for maintaining (implementing and updating) the SEP.
Representative(s) responsible for grievance management (Corporate Affairs)	• Custodian of the GM. • Responsible for receiving, screening, categorising, and logging grievances. • Responsible for collaborating with relevant department heads if their input is required for grievance investigations. • Responsible for regular and transparent communication with complainants/ their representatives throughout the grievance process. • Responsible for closure and sign-off of grievances in collaboration with complainants. • Responsible for reporting on grievances to the Project Director.
Relevant CNEL Departments Heads	• Support in stakeholder engagement activities where relevant to their department. • Support investigation and resolution of grievances relevant to their department.
Contractor's and Sub-contractor's Representative(s)	• Interact with external stakeholders only as approved by CNEL. • Receive grievances. • Ensure that any interactions and grievances received directly are reported to the Project Representative(s) and logged on the relevant database. • Support investigation and resolution of grievances with relevance to their activities.

11. REPORTING, MONITORING, AND EVALUATION

The project will implement a data management and monitoring process as part of the overall monitoring of engagement, project commitments, grievances, and performance to assess the effectiveness of stakeholder engagement and grievance redress.

11.1 REPORTING

Engagement activities will be documented and appropriately stored to track and refer to records when required and support delivery of commitments made to stakeholders.

The following stakeholder engagement tools will be used:

- Stakeholder Database (Appendix A): A database of all project stakeholders (individuals and groups) will be maintained by CNEL. The database will include contact information (name, contact number, email address, and affiliated stakeholder group). Stakeholders will be asked for their permission to store their personal information where relevant.
- Meeting Minutes (Appendix B): Used to document the minutes of stakeholder meetings. Meeting minutes will capture the date and time of the meeting, attendees (disaggregated by gender), topics of discussion, any photos taken and any decisions or commitments made. Where appropriate (e.g., government meetings) the meeting minutes will be signed.
- Stakeholder Engagement Log (Appendix C): Engagements with stakeholders will be recorded using information from the meeting minutes to track engagements and commitments. To enable more detailed information on a specific engagement to be easily accessed, the Stakeholder Engagement Log will cross-referenced the Meeting Minutes. Meetings will be entered into the Stakeholder Engagement Log within 48 hours of each engagement.
- Grievance Form Template: Grievance forms will be available through CNEL and at strategic locations as detailed in the Grievance Mechanism and can be filled in by the complainant, or by a CNEL representative that receives the grievance. The Grievance Form will be completed even when it is possible to resolve the grievance immediately.
- Grievance Receipt Form (Appendix D): All complainants will receive a Grievance Receipt to acknowledge receipt of their grievance and provide confidence that it is being addressed.
- Grievance Register Template: All grievances received will be recorded in a Grievance Log / Register in order to document progress in resolving them, to identify patterns, avoid recurrent problems and support continual improvement.

11.2 MONITORING AND EVALUATION

This Monitoring and Evaluation framework has been developed to support the effective implementation and oversight of stakeholder engagement activities during all stages of the project. It outlines key objectives, indicators, and performance metrics to support an engagement process that is transparent, inclusive, and responsive to stakeholder needs. The framework also provides a structured approach to tracking the effectiveness of grievance management, information disclosure, and the overall implementation of the SEP.

By regularly monitoring these elements, the project can identify areas for improvement and maintain compliance with national and international standards. The SEP and GM will be monitored and evaluated by CNEL regularly using the indicators described in Table 11-1 which are informed by international good practice (e.g., IFC Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets (2007)).

TABLE 11-1 MONITORING INDICATORS

Objective	Monitoring Indicator	Frequency	Key Performance Indicators (KPIs)
Strive for timely and effective grievance resolution	Average response time to grievances Number of recurring complaints	Quarterly	% of grievances resolved within 2 working days % of grievances resolved within 10 working days % of grievances resolved within 30 working days % reduction in recurring complaints
Maintain an up-to-date stakeholder database	Frequency of updates to stakeholder database Accuracy and completeness of entries	Quarterly	% of stakeholder records updated on schedule % of complete stakeholder profiles
Support proper documentation of engagement activities	Number of engagement records stored Stakeholder engagement log completeness and accuracy	Monthly	% of engagement activities documented % of logs verified for accuracy
Assess implementation of the SEP	SEP implementation audit results Compliance with planned engagement activities	Bi-annually / Annually	% of SEP actions implemented % compliance with engagement schedule
Track performance against stakeholder engagement KPIs	Number of engagement activities by group/type Attendance (expected vs actual) Frequency of disclosure	Quarterly	% of planned engagement activities conducted % attendance rate Number of disclosures per quarter
Monitor grievance management effectiveness	Number of grievances received Number unresolved/outstanding Time to resolution Satisfaction rate	Monthly / Quarterly	% of grievances resolved Average resolution time % of complainants satisfied

A quarterly report will be produced by representative responsible for stakeholder engagement to review the performance of the stakeholder engagement and grievance processes and to identify areas for improvement. This report will be shared with the Project Director and relevant heads of department and discussed within project management meetings. Actions will be minuted.

These reports and other records will be made available for external review if required.

APPENDIX A STAKEHOLDER DATABASE TEMPLATE

APPENDIX A STAKEHOLDER DATABASE TEMPLATE

Stakeholder Category	Stakeholder Name	Contact Details	Interest in Project including Level	Level of Interest	Level of Influence	Level of Impact

APPENDIX B MEETING MINUTES

MEETING MINUTES TEMPLATE

MINUTES

LOCATION	[Location / online]
DATE	DD Month Year
TIME	[00:00]
GROUP/TOPIC	[Enter Group / topic details]

Attendance

[List attendees, department, organisation, gender]

Topics for Discussion

- Item description

Decisions/ Action Items

Decision/ Action Description	Responsible	Due Date

Photos

[Insert any photos taken at the meeting]

Signature

[Provide signature of responsible party]

APPENDIX C STAKEHOLDER ENGAGEMENT LOG

See Excel attached

APPENDIX D GRIEVANCE RECEIPT FORM

Grievance Receipt Form		
Grievance Number:	Date Submitted:	Target date for initial meeting to address grievance:
Name:		
Address and Contact Details:		
Grievance Received By:		
Grievance Recorded By:		
Name of Grievance Coordinator:		
Contact details of Grievance Coordinator:	Telephone: Email: Address:	
Immediate Resolution		
Has any action been taken to resolve the grievance? (Y/N)		
Has the complainant agreed that the grievance can be closed? (Y/N)		

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DETAILED STAKEHOLDER ENGAGEMENT RECORDS (INCLUDING COMMENTS AND RESPONSE REPORT)

MINUTES OF THE STAKEHOLDER CONSULTATION MEETING WITH SENIOR FISHERIES BIOLOGIST, MINISTRY OF FISHERIES AND MARINE RESOURCES (MFMR) REGARDING THE PROPOSED OFFSHORE EXPLORATION DRILLING ACTIVITIES IN PETROLEUM EXPLORATION LICENSE (PEL) 82 AREA, BLOCKS 2112B AND 2212A, WALVIS BASIN

LOCATION	Online
DATE	03 July 2025
TIME	14:30
GROUP/TOPIC	Scoping Phase Focus Group

ATTENDANCE

- Ms. La-Toya Shivute – Senior Fisheries Biologist, MFMR
- Mr. Ernst Simon – Director, Urban Dynamics Africa
- Ms. Heidri Nel – Environmental Practitioner, Urban Dynamics Africa
- Ms Joane Focher - Team Leader Capital Project Delivery, Consulting Director, ERM
- Ms. Anathi Manyakanyaka – Senior Consultant, ERM
- Ms. Sheryl Maruca – Environmental Lead, Chevron Namibia
- Ms. Diana Espitia - Corporate Affairs Manager, Chevron Namibia

INTRODUCTION

A dedicated consultation meeting was held during the Scoping Phase with Ms Shivute of the Ministry of Fisheries and Marine Resources (MFMR) regarding the proposed offshore exploration well drilling activities in Petroleum Exploration License (PEL) area 82, located in the Walvis Basin. The meeting was facilitated by Urban Dynamics Africa on behalf of Chevron Namibia Exploration II Limited (CNEL).

Urban Dynamics opened the meeting by welcoming Ms Shivute (MFMR), introducing the project team, and explaining the agenda, objectives, and format of the session.

OVERVIEW

The project proponent provided an overview of the company and the project while the environmental consultant provided an overview of the ESIA process and the potential environmental and social impacts associated with the proposed project. More specifically:

- Ms. Maruca (CNEL) dealt with local content, explaining the company's commitments, requirements for contractors, and the importance of Namibian participation in the supply chain of core and support services.
- Ms. Espitia (CNEL) provided an overview of Chevron's community commitments and social investment initiatives, highlighting partnerships such as NAMPOA and ongoing efforts to support Namibian communities.
- Ms. Maruca (CNEL) provided a project overview and described the main project characteristics.
- Ms. Foucher (ERM) presented the ESIA approach and stakeholder engagement process, and the preliminary environmental and social findings. A copy of the presentation is attached as **"Annexure A"** and a copy was emailed to Ms. Shivute (MFMR) after the meeting.

ENGAGEMENT SESSION RECORD: QUESTIONS AND ANSWERS

Following the presentation, Mr. Simon of Urban Dynamics Africa (UDA) facilitated a question-and-answer session during which Ms. Shivute (MFMR) raised questions, shared concerns, and provided valuable input regarding the scope of the Draft Scoping Report.

Meeting notes were recorded by Ms. Heidri Nel from UDA. Questions, comments, and responses are summarised in the issues and response table below.

Issued Raised	Response and Name of respondent
Mr. Simon (UDA) invited Ms. Shivute (MFMR), to provide insights based on her experience in similar projects.	Ms. Shivute (MFMR) noted a trend of declining attendance at project meetings, possibly due to changes in public behaviour following COVID-19. She suggested that focus group meetings might be more effective for stakeholder engagement. She also mentioned that invites to meetings sometimes get lost in the process. Ms. Shivute (MFMR) pointed out that while she receives some project information through Ministry of Environment, Forestry and Tourism (MEFT) sub-committees, she often does not receive supplementary invitations or background documents directly. She recommended that hard copies be sent to the Executive Director's Office and soft copies directly to her. This approach will allow her to review data, consolidate feedback with colleagues, and prepare combined reports efficiently.

Issued Raised	Response and Name of respondent
Ms. Shivute (MFMR), raised a concern that the map presented during the session did not clearly indicate whether the boundary of PEL 82 overlaps with or lies near any Ecologically or Biologically Significant Marine Areas (EBSAs), particularly in relation to known sensitive zones along the Namibian coast. She requested that this be clarified to better assess any potential interaction between the license area and environmentally sensitive marine habitats, such as whale migration routes or productive feeding areas.	Ms. Foucher (ERM) acknowledged the concern and confirmed that the project team will review and improve the mapping. A more detailed and clearly labelled map will be included in the Scoping Report to accurately show the relationship between the PEL 82 boundary and nearby EBSA areas.
Ms. Foucher (ERM) directed a question to Ms. Shivute (MFMR), asking what more could be done by consultants to effectively reach and engage industry stakeholders, particularly those in the fisheries sector, during the public consultation process. She acknowledged that UDA, as the consultant responsible for public engagement, has complied with the requirements of the Namibian environmental impact assessment (EIA) Regulations — including placing newspaper notices, sending stakeholder emails, and displaying physical notices. However, she noted that despite these efforts, industry stakeholders are often under-represented and requested input from the Ministry on how consultation processes could be strengthened to ensure these key voices are heard during the ESIA process.	Ms. Shivute (MFMR) acknowledged that the consulting team complied with the public consultation requirements outlined in the Environmental Management Act and associated regulations. She noted that participation in general public meetings for offshore projects is often limited, particularly among sector stakeholders such as the fishing industry. This is largely due to the meetings' focus on socio-economic benefits—such as employment opportunities—rather than technical matters relevant to industry groups. Ms. Shivute encouraged that consultants to adopt additional engagement methods to strengthen participation and recommended the following: • Conduct focused group discussions with key industry stakeholders. • Engage clustered stakeholder groups, including vulnerable communities, cooperatives, and fishing associations. • Explore tailored engagement approaches beyond general community meetings. She also pointed out the need for the Ministry to update its stakeholder database, particularly for cooperatives and fishing associations, to reflect recent leadership changes.

Issued Raised	Response and Name of respondent
Mr. Simon (UDA) asked Ms. Shivute (MFMR) to share insights based on her experience within the Ministry regarding whether any environmental issues or concerns have been observed after Environmental Clearance Certificates (ECCs) have been issued for offshore exploration projects.	Ms. Shivute (MFMR) indicated that, generally, the Ministry did not receive significant complaints about negative impacts from offshore exploration activities and typically grants consent for ECCs, provided that the required notification timelines for starting and completing activities are respected. She further explained that the fishing industry seldom have objections but that stakeholders involved in aquaculture activities, are often more sensitive towards potential impacts on their industry. A specific incident was discussed regarding the death of dolphins near Lüderitz, which attracted public concern on social media. Ms. Shivute confirmed that although offshore activities were ongoing at the time, these operations were not located near the affected area, and an investigation found no direct link between the activities and the dolphin deaths. She emphasized the importance of early engagement with the Ministry, especially for projects near EBSAs. While the EBSA framework is not legally binding, it supports improved coastal and marine management through recommended zoning. Ms. Shivute (MFMR) also noted that compared to Namibia, South Africa applies stricter environmental scrutiny and tends to receive more objections to similar offshore projects.

There being no further business to discuss, Mr. Simon (UDA) confirmed that UDA would send Ms. Shivute an email containing a link to the Draft Scoping Report, the Non-Technical Summary, meeting presentation and additional information. Ms. Sheryl Maruca indicated that their team will be included in all project-related correspondence and that they would request any updated fisheries information, as their current data only extends to 2024. Mr. Simon thanked all participants and formally closed the meeting at 15:20.

MINUTES OF THE SCOPING MEETING FOR THE PROPOSED OFFSHORE EXPLORATION DRILLING ACTIVITIES IN PETROLEUM EXPLORATION LICENSE AREA 82 (PEL) 82, COMPRISING BLOCKS 2112B AND 2212A, LOCATED BETWEEN 80 AND 300 KM OFF THE NAMIBIAN COAST IN THE WALVIS BASIN

LOCATION	Walvis Bay Town Hall, Walvis Bay
DATE	12 June 2025
TIME	17:30
GROUP/TOPIC	SCOPING PHASE PUBLIC MEETING

ATTENDANCE

Number of attendees 28: Find attached as**" Annexure A"**

INTRODUCTION

The Scoping Phase public consultation meeting for the proposed offshore exploration well drilling activities in Petroleum Exploration Licence area 82 (PEL) 82, in the Walvis Basin, was facilitated by Urban Dynamics Africa on behalf of Chevron Namibia Exploration II Limited (CNEL).

Urban Dynamics opened the meeting by welcoming attendees, introducing the project team, and explaining the agenda, objectives, and format of the session.

OVERVIEW

The project proponent provided an overview of the company and the project while the environmental consultant provided an overview of the Environmental and Social Impact Assessment (ESIA) process and the potential environmental and social impacts associated with the proposed project. More specifically:

- Mr. Carlo Mcleod (Deputy General Manager, Chevron Namibia) provided an overview of Chevron Namibia, its role in Namibia's energy sector, and a general introduction to Chevron's operations worldwide.
- Ms. Ndapewoshali Mwanyengwa (Local Content & Vendor Assurance Manager, Chevron Namibia) dealt with local content, explaining the company's commitments, requirements for contractors, and the importance of Namibian participation in the supply chain of core and support services.

- Ms. Diana Espitia (Corporate Affairs Manager, Chevron Namibia) provided an overview of Chevron's community commitments and social investment initiatives, highlighting partnerships such as NAMPOA and ongoing efforts to support Namibian communities.
- Ms. Sheryl Maruca (Environmental Lead, Chevron Namibia) provided a project overview and described the main project characteristics.

Danielle Sanderson (Environmental and Social Consultant and Stakeholder Engagement Specialist, ERM) presented the ESIA Approach and stakeholder engagement process, and the preliminary environmental and social findings. A copy of the presentation is attached as **"Annexure B".**

ENGAGEMENT SESSION RECORD: QUESTIONS AND ANSWERS

Following the presentations, Mr Simon of Urban Dynamics Africa facilitated a question and answer session, where participants raised questions, shared their issues and concerns, and provided input into the scope of the ESIA.

Recordings and meeting notes were taken by Tresia Amwaalwa and Heidri Nel from Urban Dynamics.

All questions, comments, and responses were recorded and are reflected in the issues and response table below.

Issued Raised	Response and Name of respondent
Emma Johannes (Community member): What are the procedures that the youth should follow in order to take part in this industry, and what job opportunities are available? This was not explained in your presentation.	**Ndapewoshali Mwanyengwa (Chevron Namibia):** At this stage, we are still in the exploration phase, which unfortunately does not come with many direct employment opportunities yet. However, there are potential opportunities within support services. We encourage young people to find out what skills are required by local companies that might be contracted to support the project. For entrepreneurs and business owners, it's also a good idea to explore how to become a supplier or service provider to third-party contractors working with us. Information about available opportunities is often only displayed at the subcontractors' notice boards in Walvis Bay. It's important for community members to actively visit these notice boards to check for updates and opportunities. Additionally, if you are looking to up skill, you should first research what skills are needed by the companies working on the project or within the wider industry, both locally and internationally. That way, you can focus your training efforts in areas that are in actual demand. **Diana Espitia (Chevron Namibia):** Additionally, we work closely with Petrofund, which offers scholarships for students who want to study in fields related to the oil and gas industry. We also recommend attending events such as the Oil and Gas Youth Summit planned for 25 – 26 July, where more information will be shared about future

Issued Raised	Response and Name of respondent
	opportunities and how to get involved. There is a cost to it but also opportunities to volunteer to gain access to the event.
Gerald Egumbo (Community Member): I want to know, where does local content actually start? We often feel left out once the project begins. Where are these opportunities advertised, and how can we access them?	**Ndapewoshali Mwanyengwa (Chevron Namibia):** Opportunities for local participation are typically advertised directly by the subcontractors or third-party contractors who work on the project. These are usually made available through notices posted at their offices or notice boards. It is therefore important for local businesses and interested individuals to actively monitor these spaces and engage with the subcontractors directly to find out about available opportunities.
Gerald Egumbo (Community Member): How is local content defined? Does it include companies that are locally registered even if the owners are not Namibian? How exactly is it defined?	**Ndapewoshali Mwanyengwa and Diana Espitia (Chevron Namibia):** Namibia has several official instruments guiding local content, including the Local Content Policy and the Petroleum and Energy Act. These documents provide the specifications on what qualifies as local content. Chevron also has mandatory internal requirements for local content. For example, all service agreements with third-party contractors must meet criteria such as at least 50% local ownership and 30% Black Economic Empowerment (BEE) ownership. Chevron maintains a database of local companies that have formally expressed their interest in providing services, and third-party contractors are expected to use companies listed on that database. Chevron also has an open-door policy, allowing any interested local company to approach us and present their qualifications, provided they can show how they are contributing to skills development, local employment, and supplier inclusion.
Alouis Gowaseb (Rural Rise):	**Sheryl Maruca (Chevron Namibia):**

Issued Raised	Response and Name of respondent
Regarding marine life, how will the drilling, machinery, and chemicals used in this project affect marine ecosystems and the communities living along the coast?	Chevron uses biodegradable products that are not toxic to the marine environment. This includes the use of water-based drilling fluids (also known as drilling muds), which are specifically designed to minimize harm to marine life. We are also currently undertaking a full ESIA, which includes identifying sensitive marine areas, modelling potential impacts and recommending appropriate mitigation measures. For example, during previous seismic work, we halted operations during whale migration season to protect the whales. We will continue studying all potential impacts to ensure they are avoided wherever possible or reduced to the lowest practical level. While PEL 82 is located far offshore, we recognise the importance of protecting marine ecosystems throughout the project area.
Floris Steenkamp (Atlantic Gazette): PEL 82, was acquired by Chevron, does it mean they own the Walvis- basin area. Is Gemsbok prospect the license area?	**Diana Espitia (Chevron Namibia):** No, Chevron holds exploration rights over two specific blocks within PEL 82, specifically blocks 2112B and 2212A, which are part of the Walvis Basin. These blocks were previously part of the Galp portfolio and include a relatively small portion of the basin. 'Gemsbok prospect' refers to a specific prospect well within the license area; each well within the area has its own name.
Floris Steenkamp (Atlantic Gazette): Based on the ESIA process diagram, you indicated we are currently in the scoping phase. Will a full Environmental and Social Impact Assessment (ESIA) be required, and is that why we	**Diana Espitia (Chevron Namibia):** Yes, a full ESIA is required. **Ernst Simon (Urban Dynamics):** We are busy with the scoping phase currently.

Issued Raised	Response and Name of respondent
are here now at the scoping phase (the second step)?	
Floris Steenkamp (Atlantic Gazette): We have an Oil Industry Contractor (OIC) list, and there are three local companies that provide offshore oil and marine services. Will Chevron use one of these existing providers, or will a new company be brought in to do this work?	**Sheryl Maruca (Chevron Namibia):** We are likely to use one of the existing local companies, but final decision has not yet been made at this stage. The actual work is some time away and new players may enter the market before then. It will be assessed closer to the time.
Gerald Egumbo (Community member): We have noticed that when these new industries begin operations, they often don't engage directly with schools, where the future workforce is being prepared. These are new industries for our country, and we need to make sure that our children are given the right information and guidance early on, so that when they finish school, they can pursue courses and careers aligned with the demands of these industries. Please make an effort to engage with schools and provide them with clear information about potential job opportunities and the skills or technical expertise required by the industry.	**Diana Espitia (Chevron Namibia):** Thank you for your contribution. Chevron is aware of the serious challenges faced by communities in Namibia, including the lack of access to water, food insecurity, and unemployment. This is why we are part of NAMPOA (Namibian Petroleum Operators Association), where petroleum industry players come together to work on addressing these social challenges in a coordinated way. We don't believe in just providing short-term handouts; we want to focus on building skills and creating meaningful, long-term opportunities for people. While we are still in the early exploration phase, which means job opportunities are currently limited, we know that there will be a need for various skills as the project develops. These may include general workers, engineers, support staff, and specialised skills like welding and potentially even underwater work. We acknowledge that preparation needs to start now, and your recommendation about engaging directly with schools to build awareness and interest in these opportunities is valuable. We will take this suggestion forward and ensure it is considered as we continue planning our community engagement and skills

Issued Raised	Response and Name of respondent
	development initiatives.
Andreas Kagola (Community member): What qualification do you need to get involved in Oil industry?	**Ndapewoshali Mwanyengwa (Chevron Namibia):** It's important to research the skills required by the various companies involved in the industry and seek employment through them. If you already have a qualification, you can attend specific courses to upskill yourself for offshore work. **Contribution by Emma Johannes (Community Member):** Emma emphasised the importance of up skilling for young people to access opportunities in this industry. She shared her personal example of how she has prepared herself for potential offshore or oil and gas related work by obtaining: • A Welding qualification; • Work experience in welding; • Health and Safety certificates; • Medical fitness examinations required for offshore work; • A valid passport to be able to travel to South Africa for specialised offshore training courses; and • An up-to-date CV detailing her qualifications, skills, and work experience.
Andreas Kagola (Community member): Where is Chevron's office in Walvis Bay so that we can visit and get first-hand information about available opportunities? Events like conferences on oil and gas—how can we attend those if we're unemployed and don't have the means to participate?	**Diana Espitia (Chevron Namibia):** We will discuss this with Justina, who is organising the upcoming Youth Summit in July, to explore what opportunities can be made available for more youth to get involved — including as volunteers.

Issued Raised	Response and Name of respondent
Andreas Kagola (Community member): I think it is better for Chevron to do their own short listing and not the third-party contractors.	Noted

There being no further business to discuss, Mr Simon emphasised the contact details for the project and encouraged people to register via the QR Code shown on the screen. He then thanked all participants and closed the meeting at 19:50.

ERM

DRILL CUTTINGS MODEL REPORT

Environmental and Social Impact Assessment (ESIA) for Offshore Drilling Activities in Namibia in PEL 82

Drill Cuttings Deposition Modelling

PREPARED FOR

Chevron Namibia Exploration Limited II

DATE
August 28, 2025

REFERENCE
0775081

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SIGNATURE PAGE

Environmental and Social Impact Assessment (ESIA) for Offshore Drilling Activities in Namibia in PEL 82

Drill Cuttings Deposition Modelling

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ACRONYMS AND ABBREVIATIONS

Acronyms	Description
ERM	Environmental Resources Management, Inc.
GEMSS	Generalized Environmental Modelling System for Surfacewaters
GIFT	Generalized Integrated Fate and Transport
HYCOM	HYbrid Coordinate Ocean Model
km	kilometer
m	meter
mg/L	milligrams per liter
mm	millimeters
NABF	Non-Aqueous Base Fluid
NADF	Non-Aqueous Drilling Fluid
PAH	polycyclic aromatic hydrocarbon
TSS	Total Suspended Solids
WBM	Water-based muds

EXECUTIVE SUMMARY

Chevron Namibia Exploration Limited II (CNEL) proposes to initiate an offshore exploration program within Petroleum Exploration License (PEL) 82 encompassing blocks 2112B and 2212A situated in the Walvis Basin, Namibia (i.e. proposed project). CNEL holds the Exploration License for both blocks which spans over an area of approximately 11,400 km².

The plan is to initially conduct a one-well campaign in the Gemsbok prospect location, in the block 2112B. Additional follow-up drilling could potentially include up to nine additional wells (total of 5 exploration and 5 appraisal wells) in blocks 2112B and 2212A. Blocks 2212A and 2112B are located approximately 101 km and 72 km respectively from the Namibia shoreline.

CNEL requested Environmental Resources Management, Inc. (ERM) to perform a particle discharge modelling study to understand the fate of the released material in the water column and deposited on the sea floor to evaluate the potential impact due to the discharge of drill cuttings and mud. In addition to the Gemsbok prospect location, another well location was considered for the Block 2212A, considered representative of the water depth range within the block (potential second well location in Block 2212A). The drill cuttings and muds would be discharged into 917 m and 1166 m water depths from Gemsbok Well and the potential second well location in Block 2212A respectively over a period of 21 days.

Discharge of treated cuttings from the drilling of the sections with the riser will be performed near the water surface.

This drill cuttings modelling study simulated the discharge release over a range of hydrodynamic conditions (four seasons of a representative year) at two well locations: March, June, September and December in 2023. The parameters used to quantify the potential impacts are total suspended solids (TSS) for the water column, depositional thickness and hydrocarbon concentration on the seabed for the benthic environment.

The TSS plumes are transient and dissipate quickly after the cessation of discharge. Potential impacts were identified based on exceedance of a recommended maximum marine effluent TSS concentration of 35 milligrams per liter (mg/L) from MARPOL and the International Finance Corporation. TSS concentrations exceeded the 35 mg/L threshold criterion near seabed for both wells. However, TSS concentration near water surface does not exceed the 35 mg/L threshold during any of the four scenarios for either well location. The areas where TSS exceeds the 35 mg/L threshold for Gemsbok Well are smaller compared to the respective areas for the potential second well location in Block 2212A.

The conservative (lowest observed effect) burial threshold of 6.3 mm for potential impacts due to instantaneous deposition was used to indicate the thickness when smothering effects on benthic organisms may begin to occur on the most sensitive benthic organisms from cuttings and mud. Another conservative threshold of 5 cm within a month was used to assess the potential burial impact from gradual deposits as would occur during intermittent drilling and discharging. The depositional thickness due to the discharge of drilling related discharges from both wells exceed both 6.3 mm and 5 cm threshold values. The area where deposition of cuttings and muds thickness is greater than 6.3 mm remained predominantly within a 50-meter radius of the Gemsbok Well location in Block 2112B (except for the June Scenario) and a 500-meter radius of the potential second well location in Block 2212A. The areas where depositional thickness exceeds the 6.3 mm and 5 cm thresholds for Gemsbok Well are smaller compared to the respective areas for the potential second well location in Block 2212A.

The total accumulated hydrocarbon concentration on the seabed was also examined for the release of cuttings and muds. The analysis identified areas where drill cuttings and muds may lead to hydrocarbon accumulation on the seabed. While these zones of potential deposition were mapped, the extent of the potential environmental impact on seabed ecosystems remains uncertain.

1. INTRODUCTION

Chevron Namibia Exploration Limited II (CNEL) holds the Exploration License for blocks 2112B and 2212A which are situated in the Walvis Basin, Namibia (i.e. proposed project) and spans an area of approximately 11,400 km^2. CNEL proposes to initiate an offshore exploration program within Petroleum Exploration License (PEL) 82, encompassing blocks 2112B and 2212A.

The plan is to initially conduct a one-well campaign in the Gemsbok prospect location, in the block 2112B. Follow-up drilling could potentially include up to nine additional wells (total of 5 exploration and 5 appraisal wells) in blocks 2112B and 2212A. Blocks 2212A and 2112B are located approximately 101 km and 72 km respectively from the Namibia shoreline.

In support of an Environmental and Social Impact Assessment, CNEL commissioned Environmental Resources Management (ERM), to perform modelling of drill cuttings and mud discharges into the marine environment. The potential impacts on the water quality and benthic environment from the planned discharge of drill cuttings and mud discharges were evaluated for two potential well locations: Gemsbok Well in Block 2112B and the potential second well location in Block 2212A (initially called "Sable") shown in Figure 1-1. The details of the well locations are provided in Table 1-1.

FIGURE 1-1 LOCATION OF THE GEMSBOK WELL IN BLOCK 2112B AND THE POTENTIAL SECOND WELL LOCATION IN BLOCK 2212A

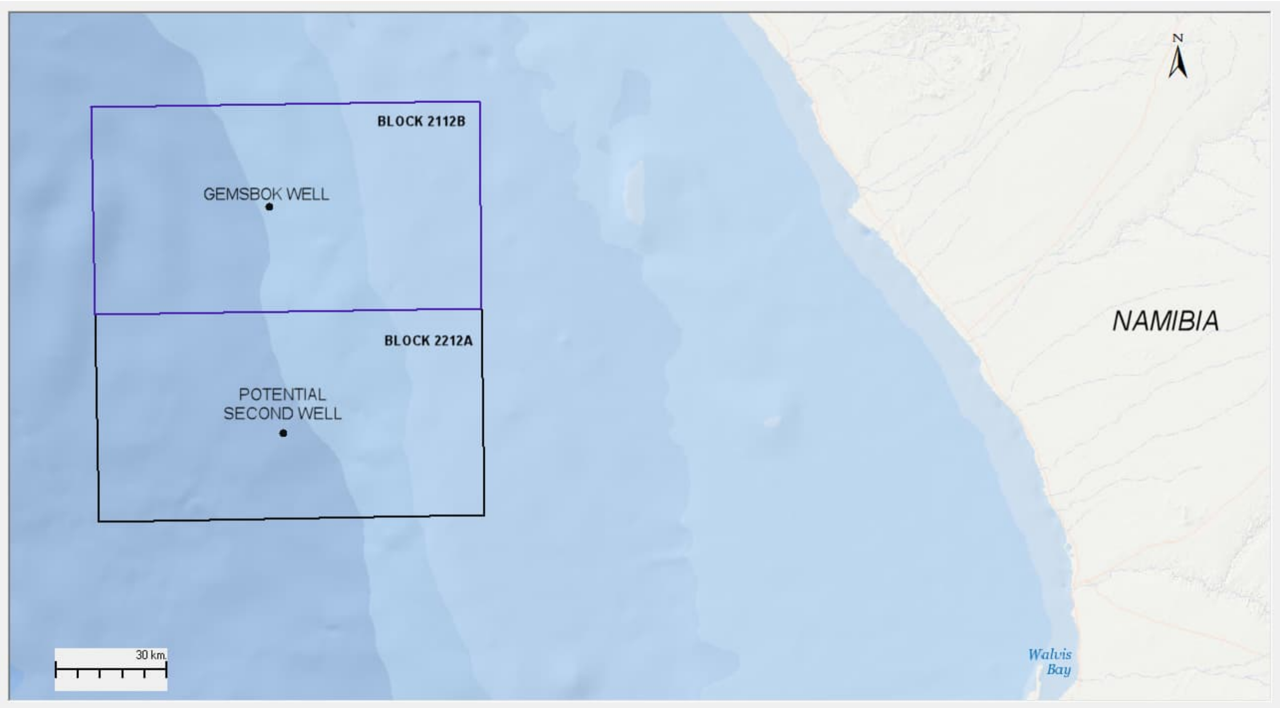


TABLE 1-1 DETAILS OF THE GEMSBOK WELL IN BLOCK 2112B AND A POTENTIAL SECOND WELL IN BLOCK 2212A

Well / Block	Latitude	Longitude	Easting UTM 33S (m)	Northing UTM 33S (m)	Sea Depth (m)*
Gemsbok / Block 2112B	21° 44’ 48.15” S	12° 27’ 13.74” E	236,653	7,593,043	917
Potential second well / Block 2212A	22° 17' 38.04" S	12° 28' 51.21" E	240,449	7,532,469	1166

Source: CNEL, 2025
Note: * Based on the bathymetric survey data provided by CNEL

1.1 OBJECTIVE

The objective of this study was to predict the dispersion and deposition of drill cuttings and muds discharged into the Atlantic Ocean off the coast of Namibia. The potential for adverse impacts were assessed through estimation of the suspended sediment concentrations added to the water column above the background concentration and the thickness of the seabed accumulation of the drill cuttings and drilling fluids (the “footprint”), both indicators of how the marine and benthic organisms could potentially be impacted.

1.2 APPROACH

In this report, potential impacts on water quality and the benthic environment from the planned discharge of drill cuttings and muds were evaluated. This assessment assumed that cuttings with water-based muds (WBM) will be discharged during the drilling of the first and second sections (36” and 26” diameter sections respectively) of each well while cuttings with Non-Aqueous Base Fluid (NABF), which is the solvent (base oil) of Non-Aqueous Drilling Fluid (NADF), will be discharged for drilling the remaining sections (17.5” and 12.25” diameter section) of each well. The material will be brought to the surface for treatment (e.g. shakers, dryer, etc.) and discharged near the water surface (assumed to be at the depth of 10 m for modelling purposes) during the drilling of Sections 3 and 4. NADF will be treated before being discharged to the ocean such that attached NABF is minimal. For each well location, simulations were conducted during four seasons of a representative year (Year 2023) to model the representative range of particle settling and associated potential impacts.

Modelling was performed to predict the following as a result of the discharge of cuttings and mud (WBM and NADF):

- Total suspended solids (TSS) concentrations in the water column;
- Seabed accumulation (thickness) of the cuttings; minerals of WBM and NADF; attached NABF;
- Concentration attached NABF on cuttings deposited on the seabed.

The higher density of drill cuttings and mud particles (relative to water) cause them to undergo a vertical descent through the water column upon their release. This descent can be several minutes to few hours for larger particles, and several hours to few days for tiny particles to reach the seabed when released near the surface, depending on the particle sizes and water depth. Tiny particles may at times travel upwards against gravity during their descent due to vertical dispersion. Released material will also migrate horizontally due to advection by local and regional currents. Thus, the dispersion of cuttings and muds is fundamentally a three-dimensional phenomenon requiring three-dimensional hydrodynamic fate and transport modelling. The scenarios modeled are presented in Table 1-2.

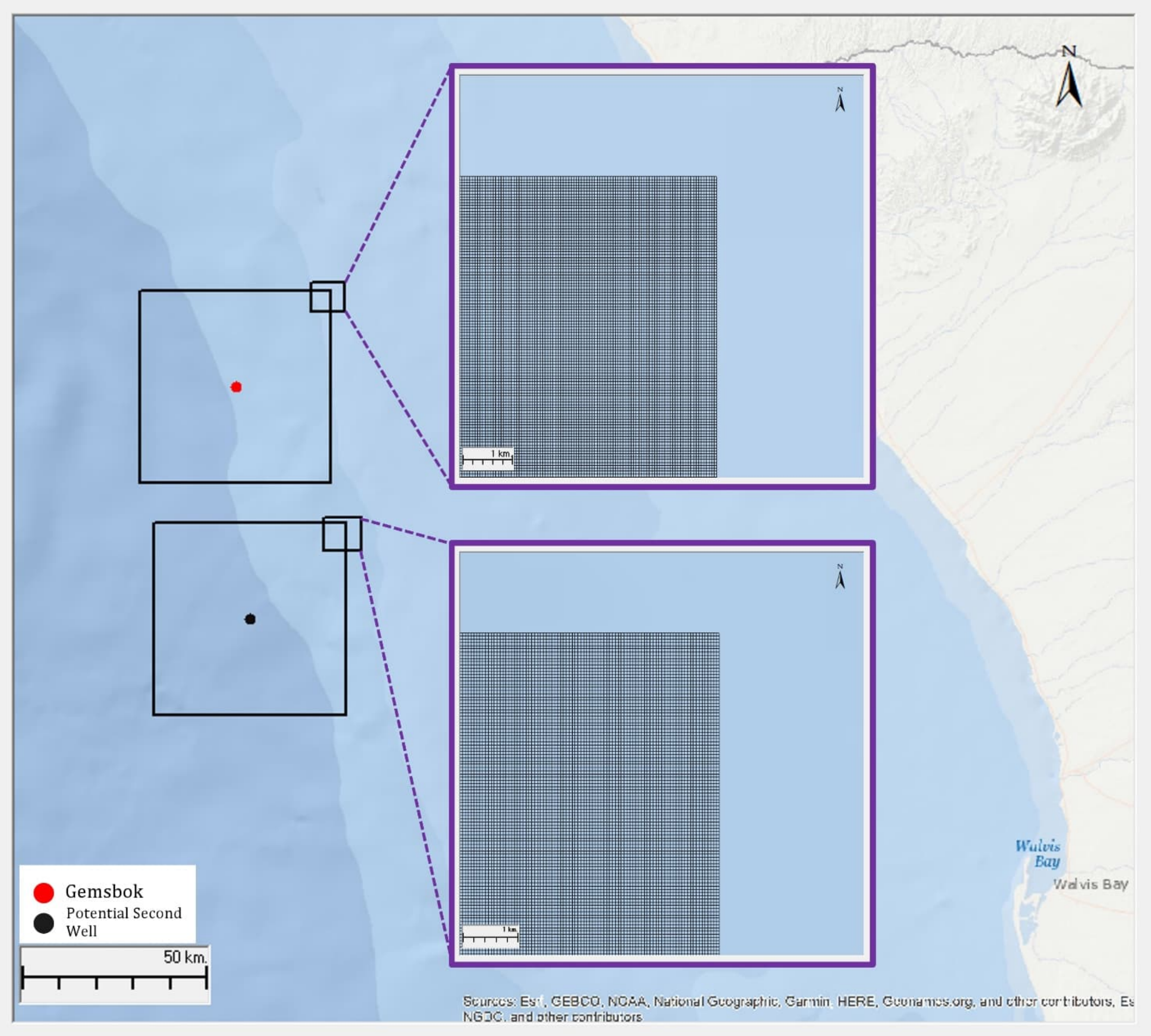
TABLE 1-2 SUMMARY OF SCENARIOS

Well / Block	Scenario	Simulation Period
Gemsbok / Block 2112B	Gemsbok 2112B March	March 01, 2023 12:00 to March 22, 2023 12:00
	Gemsbok 2112B June	June 01, 2023 12:00 to June 22, 2023 12:00
	Gemsbok 2112B September	September 01, 2023 12:00 to September 22, 2023 12:00
	Gemsbok 2112B December	December 01, 2023 12:00 to December 22, 2023 12:00
Potential second well location in Block 2212A	Potential second well location in Block 2212A March	March 01, 2023 12:00 to March 22, 2023 12:00
	Potential second well location in Block 2212A June	June 01, 2023 12:00 to June 22, 2023 12:00
	Potential second well location in Block 2212A September	September 01, 2023 12:00 to September 22, 2023 12:00
	Potential second well location in Block 2212A December	December 01, 2023 12:00 to December 22, 2023 12:00

1.3 PARTICLE GRIDS

A particle-based model is applied to simulate drilling related discharges from each well location (two distinct model applications for two well locations). Three computational grids, including a particle grid, a depositional grid, and a concentration grid were used in each model application. The movement of the discharged cuttings and muds using Lagrangian algorithms was computed within the associated particle grid (Figure 1-2), each of which was placed at the centers of each modeled well location (the Gemsbok Well and the potential second well location in Block 2212A). Both particle grids are square in shape, approximately 50 kilometers on each side, with each cell approximating 50 meters by 50 meters. Each grid cell contains an interpolated depth value derived from the bathymetry data (Section 1.5.1, Bathymetry). Particles are free to move horizontally and vertically within this grid's domain, independently of the grid, except for movement past any shorelines and past the grid bottom boundaries representing the seabed, as defined by the bathymetry.

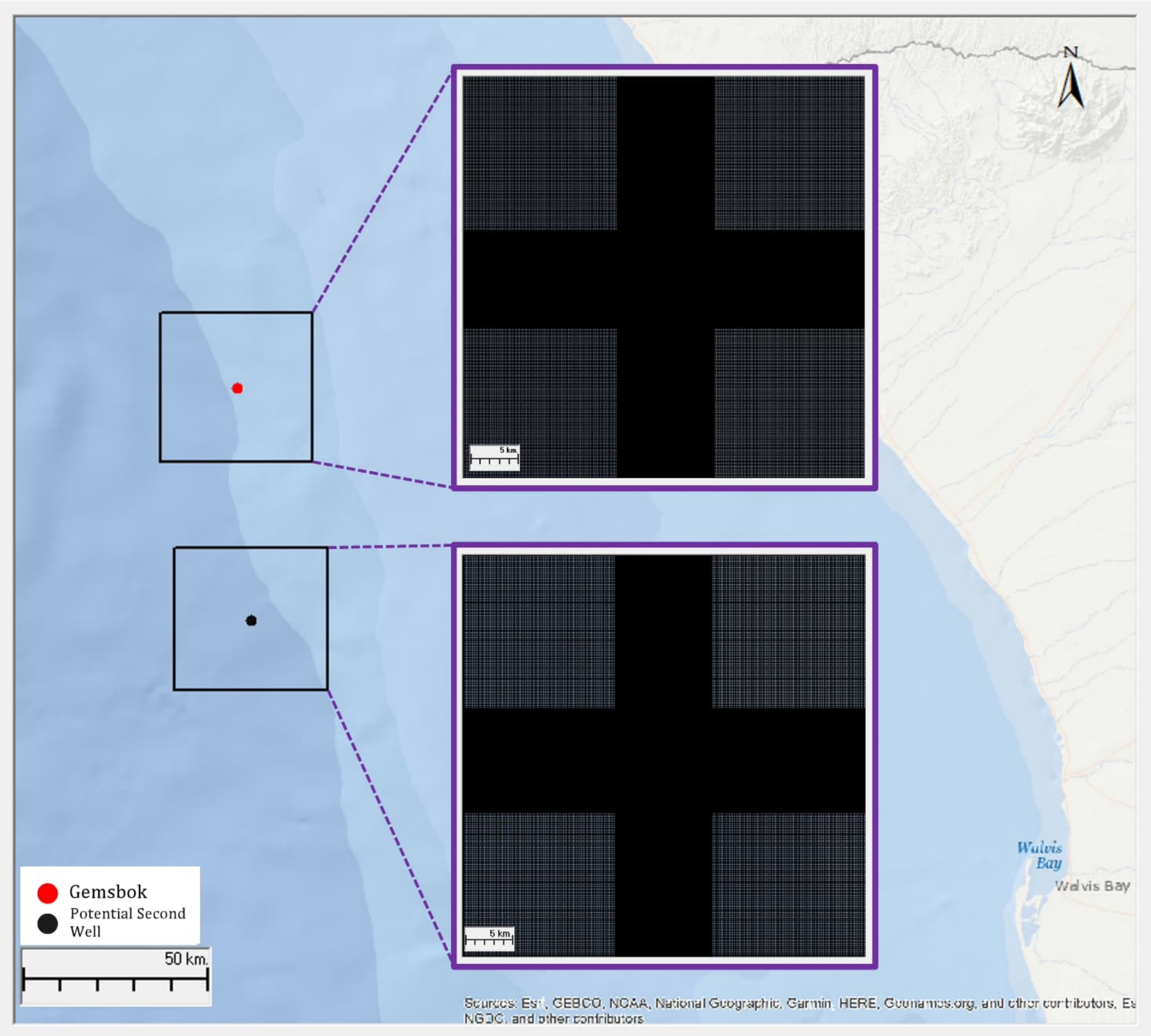
FIGURE 1-2 PARTICLE GRID



For computation of seabed deposition, two model applications used two smaller, more finely spaced two-dimensional depositional grids that are centered on each well (the Gemsbok Well and the potential second well location in Block 2212A). The two depositional grids used in the two model applications are identical, square in shape, approximately 400 kilometers on each side. Cell sizes vary from 10 meters by 10 meters near the center to 100 meters by 100 meters at the edge of the grid.

Model applications of discharges at the two wells used two separate concentration grids for TSS calculations. The concentration grids, used for computation of TSS concentrations in the water column, are three-dimensional, with the same center point and horizontal dimensions as the depositional grid of their respective model applications. Vertically, the cell thicknesses are 3 meters near the water surface and bottom of the water column, where the maximum TSS concentrations are predicted to occur. Figure 1-3 shows the depositional and concentration grids.

FIGURE 1-3 DEPOSITIONAL AND CONCENTRATION GRIDS



1.4 DRILL CUTTINGS AND MUD DEPOSITION SOFTWARE

The modelling was performed using the Generalized Environmental Modelling System for Surfacewaters (GEMSS®) software package and its particle discharge module, Generalized Integrated Fate and Transport (GIFT) (Kolluru and Spaulding 1993; Kolluru et al. 1998; Fichera and Kolluru 2007; Fichera et al. 2013; Prakash and Kolluru 2014). GIFT can simulate the fate of dissolved and particulate material discharged from a range of sources, including drill cuttings and muds and produced water. This three-dimensional particle-based model uses Lagrangian algorithms in conjunction with currents, specified mass load rates, release times and locations, particle sizes, settling velocities, and shear stress values. The modelling methodology is based on a deterministic mode of simulation. In deterministic, single-event simulations, the starting date and current speed and direction at each modeled time step are chosen from a database of variables in the selected periods.

Drill cuttings and muds were modeled as particles. The particles settling and deposition, based on particle size distribution and the intensity of release, result in the predicted accumulation of discharged material on the seabed.

Modelling data inputs included:

- Drill section sizes and schedule;
- Drilling mud types;
- Grain-size distribution of cuttings and minerals of mud;
- Densities of cuttings and mud (WBM, NADF, mud mineral and NABF);
- Cuttings and mud release rates, durations, and discharge depths.

1.5 ENVIRONMENTAL DATA

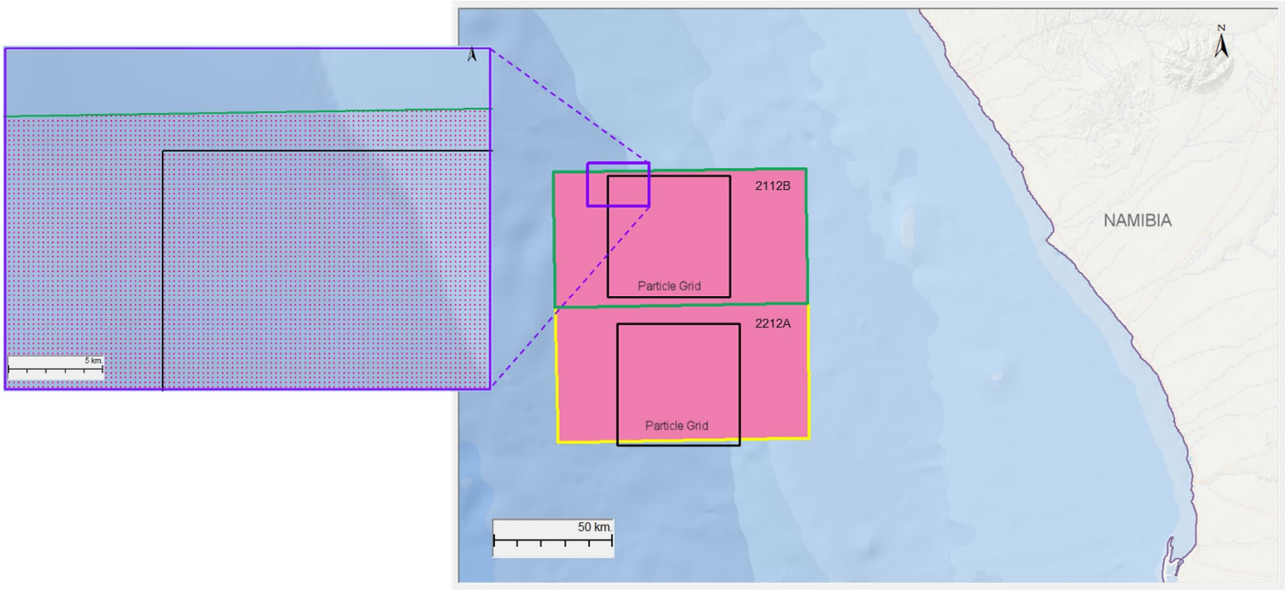
Model inputs were assembled and formatted for use within the GIFT model. The environmental data needed for the modelling included bathymetry, ocean currents, water temperature, and salinity data. Spatially and temporally varying oceanic data were used to characterize the hydrodynamic circulation and environmental conditions in the area where the discharges will occur, as well as determine appropriate simulation periods to represent the range of potential results based on the current speed.

1.5.1 BATHYMETRY

The primary spatial dataset is bathymetric data, which is used to describe the depth and geometry of the seabed. Bathymetric data are used to develop the lower boundary of the modelling grids. Bathymetric data within two blocks (2212A and 2112B) collected from a bathymetric survey provided by CNEL was used as the primary data source to extract seabed bathymetry in two modelling domains. The coverage of CNEL’s bathymetric survey is shown in Figure 1-4 across both blocks. The resolution of CNEL’s bathymetric survey is 250 m in both longitudinal and latitude directions. As Figure 1-4 shows, CNEL’s bathymetric survey data was not sufficient to cover the southern portion of the particle grid used for the well in Block 2212A. Bathymetric contour data from the General Bathymetric Chart of the Oceans (GEBCO) (GEBCO Compilation Group, 2024[1]) was used to supplement that area. The GEBCO database used to supplement the data gap is the GEBCO_2024 Grid, which has a 15 arc-second resolution. The bathymetric contours developed using above data sources for two model domains that were used to simulate the drilling material from two wells, Gemsbok Well (in Block 2112B) and the potential second well location (in Block 2212A), are shown on Figure 1-5 and Figure 1-6 respectively.

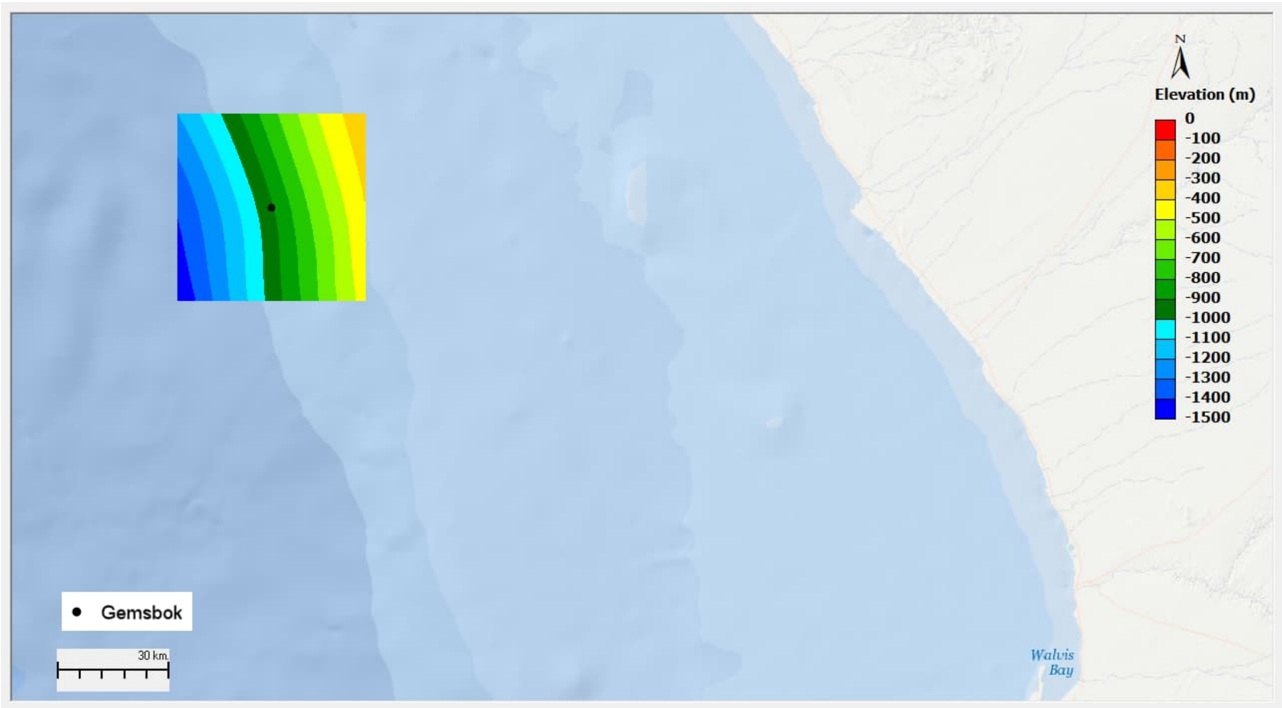
[1] https://www.gebco.net/data-products/gridded-bathymetry-data

FIGURE 1-4 BATHYMETRIC SURVEY DATA LOCATIONS



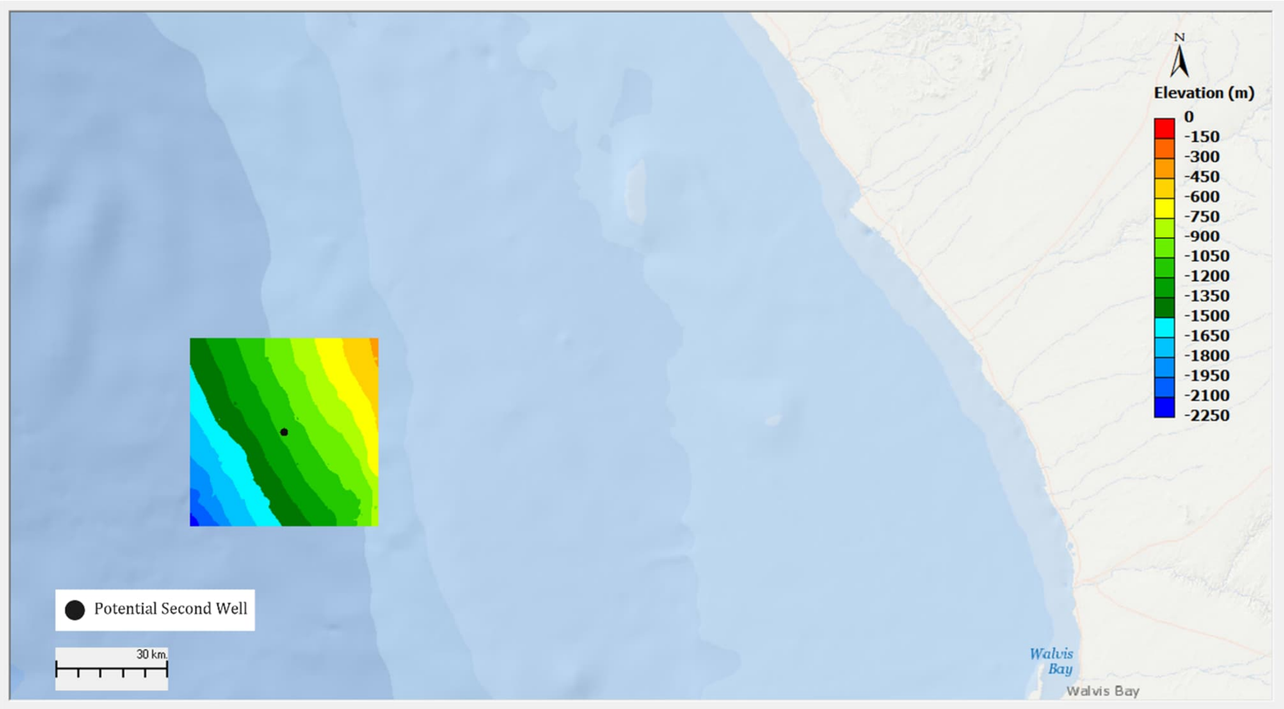
Data source: CNEL

FIGURE 1-5 MODEL DOMAIN BATHYMETRY FOR BLOCK 2112B



Source: ERM and CNEL

FIGURE 1-6 MODEL DOMAIN BATHYMETRY FOR BLOCK 2212A



Source: ERM and CNEL

1.5.2 TIME-VARYING HYDODYNAMIC DATA

The time-varying data used for the drill cuttings deposition modelling included ocean current speed and direction, water temperature, and salinity on a three-dimensional grid. Three hourly depth-varying and spatially varying currents, water temperature and salinity were obtained from HYCOM (HYbrid Coordinate Ocean Model), a data assimilative, hybrid isopycnal-sigma-pressure coordinate model (www.hycom.org). The data was obtained to cover both modelling domains (for the Gemsbok Well and the potential second well location in Block 2212A) at a frequency of every 3 hours for the first 21 days of the months of March, June, September, and December in 2023. The modelling data extended from 21.52°S to 22.56°S latitude and 12.16003°E to 12.71997°E latitude for , with 40 depth bins at 0-, 2-, 4-, 6-, 8-, 10-, 12-, 15-, 20-, 25-, 30-, 35-, 40-, 45-, 50-, 60-, 70-, 80-, 90-, 100-, 125-, 150-, 200-, 250-, 300-, 350-, 400-, 500-, 600-, 700-, 800-, 900-, 1,000-, 1250-, 1,500-, 2,000-, 2,500-, 3,000-, 4000-, and 5,000-meter depths. Modelling was performed during the first 21 days of March, June, September, and December in 2023 to provide the seasonal variation of the extent of depositional patterns (i.e., from a larger and thinner footprint when the current speeds are highest to a smaller and thicker footprint when the current speeds are lowest).

Current rose diagrams using the HYCOM current data at Gemsbok Well location during the four simulation periods at the sea surface at the depth of 500 m, and at the seabed (at the depths of 800 m at which the deepest elevation where HYCOM current is available) are shown in Figure 1-7, Figure 1-8, and Figure 1-9. Similarly, Figure 1-10, Figure 1-11, and Figure 1-12 respectively provide current roses for the HYCOM current data at the potential second well location in Block 2212A during the four simulation periods in March, June, September, and December at the sea surface, at the depth of 500 m, and at the seabed (at the depths of 1,000 m at which the deepest elevation where HYCOM current is available) are shown on . .

FIGURE 1-7 CURRENT ROSE DIAGRAMS AT GEMSBOK WELL IN BLOCK 2112B (AT SEA SURFACE)

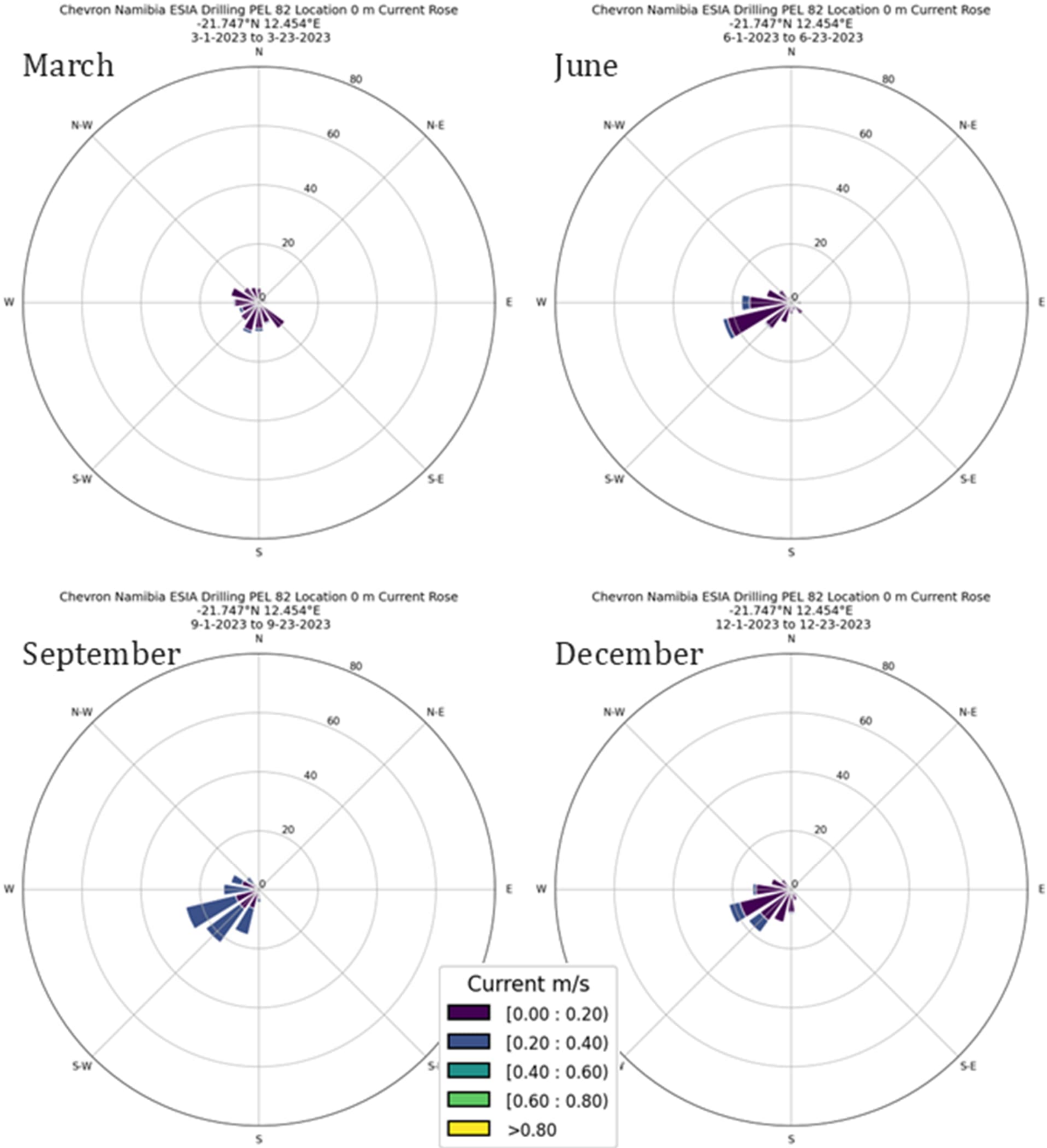


FIGURE 1-8 CURRENT ROSE DIAGRAMS AT GEMSBOK WELL IN BLOCK 2112B (AT DEPTH OF 500 M)

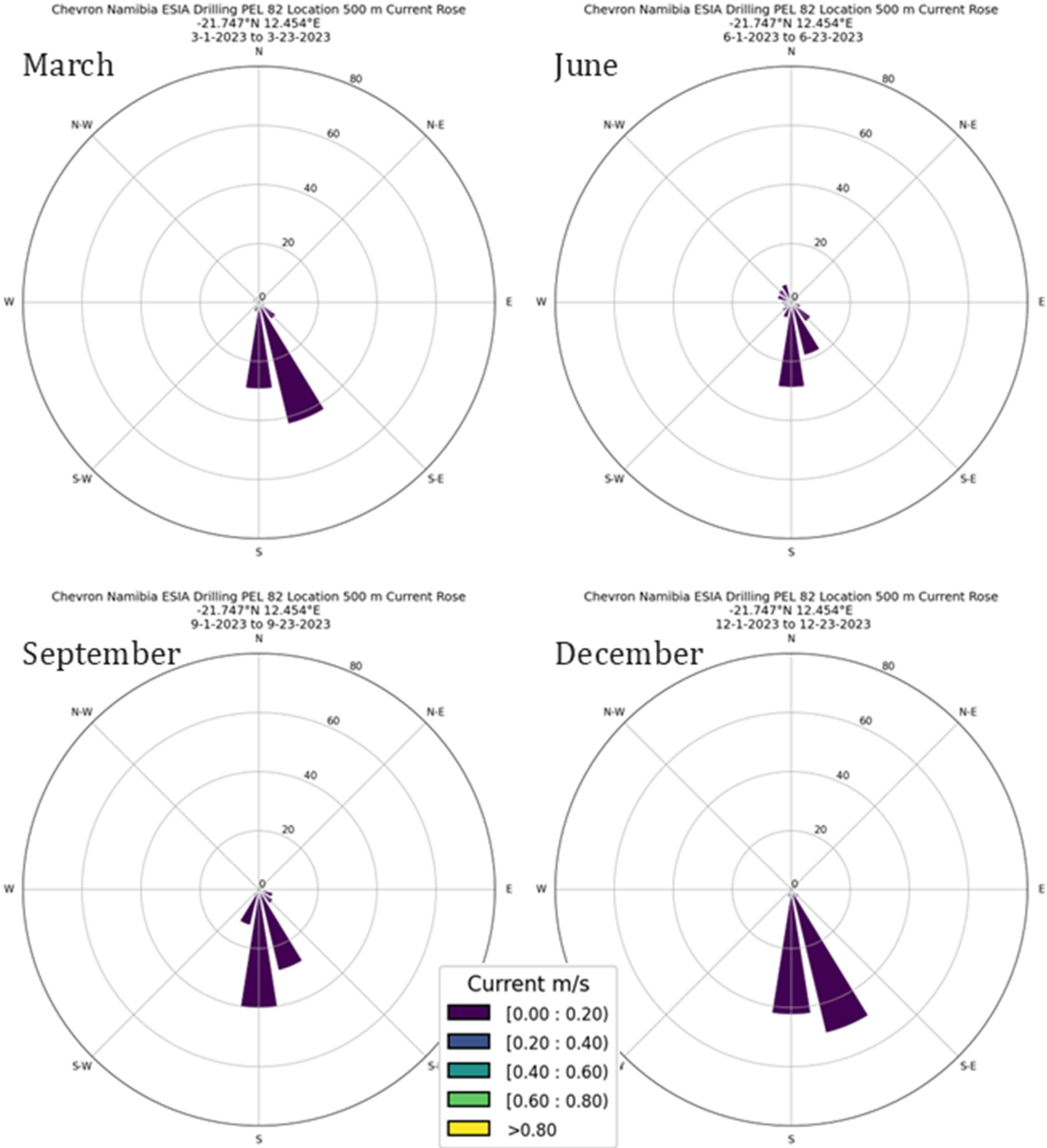


FIGURE 1-9 CURRENT ROSE DIAGRAMS AT GEMSBOK WELL IN BLOCK 2112B (AT DEPTH OF 800 M)

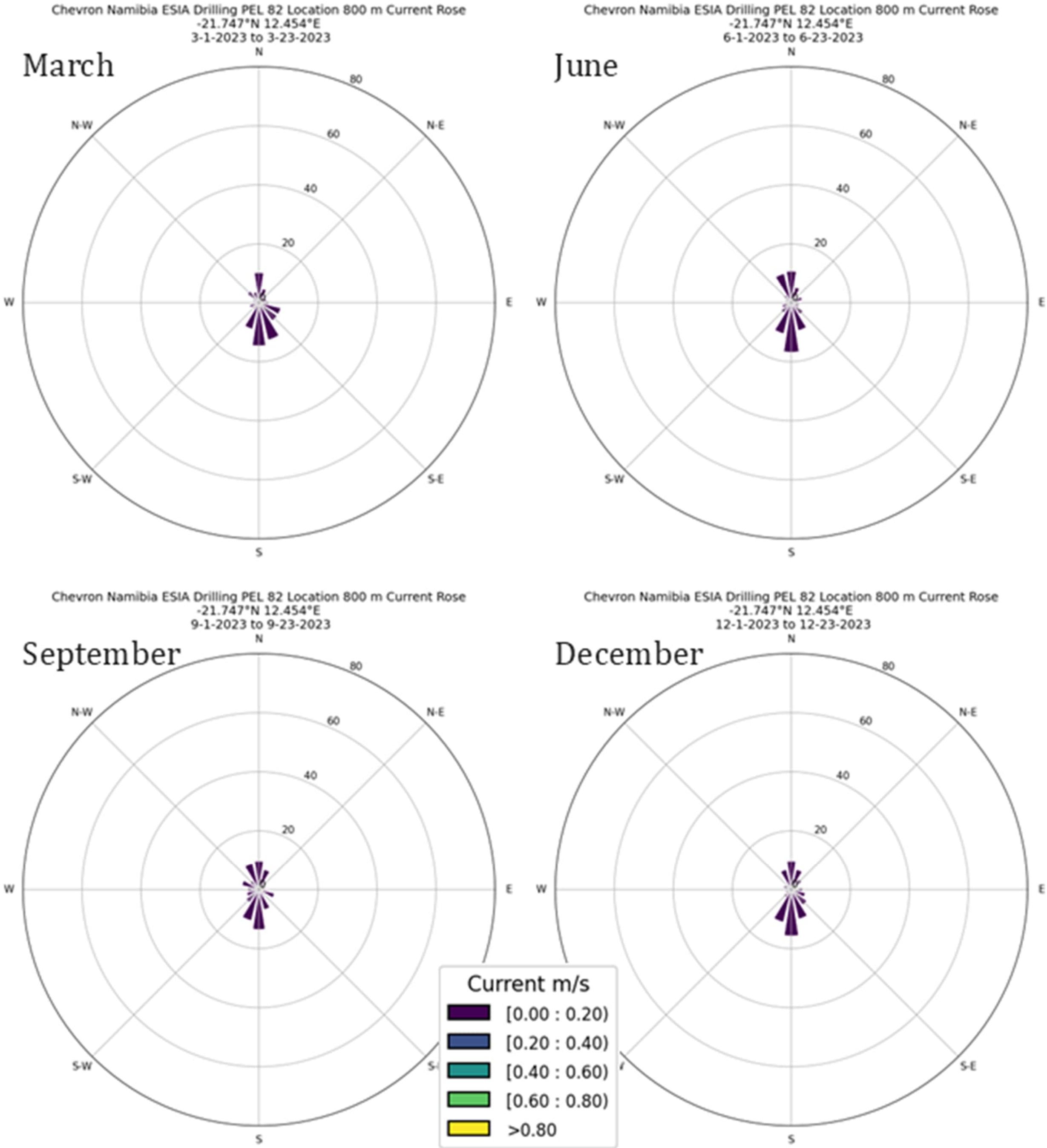


FIGURE 1-10 CURRENT ROSE DIAGRAMS AT POTENTIAL SECOND WELL LOCATION IN BLOCK 2212A (AT SEA SURFACE)

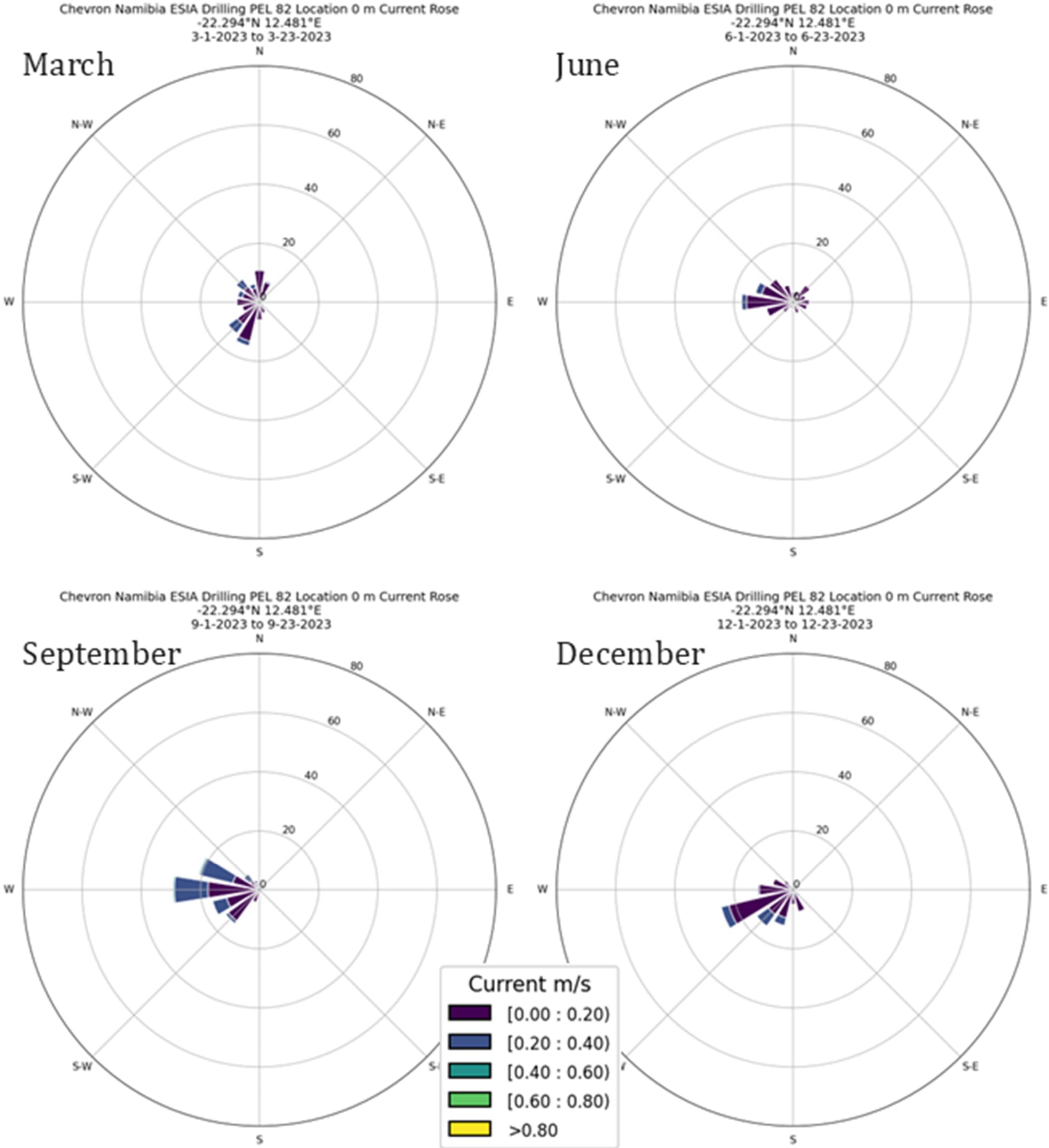


FIGURE 1-11 CURRENT ROSE DIAGRAMS AT POTENTIAL SECOND WELL LOCATION IN BLOCK 2212A (AT DEPTH OF 500 M)

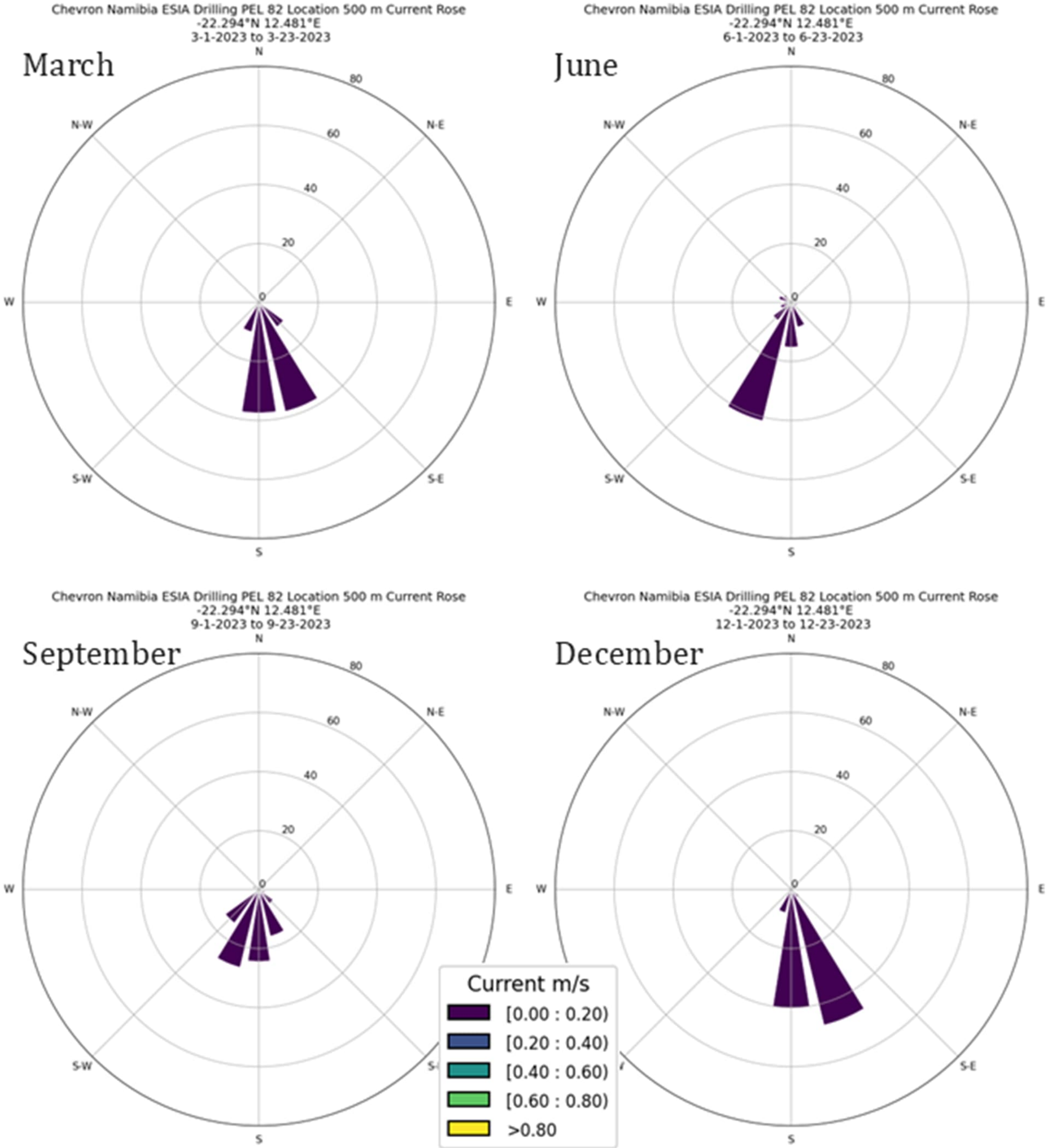
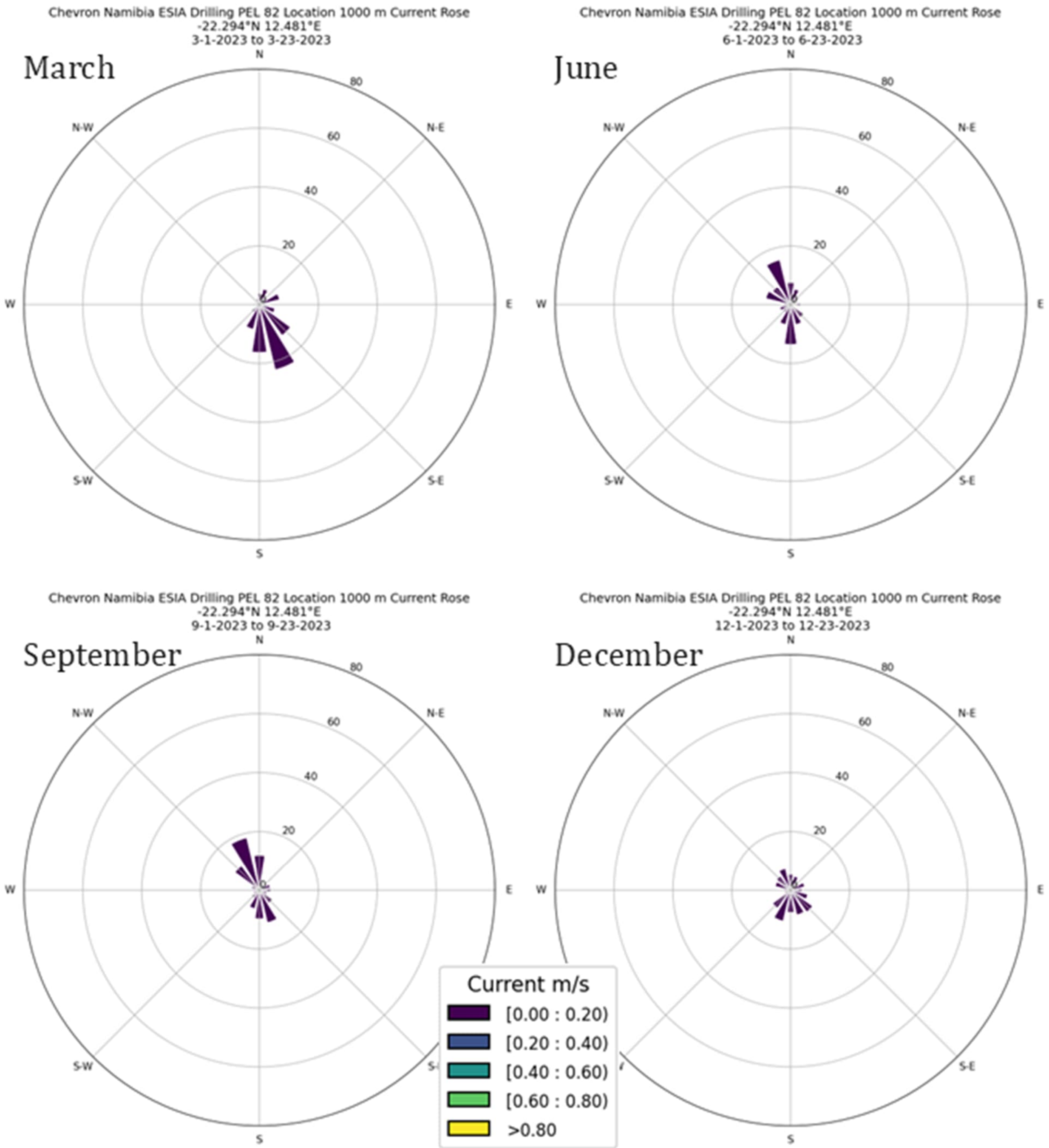


FIGURE 1-12 CURRENT ROSE DIAGRAMS AT POTENTIAL SECOND WELL LOCATION IN BLOCK 2212A (AT DEPTH OF 1000 M)



1.5.3 DRILL CUTTINGS AND MUD VOLUMES AND PROPERTIES

The details of the well profiles, drilling schedule, discharge rates of cuttings and mud (WBM, NADF with mineral and NABF), and their densities are presented in Table 1-3. Both wells (the Gemsbok Well and the potential second well location in Block 2212A) have identical drilling and discharging schedules although the ocean depth at the two locations are different (1,180 m at the Gemsbok Well and 1,026 m at the potential second well location in Block 2212A). The cuttings are discharged with WBM in Section 1 and Section 2. The cuttings are discharged with adhered NABF in Section 3 and Section 4. Cuttings and WBM were modeled discharging near the seabed (at a height of 5 m above the seabed) for Section 1 and Section 2. The mineral portion of NADF and treated cuttings with adhered NABF were modeled discharging at a depth of 10 m below the water surface for Section 3 and Section 4. The duration of the drilling of the four sections was approximately 16 days, with a gap of one day between each section's discharges. Simulations were conducted for two more days at the end of the discharge period making the total simulation duration to 21 days.-The actual drilling schedule will likely be longer, because of the time needed between sections to set up and close out the drilling in each section. However, a nominal one day pause between section discharges is sufficient to allow the suspended solids to settle or exit the model domain; any additional time simulated without any discharges occurring is not useful for computational efficiency.

TABLE 1-3 WELL PROFILE, DRILLING SCHEDULE, AND DISCHARGE PROPERTIES

Section No. and Bore Diameter (ft)	Section Length (m)	Discharge Duration (hours)	Cuttings Mass (MT)	Discharged Mineral Mass of Mud /Attached NABF Mass (MT)	Cuttings Bulk Density (kg/m^3)	Density of Mineral Mass of Mud / Density of NABF (kg/m^3)
Section 1 36"	85	24	165.49	468.43 / NA	2,588	1,031 (of WBM)
Section 2 26"	938	48	1321.11	9,962.98 / NA	2,588	1,234 (of WBM)
Section 3 17.5"	2,041	120	867.00	101.5 / 101.5	2,108 (Cuttings with adhered NADF Base Oil)	1,984 / 810
Section 4 12.25"	1,417	192	296.75	37.5 / 37.5	2,078 (Cuttings with adhered NADF Base Oil)	2,817 / 810

Source: CNEL

The distribution of particle sizes used in this study are listed in Table 1-4 for cuttings discharged from Section 1 and Section 2 based on Brandsma and Smith (1999). The particle size distribution of the components of a typical WBM is generally described in terms of the two main solid particles: barite and bentonite. The particle sizes of barite ranges between 1 µm to 200 µm, with a median size around 30 µm. Bentonite particles range between 1 µm to 100 µm with a smaller median diameter around 5 µm (Malvern Instruments, 2007). The WBM grain size distribution used for modelling is shown in Table 1-5. Table 1-6 provides the assumed grain sizes for the treated cuttings with adhered NABF of NADF mud assuming a maximum particle size of 300 µm. Table 1-7 provides the grain size distribution for the mineral particles in NADF.

The density of drill cuttings typically ranges between 2,300 kg/m^3 and 2,650 kg/m^3 (Neff 2010); a value of 2,588.24 kg/m^3 (21.6 ppg) was chosen for this analysis. The WBM densities used in Section 1 and Section 2 were 1,031.5 kg/m^3 (8.6 ppg) and 1,234.21 kg/m^3 (10.3 ppg) respectively based on the information provided by CNEL. Densities of Non-aqueous Drilling Fluids (NADF) used in Section 3 and Section 4 were provided by CNEL as 1,150.33 kg/m^3 (9.6 ppg) and 1,258.17 kg/m^3 (10.5 ppg) respectively. The density of NABF (base oil) of NADF was provided by CNEL as 810 kg/m^3. The bulk densities of cuttings with adhered NABF in Section 3 and Section 4 were calculated using densities and mass values provided by CNEL to be 2,107.76 kg/m³ and 2,076.74 kg/m³ respectively. The bulk densities of minerals of NADF used in Section 3 and Section 4 were also calculated to be 1,983.87 kg/m³ and 2,816.60 kg/m³ respectively.

TABLE 1-4 PROPERTIES OF CUTTINGS FOR SECTION 1 AND SECTION 2 (WITH WATER-BASED MUDS)

Estimated diameter (centimeters)	Mass Fraction (wt%)
0.00126	2
0.00411	9
0.0108	15
0.0218	18
0.06205	16
0.10567	15
0.36123	25

TABLE 1-5 WATER-BASED MUDS GRAIN-SIZE DISTRIBUTION

Estimated diameter (centimeters)	Mass Fraction (wt%)
0.00025	9.370
0.00075	16.278
0.00125	14.710
0.00175	8.306
0.00225	7.613
0.00275	8.395
0.00325	4.240
0.00375	3.822
0.00425	4.526
0.00475	3.748
0.00625	13.313
0.00875	4.187
0.011	1.491

TABLE 1-6 PROPERTIES OF TREATED CUTTINGS FOR SECTION 3 AND SECTION 4 (WITH NON-AQUEOUS DRILLING FLUID)

Estimated diameter (centimeters)	Mass Fraction (wt%)
0.00126	6
0.00411	44
0.0108	23
0.0218	27

TABLE 1-7 GRAIN-SIZE DISTRIBUTION OF MINERALS IN NON-AQUEOUS DRILLING FLUID

Estimated diameter (centimeters)	Mass Fraction (wt%)
0.00025	1.257
0.00075	3.276
0.00125	5.357
0.00175	5.122
0.00225	6.525
0.00275	9.908
0.00325	6.409
0.00375	6.425
0.00425	6.137
0.00475	6.381
0.00625	30.178
0.00875	8.339
0.011	4.685

2. ASSESSMENT CRITERIA

2.1 DEPOSITIONAL THICKNESS

Drill cuttings and adhered mud discharges will create a footprint on the seabed. The deposition of cuttings and adhered muds may result in physical damage and habitat loss or disruption over a defined area of the seabed. Excessive burial by drilling mud and cuttings may cause some benthic organisms to be immobilized and smothered. The potential severity of burial impacts depends on the sensitivity of the benthic organism, thickness of deposition, amount of oxygen-depleting material, and duration of the burial. Thickness thresholds vary by species and sediment impermeability. For continuous deposits over days or weeks, Ellis and Heim (1985) and MarLIN (2023) suggested threshold deposition rate of 5 centimeters per month. However, for relatively quick deposits, an “instantaneous deposition” threshold of 6.3 mm (Smit, et al. 2006, 2008) is recommended. According to Smit, et al. (2008), sudden deposits of 6.3 mm was the lowest thickness in which adverse effects to benthic biota were observed. Although the total thickness of the deposits may be the result of gradual deposition throughout several days or weeks, for a conservative estimate of potential impacts by burial, results are presented in terms of the area of deposition exceeding 6.3 mm in thickness.

2.2 TOTAL SUSPENDED SOLIDS

Increases in the concentration of TSS will occur due to discharges of drill cuttings and muds. The highest concentration increases will exist at the point of discharge and decrease over time and distance, as the suspended solids plume dissipates and settles. Larger particles will settle out more quickly than fine particles, such that a TSS plume of tiny particles may linger and travel farther than plumes of larger grain sizes. As such, elevated TSS concentrations may form in regions where tiny, suspended particles linger in cloud form and mix with subsequent discharges.

Impacts on marine organisms related to elevated TSS may potentially occur if light penetration in the photic zone (typically the top 200 meters) is impeded significantly for long periods of time reducing the ability of plants and phytoplankton to photosynthesize. For discharges near the seafloor at depths greater than 1,000 meters, light inhabitation is not a concern.

Increases in TSS may also decrease water clarity and clog fish gills. The guidance value for excessive TSS provided by the MARPOL Resolution MEPC.159(55) (IMO 2006) is 35 mg/L for its maritime effluent discharge standard, as well as the International Finance Corporation (IFC) for marine effluent discharges (IFC 2007). Although the 35 mg/L limit for TSS in marine waters is based on an effluent limit, it is useful in the absence of other regulatory TSS standards as an indicator of the start of adverse effects related to excess TSS. The likelihood of impacts related to elevated TSS concentrations tends to decrease with short durations above this threshold and in deeper waters below the photic zone, where photosynthesis does not occur.

2.3 MASS OF HYDROCARBON DEPOSITION

Cuttings containing NADF will be treated through the onboard systems (shakers and dryers). The NABF portion of the NADF that remains will be reduced to minimize base fluid retention on cuttings (average, by mass). These NABF made of hydrocarbons, once settled to the seabed, degrade over time, and may enter the pore water within the sediments or become dissolved in the water column, depending on each specific hydrocarbon's tendency to remain partitioned to the solids.

Potential impacts related to the hydrocarbons are typically related to aromatics. The NABF to be used is assumed to be considered "low toxicity" due to the very low percentage of aromatics within the hydrocarbon mixture. Low toxicity Group III NABF (as defined by the International Association of Oil and Gas Producers, OGP 2003) includes fluids produced by chemical reactions and highly refined mineral oils that contain levels of total aromatics below 0.5 percent and total polycyclic aromatic hydrocarbon (PAH) levels below 0.001 percent (Sanzone et al. 2016). Although low toxicity, other potential impacts may occur as the hydrocarbons degrade and consume dissolved oxygen in the sediments. Dissolved oxygen in the overlying water column can replenish the deficit.

3. MODELLING RESULTS

The modelling results estimating the potential impacts related to TSS, depositional thickness, and mass of NABF hydrocarbon deposited on the seabed for each well (the Gemsbok Well and the potential second well location in Block 2212A) are presented below.

3.1 TOTAL SUSPENDED SOLIDS

TSS concentration increases above ambient were examined for the release of cuttings and muds using deterministic simulations of discharged particle suspension in the water column. TSS concentration due to the discharging of the drill cuttings and muds from Gemsbok well (in Block 2112B) during the first 21 days of March, June, September, and December in 2023 are presented in Section 3.1.1. Similarly, TSS concentrations due to the discharging of drill cuttings and muds from the potential second well location (in Block 2212A) during the first 21 days of March, June, September, and December in 2023 are presented in Section 3.1.2. Figures are provided corresponding to the depth layer in which the maximum area in which the TSS exceeds the 35 mg/L threshold occurs. TSS concentration exceeds the 35 mg/L threshold near the seabed where drilling related materials from Section 1 and Section 2 of wells are discharged, as well as near water surface where drilling related materials from Section 3 and Section 4 of wells are discharged for all four scenarios (March, June, September, and December) of both wells (the Gemsbok Well and the potential second well location in Block 2212A).

3.1.1 TOTAL SUSPENDED SOLIDS CONCENTRATION FROM GEMSBOK WELL (BLOCK 2112B) DURING MARCH, JUNE, SEPTEMBER, AND DECEMBER

Figure 3-1, Figure 3-2, Figure 3-3, and Figure 3-4 show the maximum area of TSS concentration exceeding the 35 mg/L TSS threshold near seabed during March, June, September, and December scenarios for Gemsbok Well (in Block 2112B) as 0.030 km^2, 0.031 km^2, 0.024 km^2, and 0.025 km^2 respectively. However, TSS concentration near water surface due to the discharges from Gemsbok Well also does not exceed the 35 mg/L threshold during any of the four scenarios.

FIGURE 3-1 MAXIMUM AREA OF TSS ABOVE THRESHOLD NEAR SEABED IN MARCH FOR GEMSBOK WELL (BLOCK 2112B)

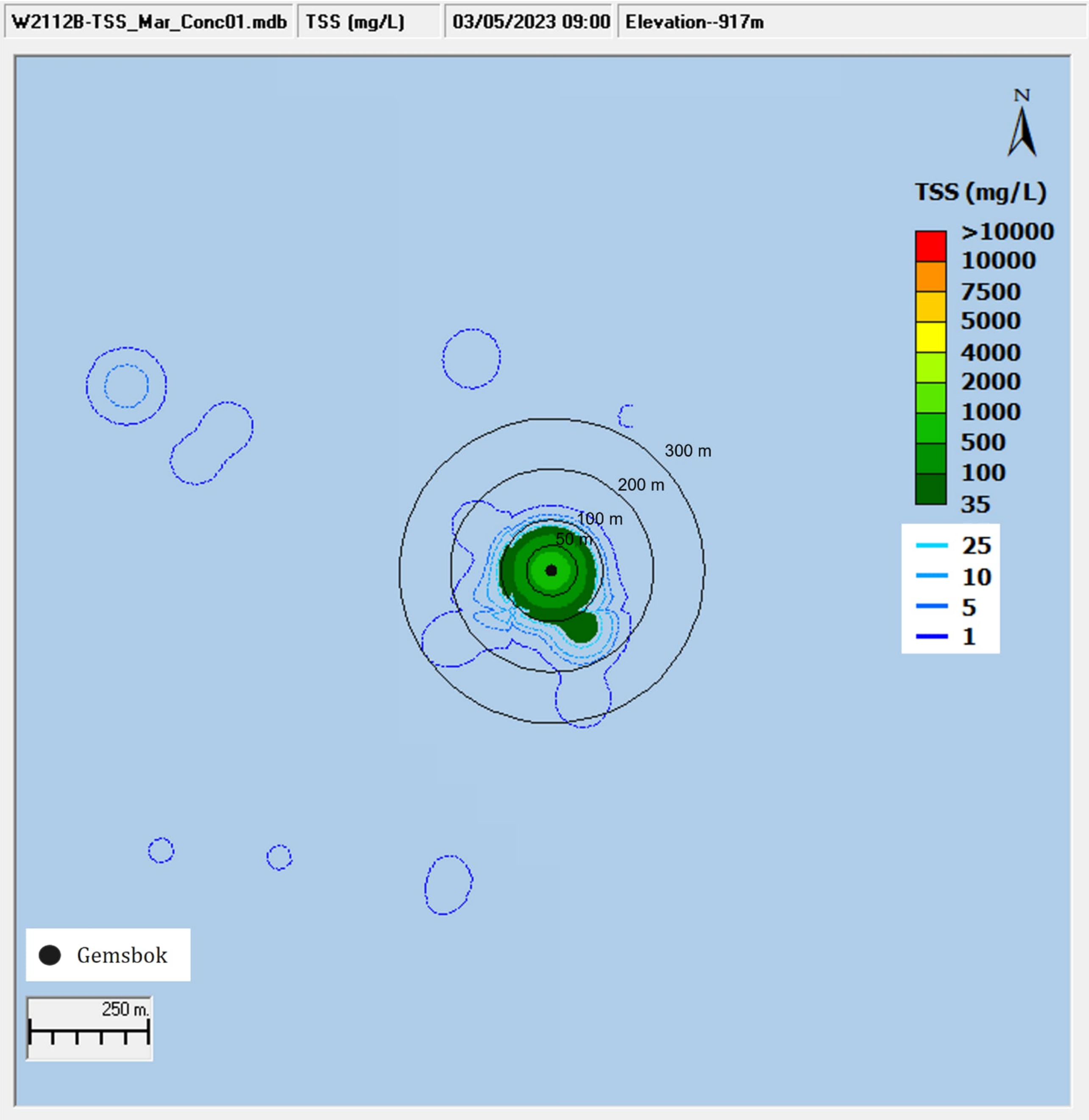


FIGURE 3-2 MAXIMUM AREA OF TSS ABOVE THRESHOLD NEAR SEABED IN JUNE FOR GEMSBOK WELL (BLOCK 2112B)

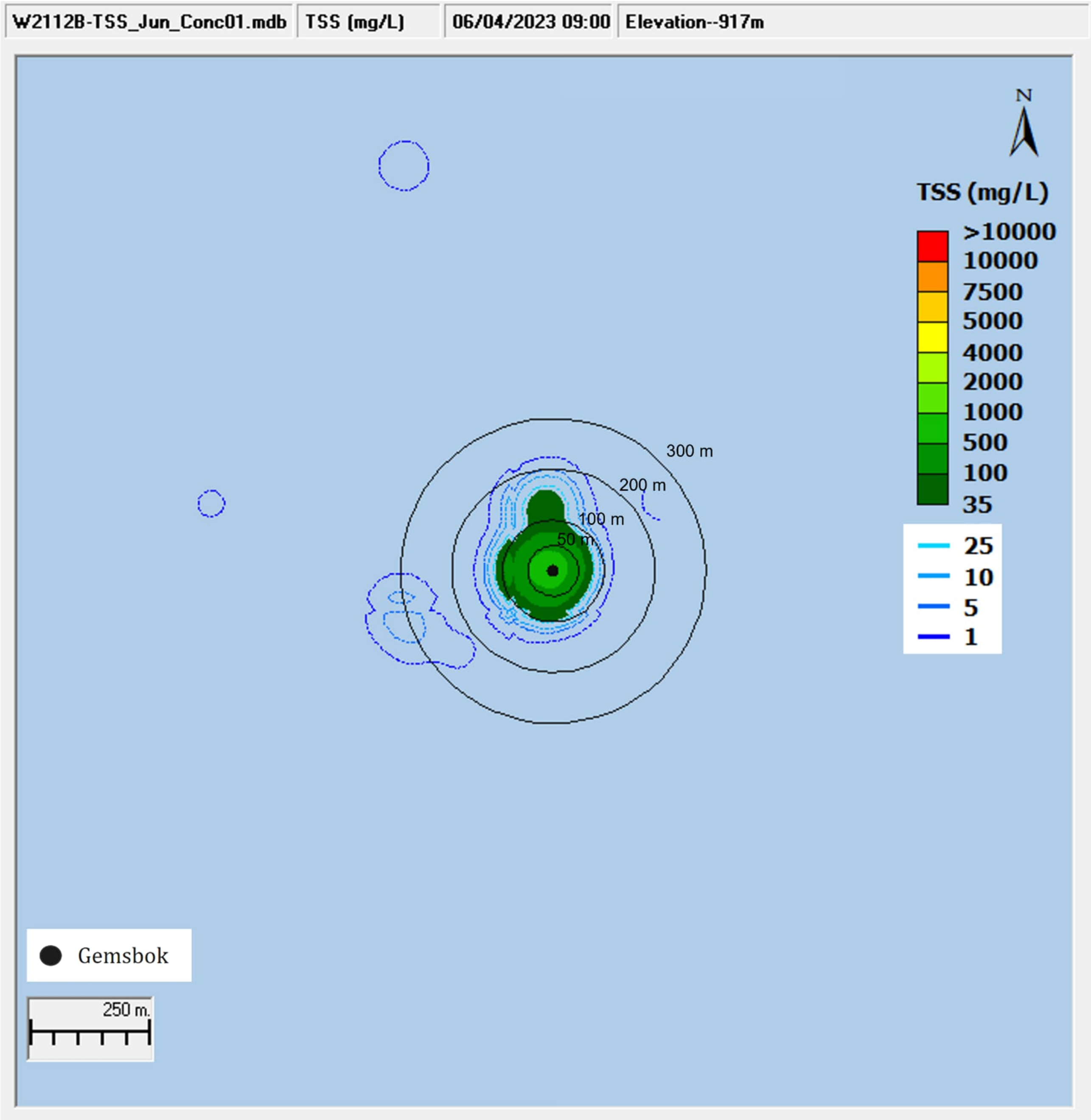


FIGURE 3-3 MAXIMUM AREA OF TSS ABOVE THRESHOLD NEAR SEABED IN SEPTEMBER FOR GEMSBOK WELL (BLOCK 2112B)

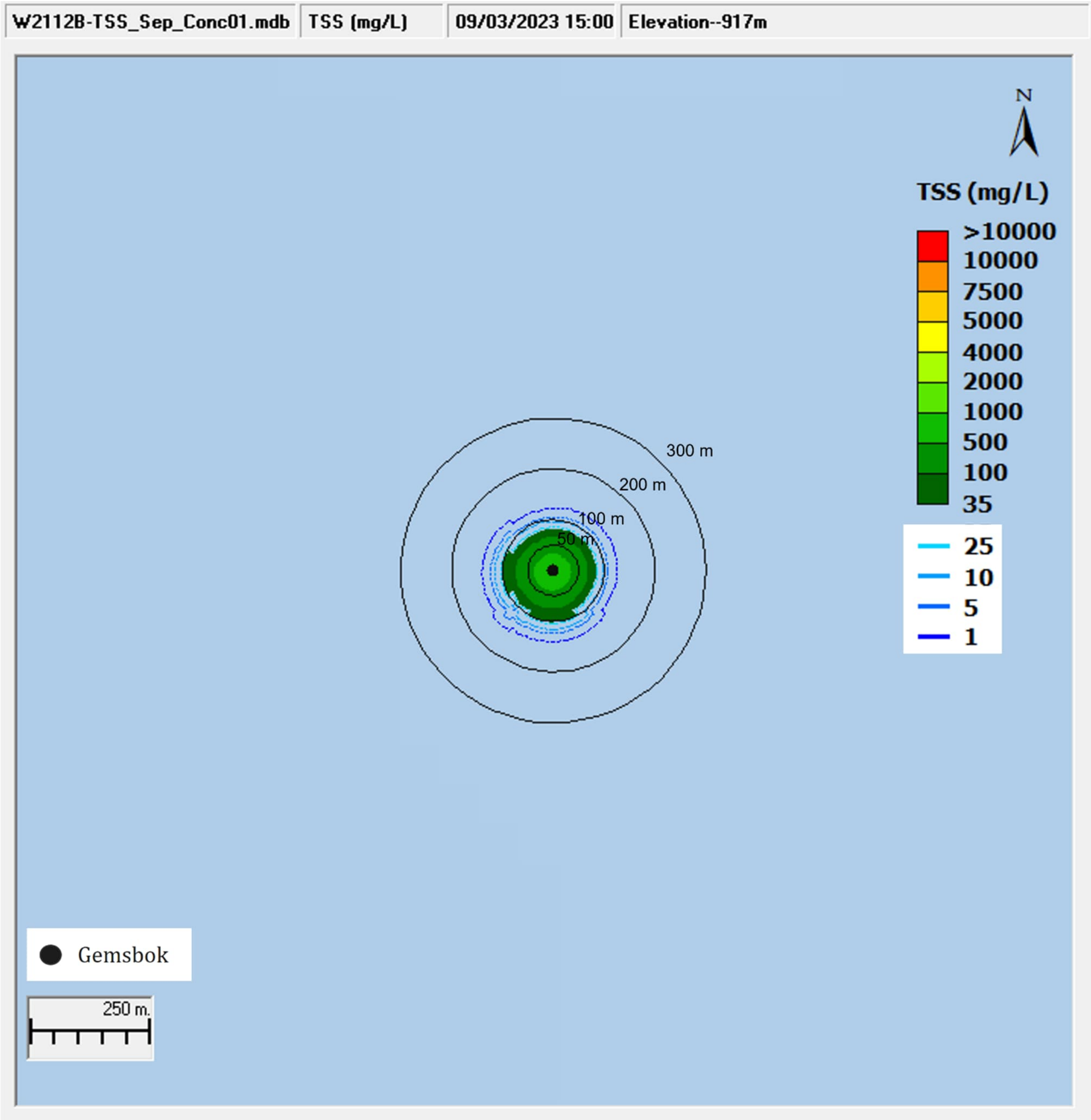
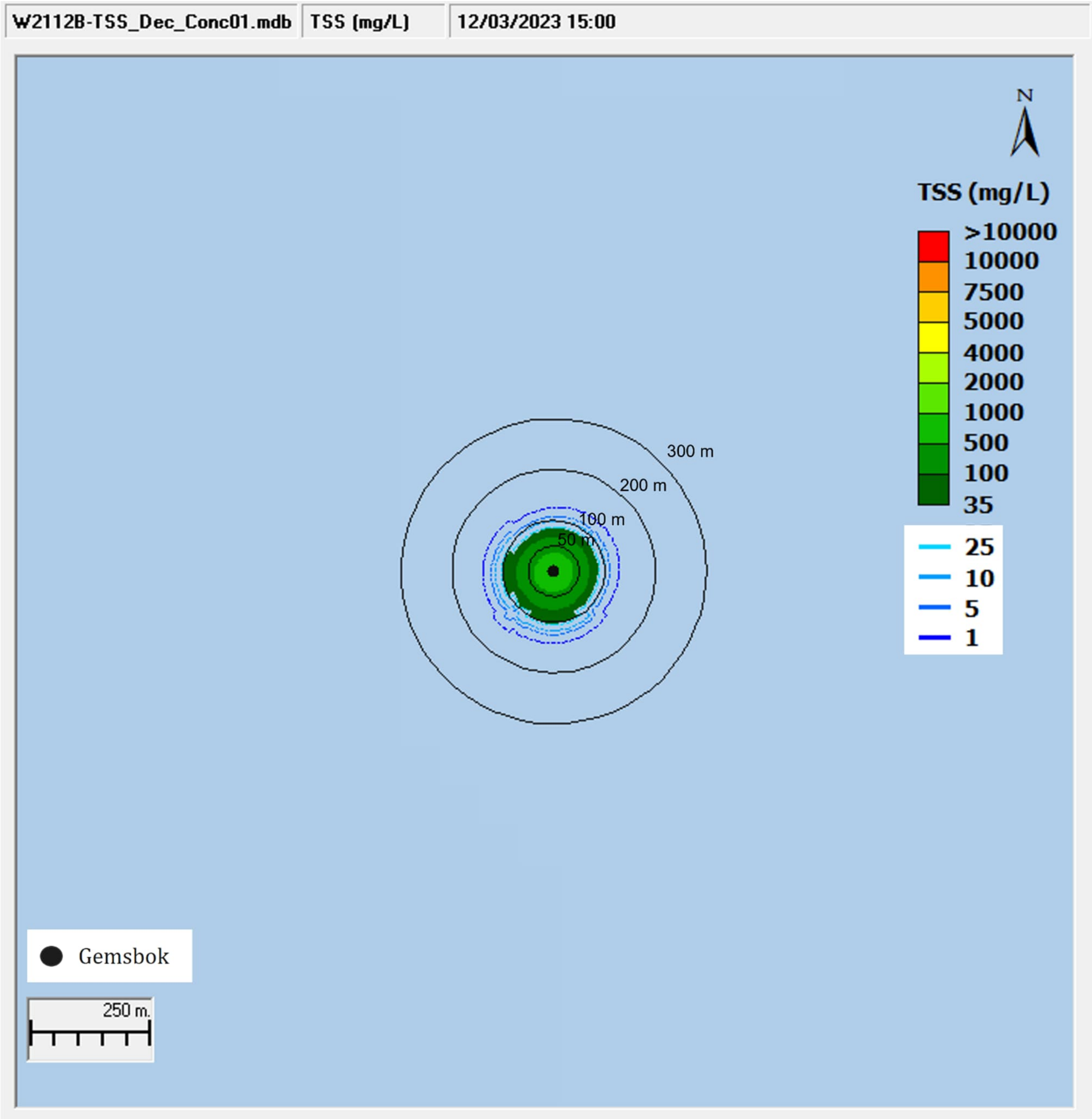


FIGURE 3-4 MAXIMUM AREA OF TSS ABOVE THRESHOLD NEAR SEABED IN DECEMBER FOR GEMSBOK WELL (BLOCK 2112B)



3.1.2 TOTAL SUSPENDED SOLIDS CONCENTRATION FROM POTENTIAL SECOND WELL LOCATION (BLOCK 2212A) DURING MARCH, JUNE, SEPTEMBER, AND DECEMBER

Figure 3-5, Figure 3-6, Figure 3-7, and Figure 3-8 show the maximum area of TSS concentration exceeding the 35 mg/L TSS threshold near seabed during March, June, September, and December scenarios for the potential second well location (in Block 2212A) as 0.152 km², 0.171 km², 0.136 km², and 0.291 km² respectively. However, TSS concentration near water surface due to the discharges from the potential second well location in Block 2212A does not exceed the 35 mg/L threshold during any of the four scenarios.

FIGURE 3-5 MAXIMUM AREA OF TSS ABOVE THRESHOLD NEAR SEABED IN MARCH FOR POTENTIAL SECOND WELL LOCATION (BLOCK 2212A)

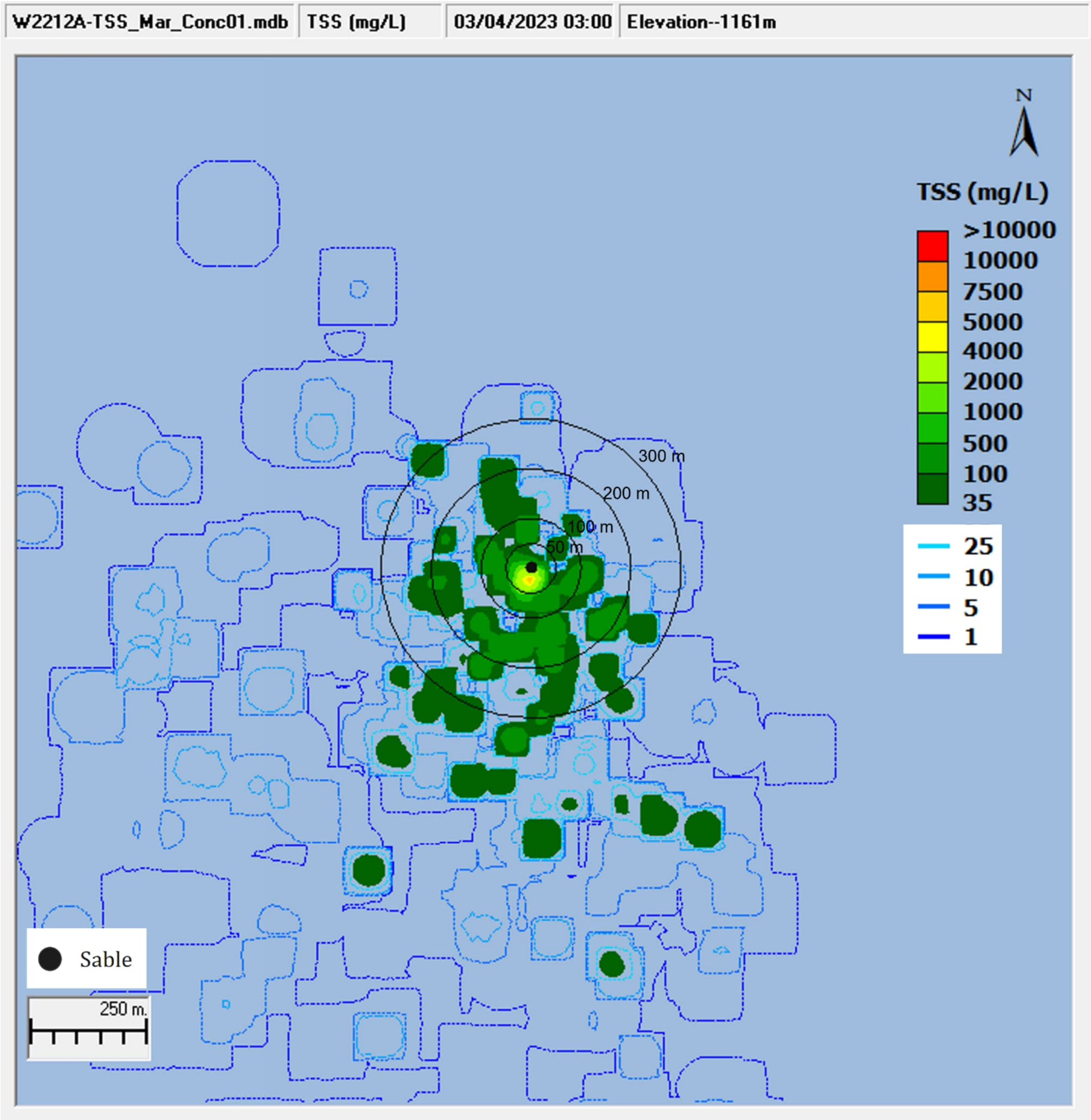


FIGURE 3-6 MAXIMUM AREA OF TSS ABOVE THRESHOLD NEAR SEABED IN JUNE FOR POTENTIAL SECOND WELL LOCATION (BLOCK 2212A)

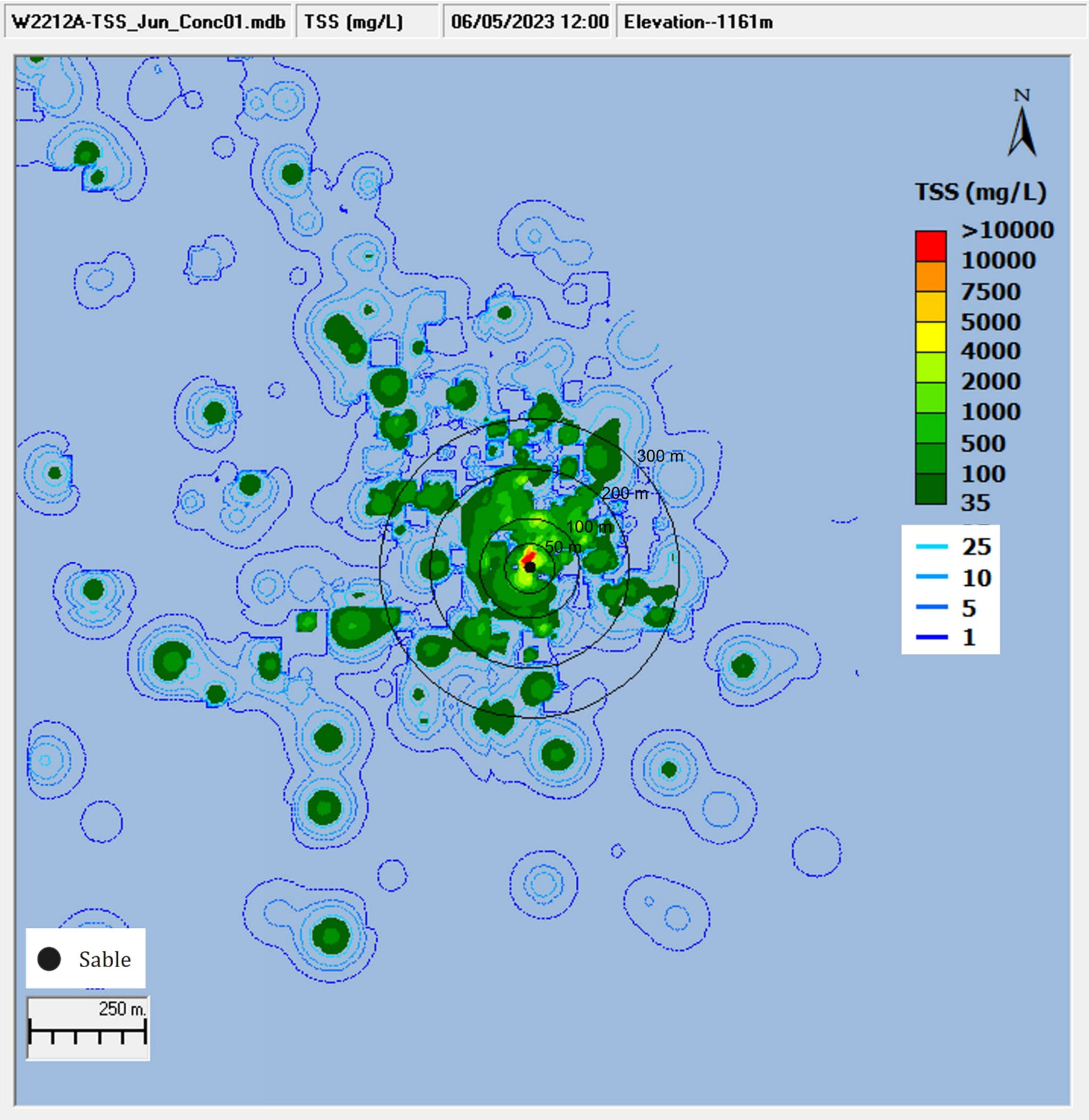


FIGURE 3-7 MAXIMUM AREA OF TSS ABOVE THRESHOLD NEAR SEABED IN SEPTEMBER FOR POTENTIAL SECOND WELL LOCATION (BLOCK 2212A)

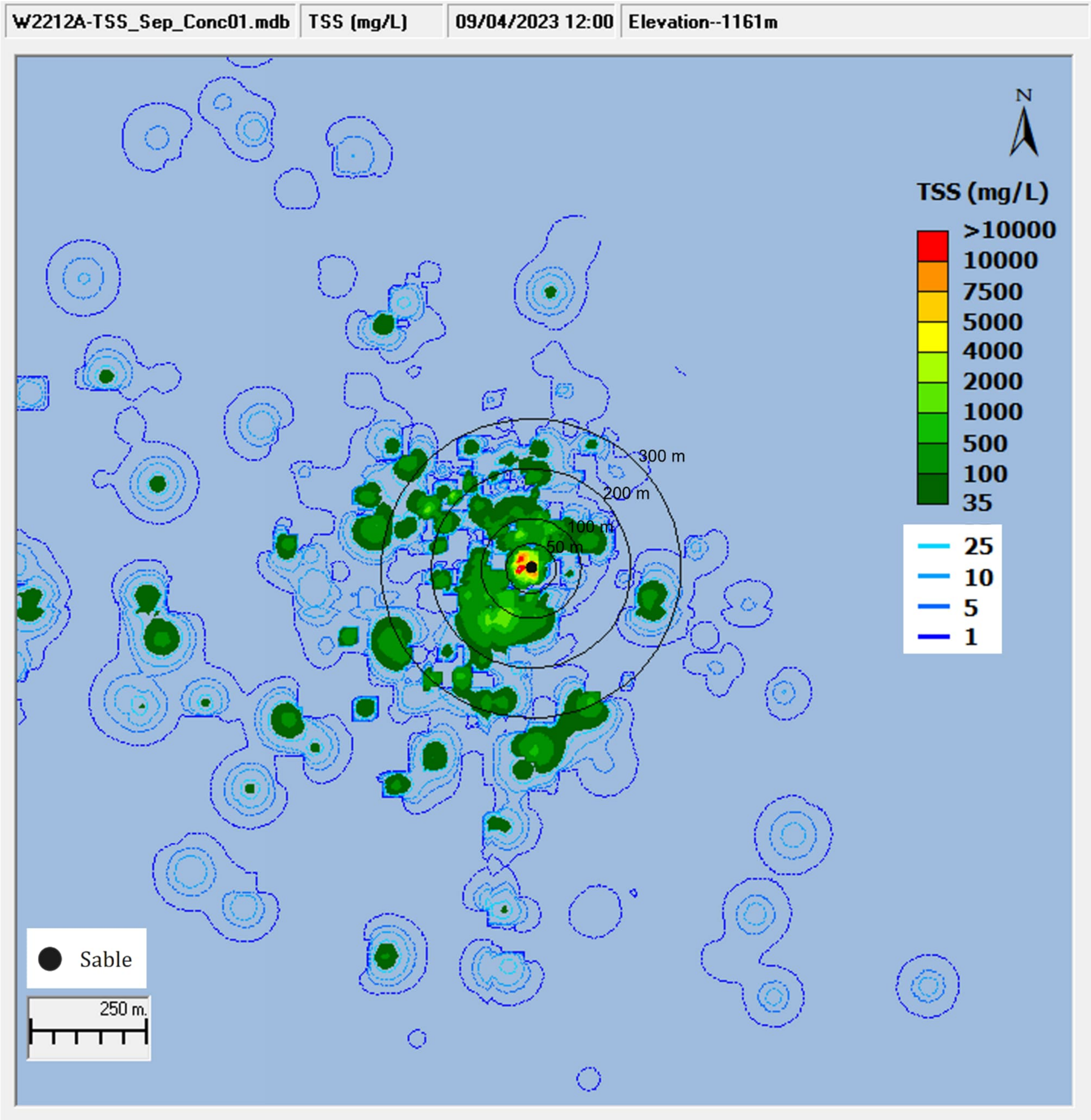
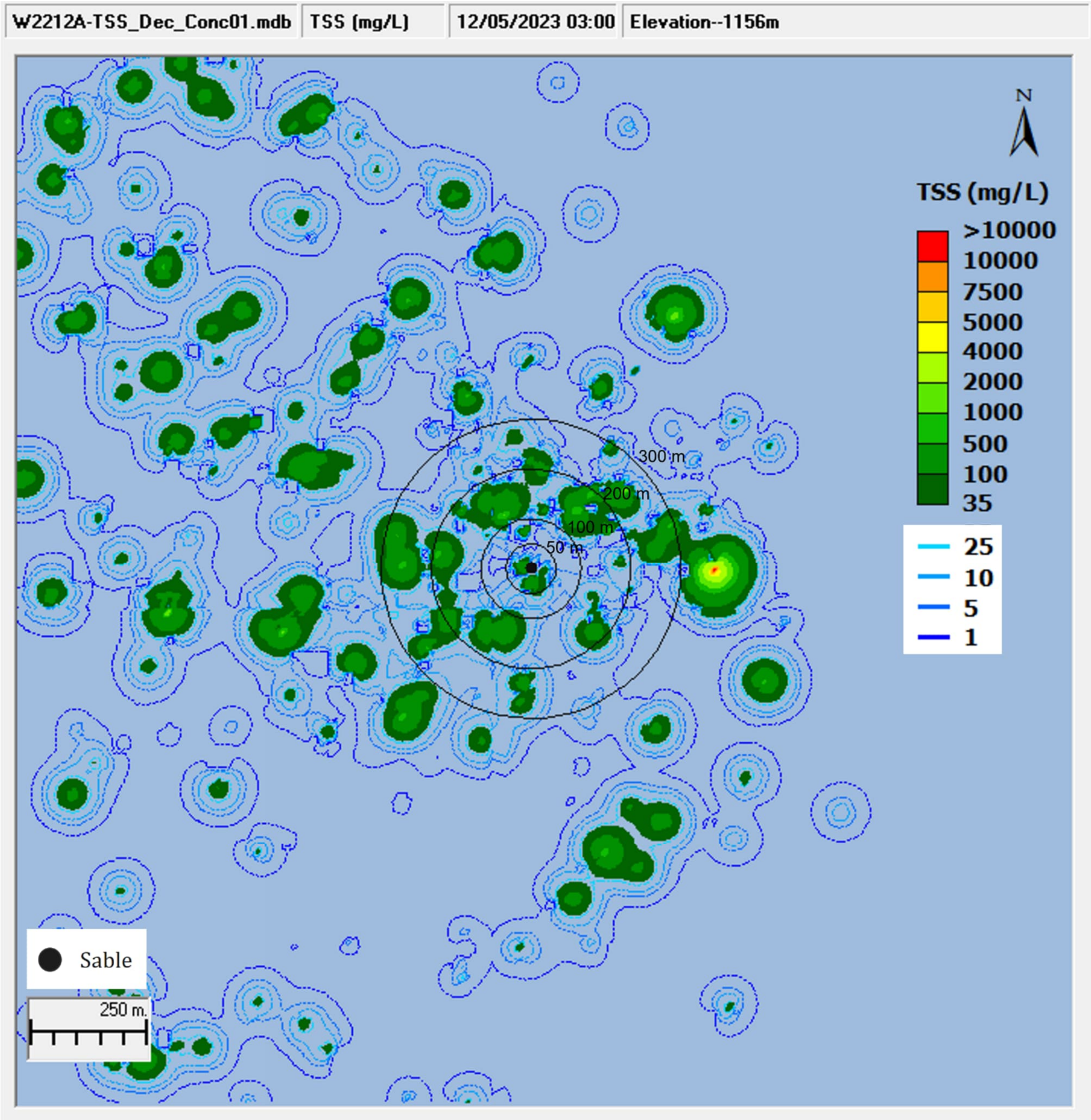


FIGURE 3-8 MAXIMUM AREA OF TSS ABOVE THRESHOLD NEAR SEABED IN DECEMBER FOR POTENTIAL SECOND WELL LOCATION (BLOCK 2212A)



3.1.3 SUMMARY

The TSS levels occurred due to the discharge of drilling related discharges from the Gemsbok Well (in Block 2112B) and the potential second well location (in Block 2212A) were examined for four scenarios (March, June, September and December). TSS concentrations exceeded the 35 mg/L threshold criterion near seabed for both wells. However, TSS concentration near water surface did not exceed the 35 mg/L threshold during any of the four scenarios for either well location. Simulations show that the areas where TSS exceeds the 35 mg/L threshold for Gemsbok Well (in Block 2112B) are smaller compared to the respective areas for the potential second well location (in Block 2212A) in their respective scenarios because the current magnitude near seabed at Gemsbok Well location is smaller compared to the potential second well location in Block 2212A, and hence the TSS plumes of Gemsbok Well do not get transported as far as the TSS plume from the potential second well location in Block 2212A. Table 3-1 summarizes the results found in the TSS analysis for the two well locations under four simulated scenarios.

TABLE 3-1 SUMMARY OF TOTAL SUSPENDED SOLIDS RESULTS NEAR SEABED AND WATER SURFACE FOR THE GEMSBOCK WELL AND THE POTENTIAL SECOND WELL LOCATION IN BLOCK 2212A

Well	Month	Location of Water Column	Area (km^2) with TSS> 35 mg/L Threshold
Gemsbok Well (in Block 2112B)	March	Seabed	0.030
		Water Surface	N/A
	June	Seabed	0.031
		Water Surface	N/A
	September	Seabed	0.024
		Water Surface	N/A
	December	Seabed	0.025
		Water Surface	N/A
Potential second well location (in Block 2212A)	March	Seabed	0.152
		Water Surface	N/A
	June	Seabed	0.171
		Water Surface	N/A
	September	Seabed	0.136
		Water Surface	N/A
	December	Seabed	0.291
		Water Surface	N/A

Source: ERM

3.2 DRILL CUTTINGS DEPOSITIONAL THICKNESS

The seabed accumulation of the drill cuttings and muds from both wells (the Gemsbok Well and the potential second well location in Block 2212A) were predicted by computation of the total thickness deposited on the seabed after all discharged material has settled. Seabed accumulation of the drill cuttings and muds from Gemsbok Well (in Block 2112B) during the first 21 days of March, June, September, and December in 2023 is presented in Section 3.2.1.. Similarly, Seabed accumulation of the drill cuttings and muds from the potential second well location (in Block 2212A) during the first 21 days of March, June, September, and December in 2023 is presented in Section 3.2.2.

3.2.1 SEABED ACCUMULATION FROM GEMSBOK WELL (BLOCK 2112B) DURING MARCH, JUNE, SEPTEMBER, AND DECEMBER

The total thickness of deposits on the seabed was examined for the release of cuttings and muds using deterministic simulations of particle deposition. Figure 3-9, Figure 3-10, Figure 3-11, and Figure 3-12 show the accumulated total thickness of deposits on the seabed at the end of the 21-day simulation period for Gemsbok Well. The simulation period includes the discharge duration of each section, and a 1-day gap between each drilling of sections in which particles have ample time to settle. The depositional thickness of cuttings on the seabed exceeds both threshold values (6.3 mm and 5 cm). The area where the deposition of cuttings and muds thickness is greater than 6.3 mm remained predominantly within a 50-meter radius of Gemsbok Well location (in Block 2112B) except for the June Scenario. The area of depositional thickness exceeding the 6.3 mm threshold during March, June, September, and December scenarios for Gemsbok Well location (in Block 2112B) are 15,869 m^2, 33,948 m^2, 6,424 m^2, and 4,451 m^2 respectively. Similarly, the area of depositional thickness exceeding the 5 cm threshold during March, June, September, and December scenarios are 4,157 m^2, 4,943 m^2, 2,574 m^2, and 2,189 m^2 respectively.

FIGURE 3-9 MAXIMUM DEPOSITIONAL THICKNESS ON SEABED IN MARCH FOR GEMSBOK WELL (BLOCK 2112B)

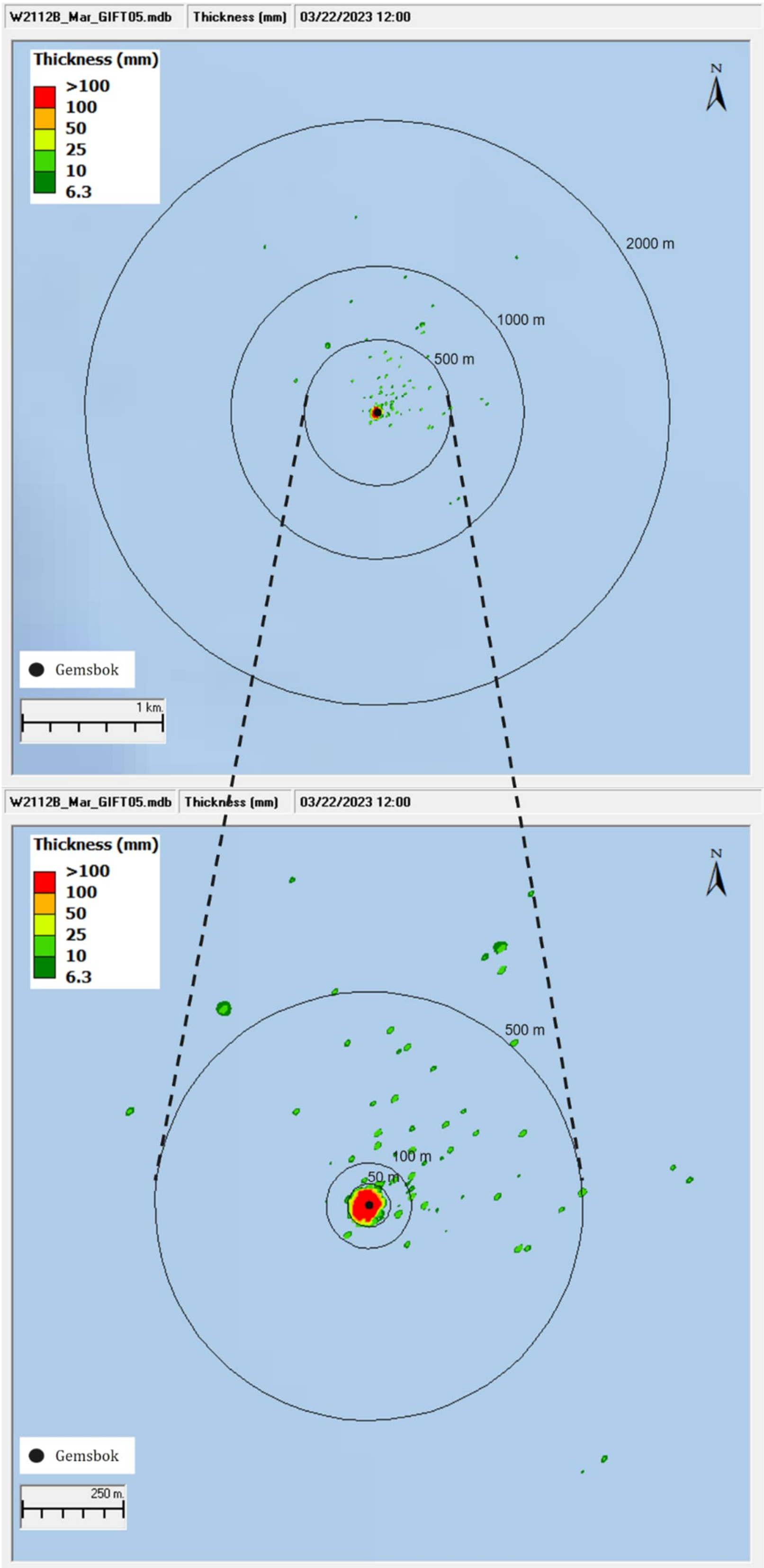


FIGURE 3-10 MAXIMUM DEPOSITIONAL THICKNESS ON SEABED IN JUNE FOR GEMSBOK WELL (BLOCK 2112B)

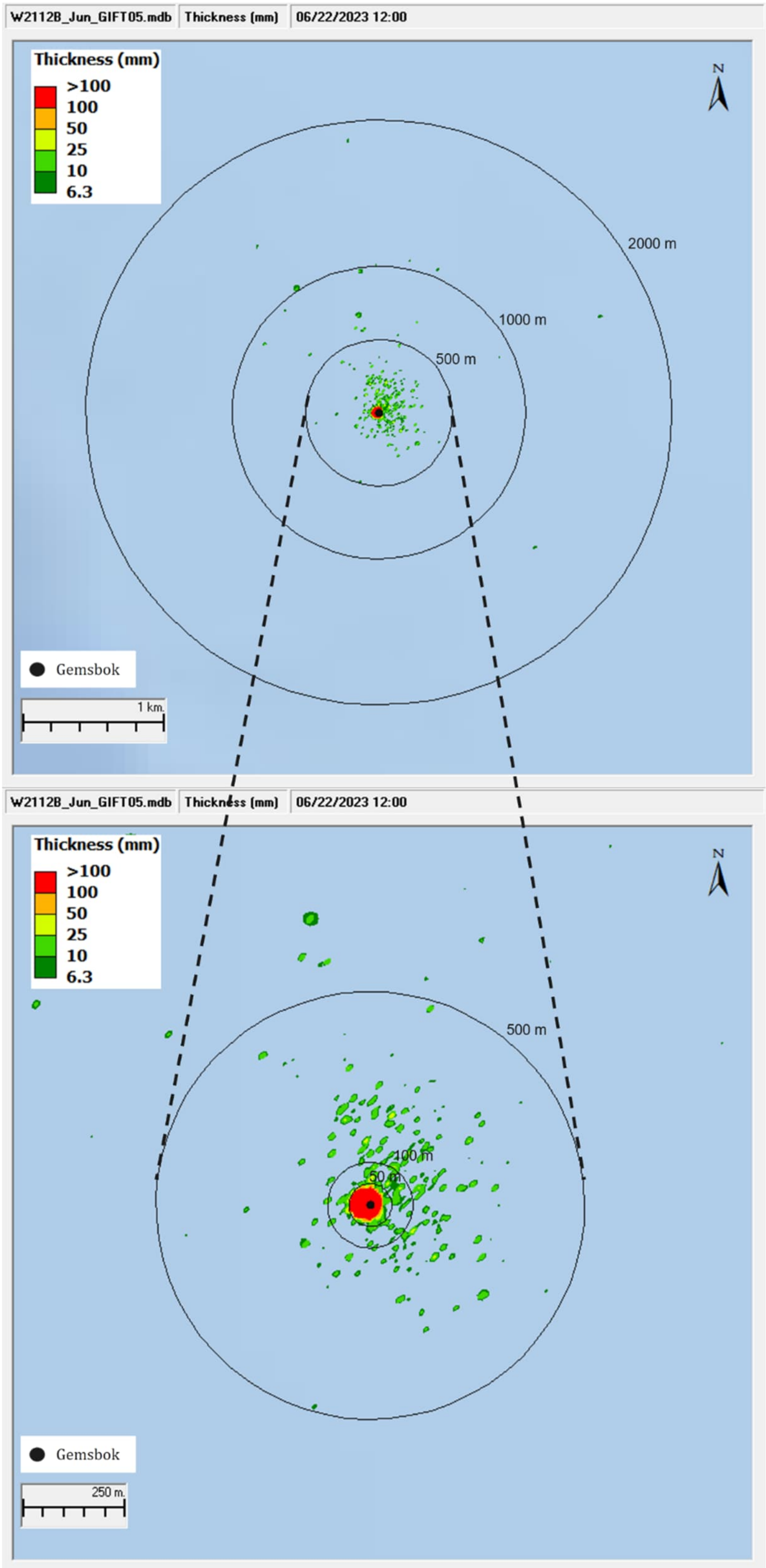


FIGURE 3-11 MAXIMUM DEPOSITIONAL THICKNESS ON SEABED IN SEPTEMBER FOR GEMSBOK WELL (BLOCK 2112B)

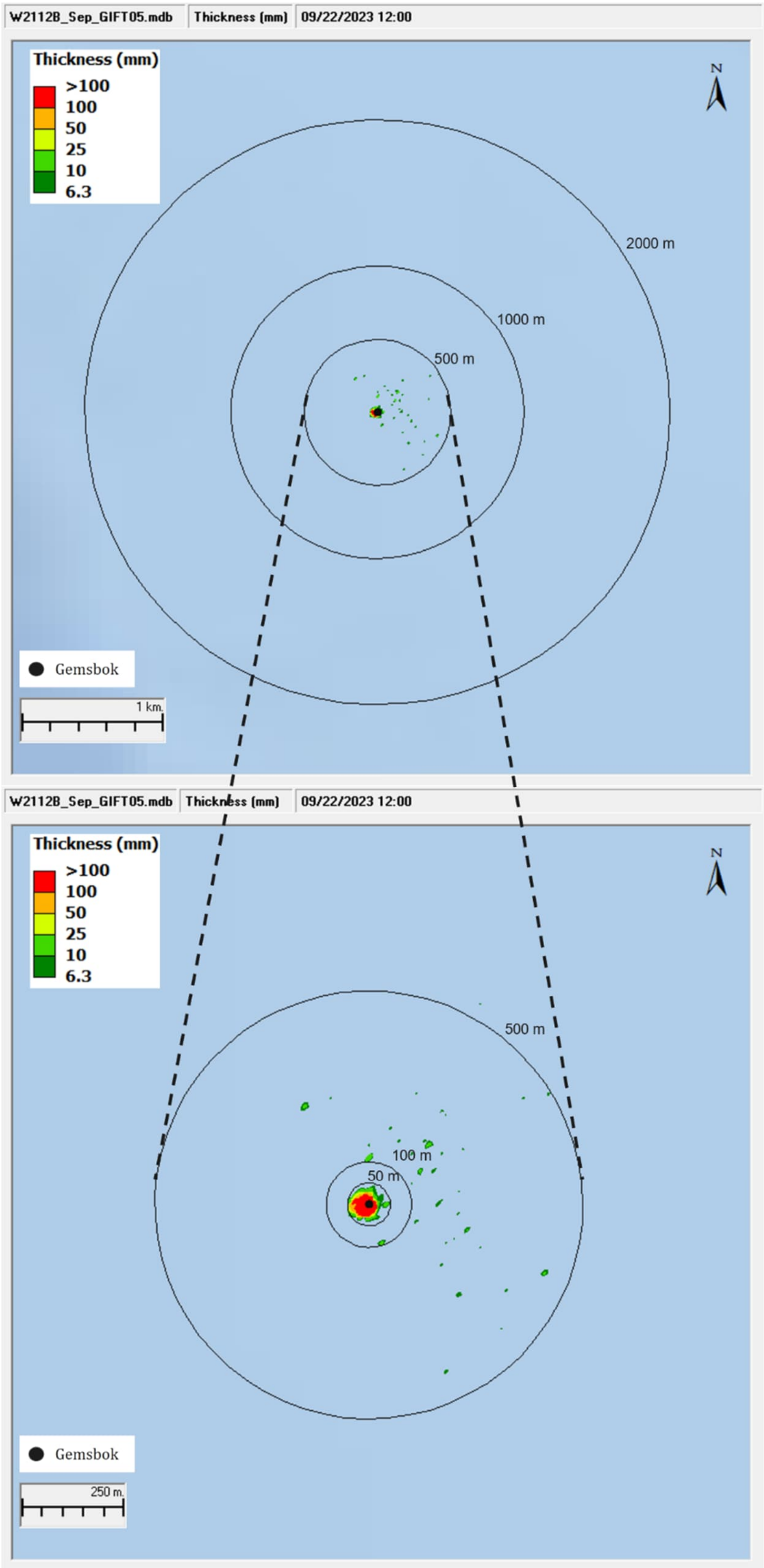
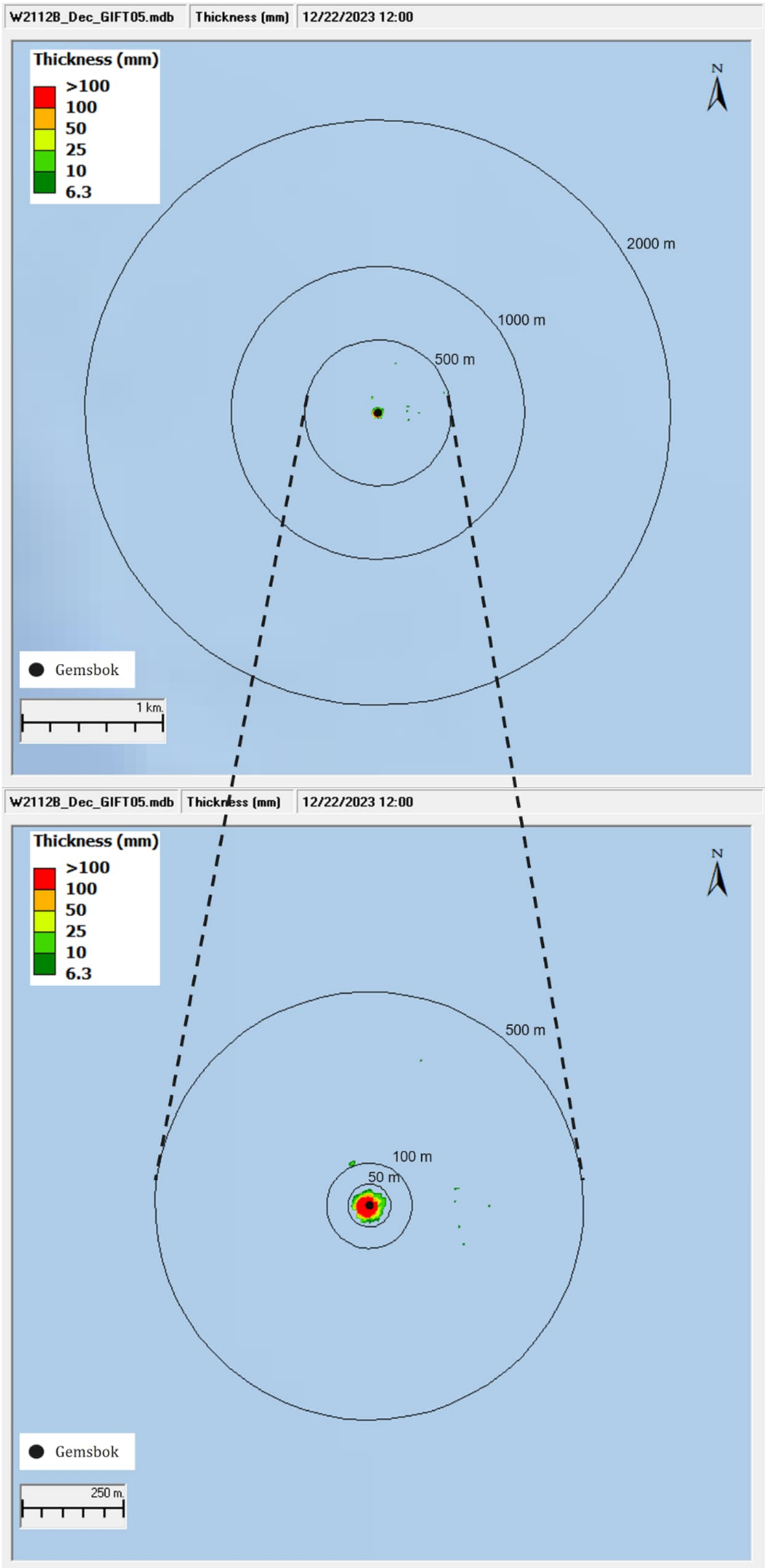


FIGURE 3-12 MAXIMUM DEPOSITIONAL THICKNESS ON SEABED IN DECEMBER FOR GEMSBOK WELL (BLOCK 2112B)



3.2.2 SEABED ACCUMULATION FROM POTENTIAL SECOND WELL LOCATION (BLOCK 2212A) DURING MARCH, JUNE, SEPTEMBER, AND DECEMBER

The total thickness of deposits on the seabed was examined for the release of cuttings and muds using deterministic simulations of particle deposition. Figure 3-13, Figure 3-14, Figure 3-15, and Figure 3-16 show the accumulated total thickness of deposits on the seabed at the end of the 21-day simulation period for the potential second well location in Block 2212A. The simulation period includes the discharge duration of each section, 1-day gap between each drilling of sections in which particles have ample time to settle. The depositional thickness of cuttings on the seabed exceeds both threshold values (6.3 mm and 5 cm). The area where deposition of cuttings and muds thickness is greater than 6.3 mm remained predominantly within a 500-meter radius of the potential second well location (in Block 2212A). The area of depositional thickness exceeding the 6.3 mm threshold during March, June, September, and December scenarios for the potential second well location (in Block 2212A) are 364,244 m^2, 219,030 m^2, 228,540 m^2, 243,553 m^2 respectively. Similarly, the area of depositional thickness exceeding the 5 cm threshold during March, June, September, and December scenarios are 8,780 m^2, 13,212 m^2, 15,002 m^2, and 15,814 m^2 respectively.

FIGURE 3-13 MAXIMUM DEPOSITIONAL THICKNESS ON SEABED IN MARCH FOR POTENTIAL SECOND WELL LOCATION (BLOCK 2212A)

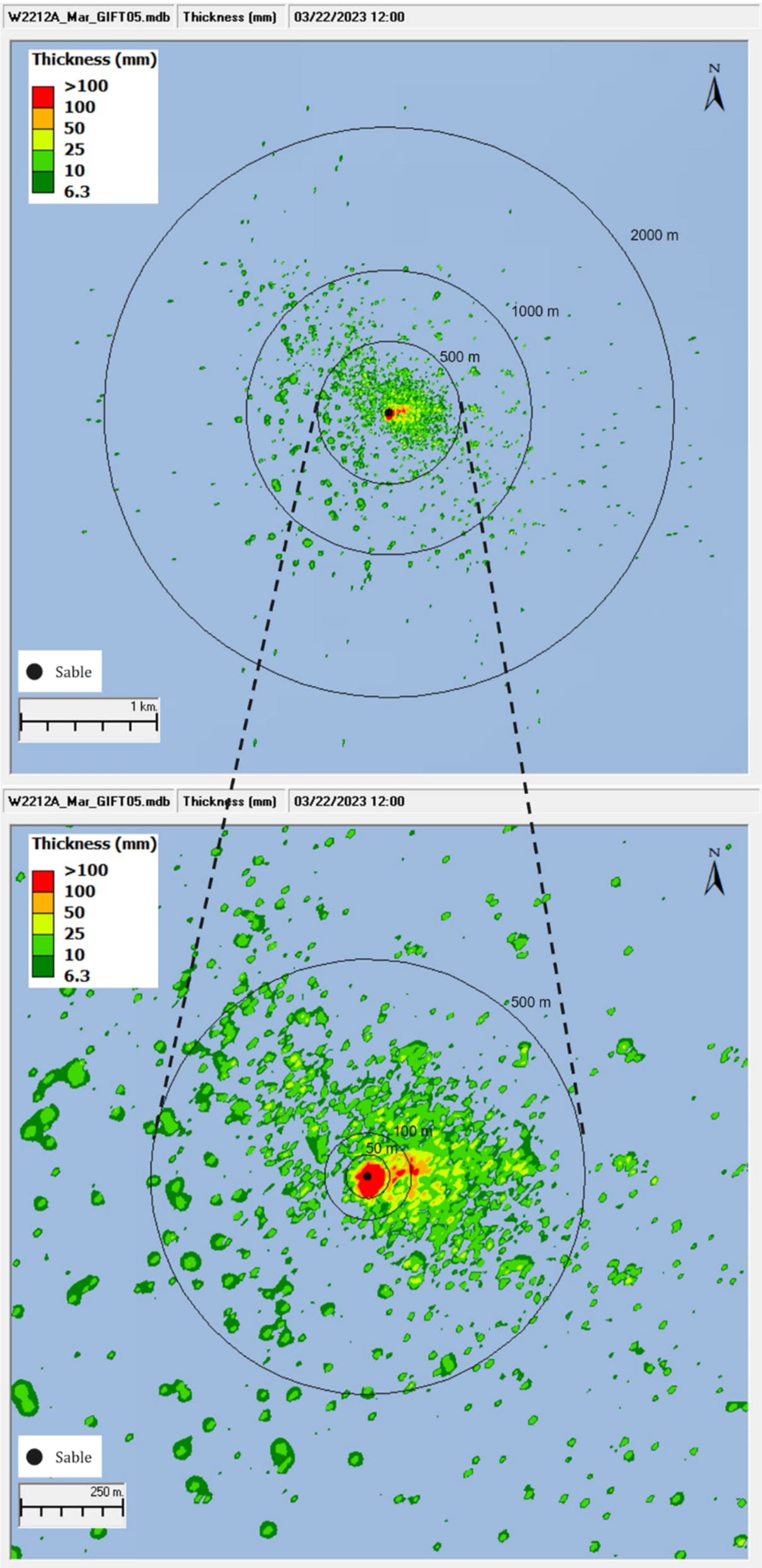


FIGURE 3-14 MAXIMUM DEPOSITIONAL THICKNESS ON SEABED IN JUNE FOR POTENTIAL SECOND WELL LOCATION (BLOCK 2212A)

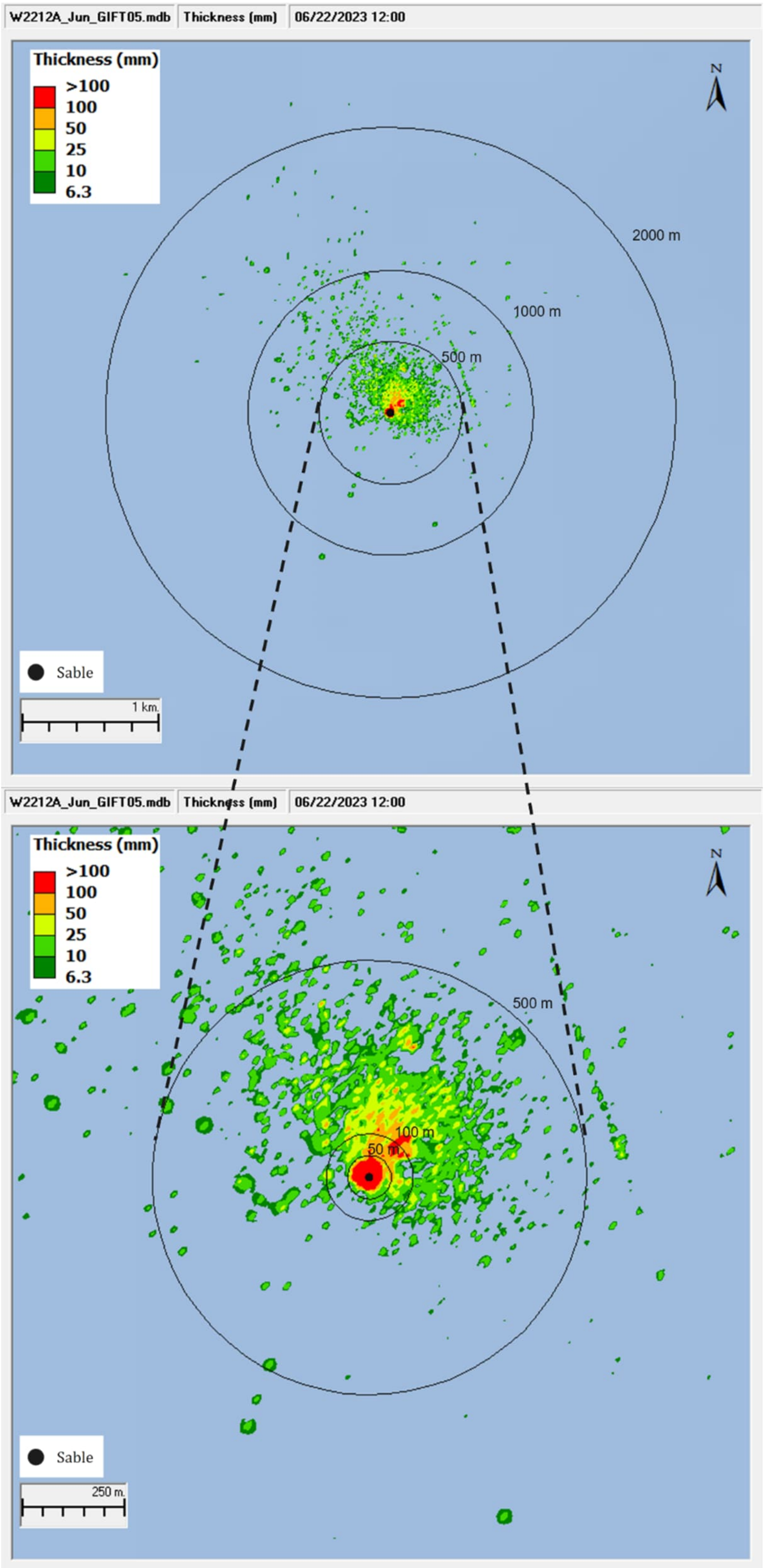


FIGURE 3-15 MAXIMUM DEPOSITIONAL THICKNESS ON SEABED IN SEPTEMBER FOR POTENTIAL SECOND WELL LOCATION (BLOCK 2212A)

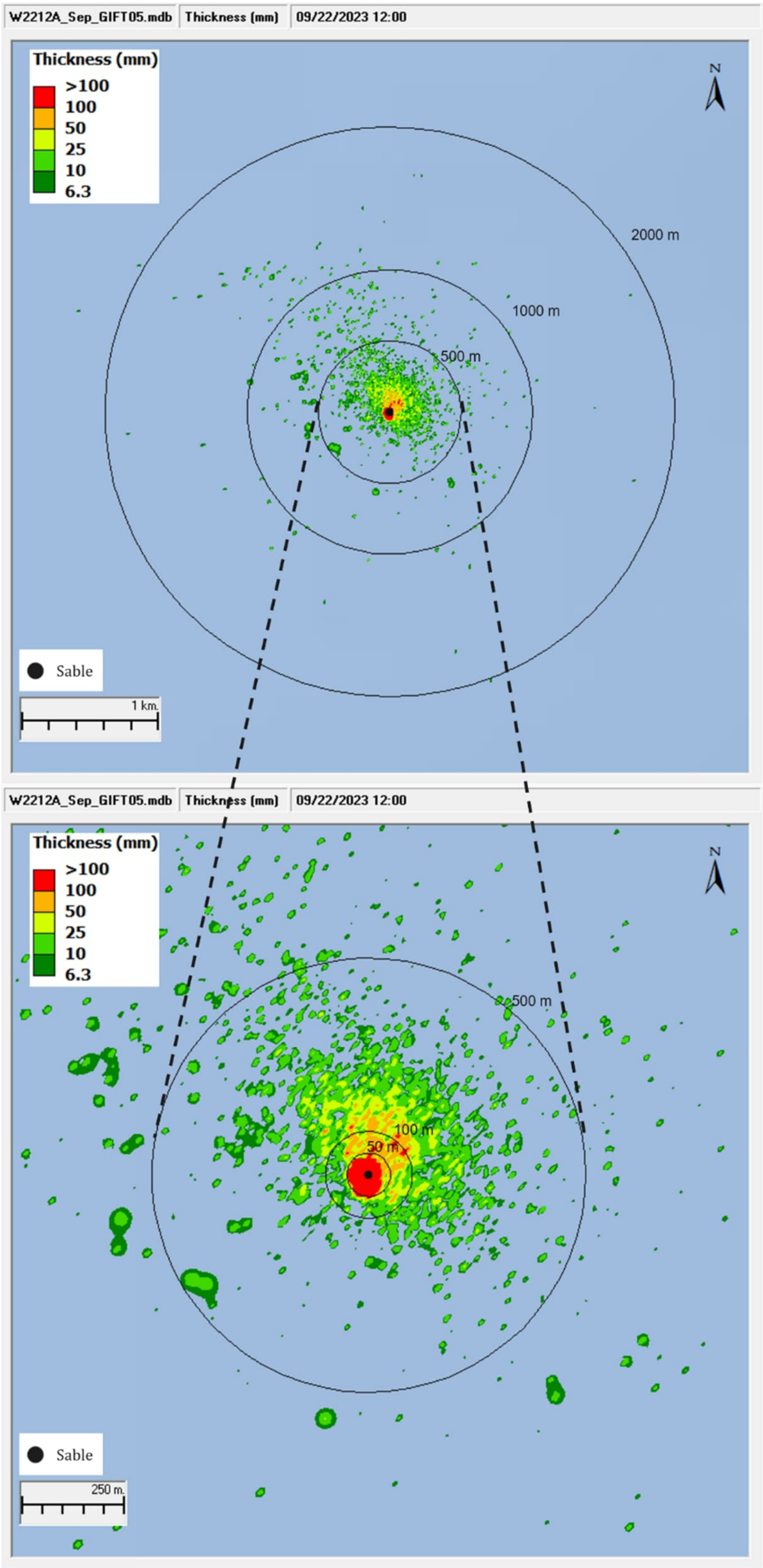
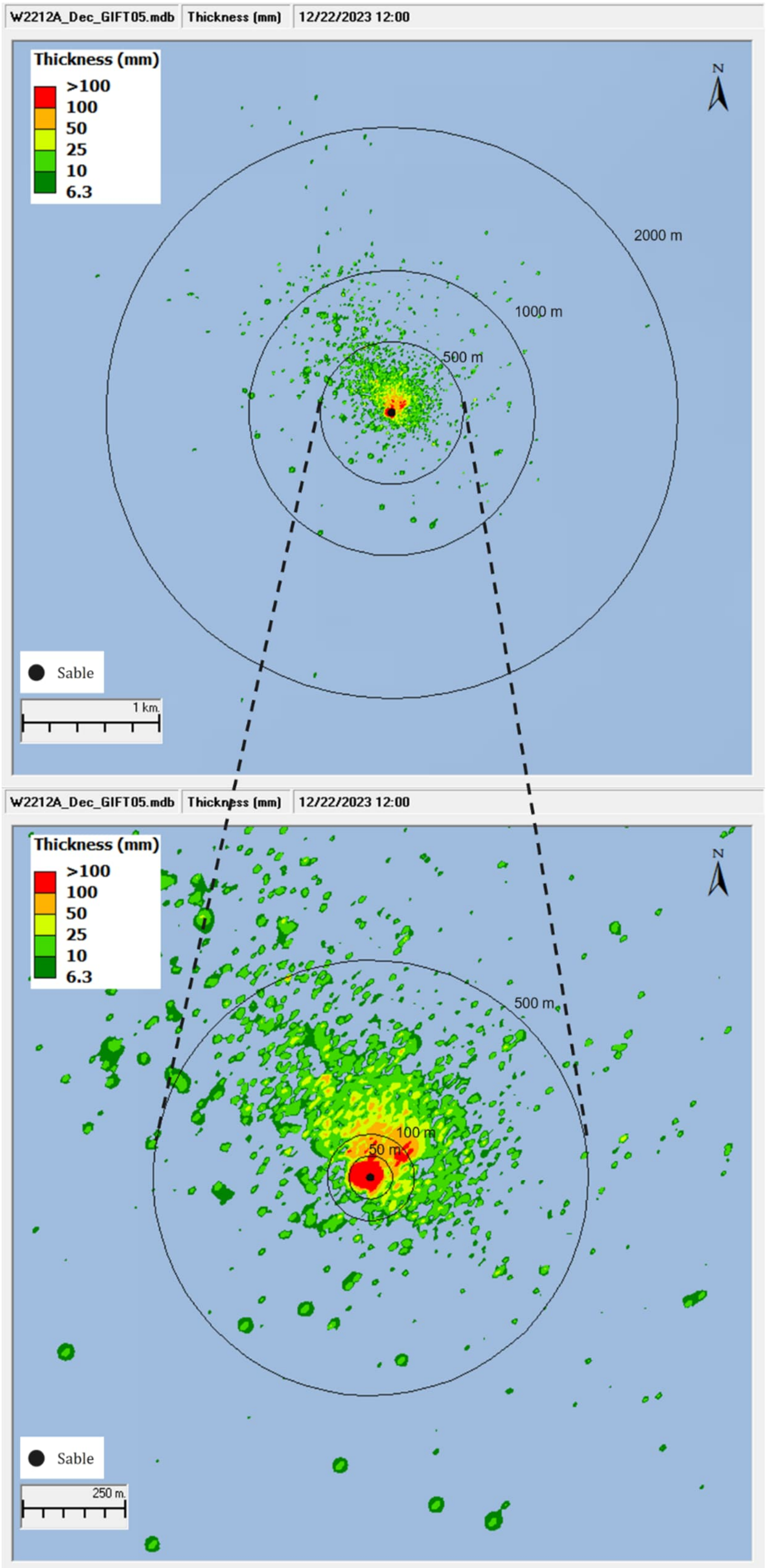


FIGURE 3-16 MAXIMUM DEPOSITIONAL THICKNESS ON SEABED IN DECEMBER FOR POTENTIAL SECOND WELL LOCATION (BLOCK 2212A)



3.2.3 SUMMARY

The depositional thickness due to the discharge of drilling related discharges from Gemsbok Well (in Block 2112B) and the potential second well location (in Block 2212A) exceed both

6.3 mm and 5 cm threshold values. The area where deposition of cuttings and muds thickness is greater than 6.3 mm remained predominantly within a 50-meter radius of the Gemsbok Well location (except for the June Scenario) and a 500-meter radius of the potential second well location in Block 2212A. Simulations show that the areas where depositional thickness exceeds the 6.3 mm and 5 cm thresholds for the Gemsbok Well (in Block 2112B) are smaller compared to the respective areas for the potential second well location (in Block 2212A) in their respective scenarios because the current magnitude near seabed at the Gemsbok Well location is smaller compared to the potential second well location in Block 2212A, and hence the depositional material from the Gemsbok Well drilling does not get transported as much farther as the depositional material from the potential second well location in Block 2212A. Table 3-2 summarizes the areas exceeding the thickness threshold for each scenario.

TABLE 3-2 SUMMARY OF CUTTINGS DEPOSITION RESULTS FOR GEMSBOK WELL AND POTENTIAL SECOND WELL LOCATION IN BLOCK 2212A

Well	Month	Area (m^2) with Thickness> 5 cm threshold	Area (m^2) with Thickness> 6.3 mm threshold
Gemsbok Well (in Block 2112B)	March	4,157	15,869
	June	4,943	33,948
	September	2,574	6,424
	December	2,189	4,451
Potential second well location (in Block 2212A)	March	8,780	364,244
	June	13,212	219,030
	September	15,002	228,540
	December	15,814	243,553

Source: ERM

3.3 MASS OF HYDROCARBON DEPOSITION

The seabed accumulation of hydrocarbons due to the retained NABF mass on drill cuttings from both wells (the Gemsbok Well and the potential second well location in Block 2212A) were predicted as a part of the computation of the thickness deposited on the seabed due to the discharged material from Section 3 and Section 4. Hydrocarbon mass due to the discharge of drill cuttings and retained NABF from Section 3 and Section 4 of Gemsbok Well (in Block 2112B) for March, June, September, and December scenarios are presented in Section 3.3.1.. Similarly, Hydrocarbon mass due to the discharge of drill cuttings and retained NABF from Section 3 and Section 4 of the potential second well location (in Block 2212A) for March, June, September, and December scenarios are presented in Section 3.3.2 .

Hydrocarbon concentrations were not compared to toxicological benchmarks since such values are typically in terms of hydrocarbon concentration mass per gram of dry sediment, assuming a homogenous mixture with depth into the benthos. Model output is in terms of mass of hydrocarbons per square meter of seafloor. Deposits of NABF adhered to cuttings scattered across the sediment bed surface may eventually mix into the sediments due to biological mixing (bioturbation). However, a direct comparison to a benchmark would require specific understanding of the depth of mixing and the degree of homogeneity. Furthermore, the composition of the hydrocarbons will change over time as the compounds degrade. The hydrocarbon deposits identified by the modelling are locations where there are varying degrees of likelihood of impact proportional to the concentrations, but clear determination of impacts cannot be made.

3.3.1 NABF HYDROCARBON MASS FROM GEMSBOK WELL (BLOCK 2112B) DURING MARCH, JUNE, SEPTEMBER, AND DECEMBER

Figure 3-17, Figure 3-18, Figure 3-19, and Figure 3-20 show the accumulated hydrocarbons on the seabed at the end of the 21-day simulation period for Gemsbok Well. The area where deposited hydrocarbon concentration exceeds 10 g/m^2 (this is not a value related any environmental threshold) during March, June, September, and December scenarios for Gemsbok Well are 3.950 km^2, 6.860 km^2, 5.560 km^2, and 0.619 km^2 respectively for Gemsbok Well.

FIGURE 3-17 MAXIMUM NABF HYDROCARBON MASS ON SEABED IN MARCH FOR GEMSBOK WELL (BLOCK 2112B)

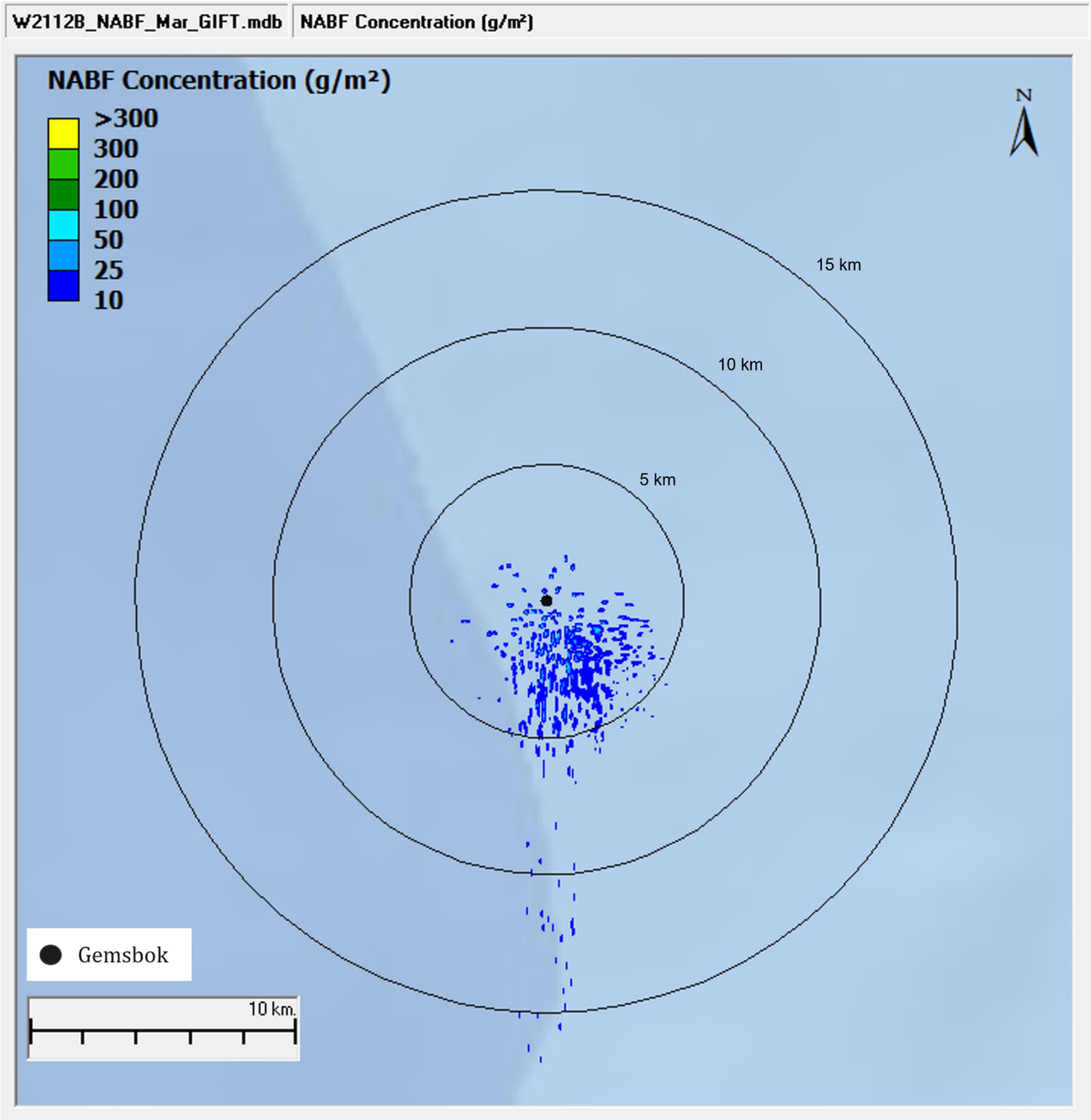


FIGURE 3-18 MAXIMUM NABF HYDROCARBON MASS ON SEABED IN JUNE FOR GEMSBOK WELL (BLOCK 2112B)

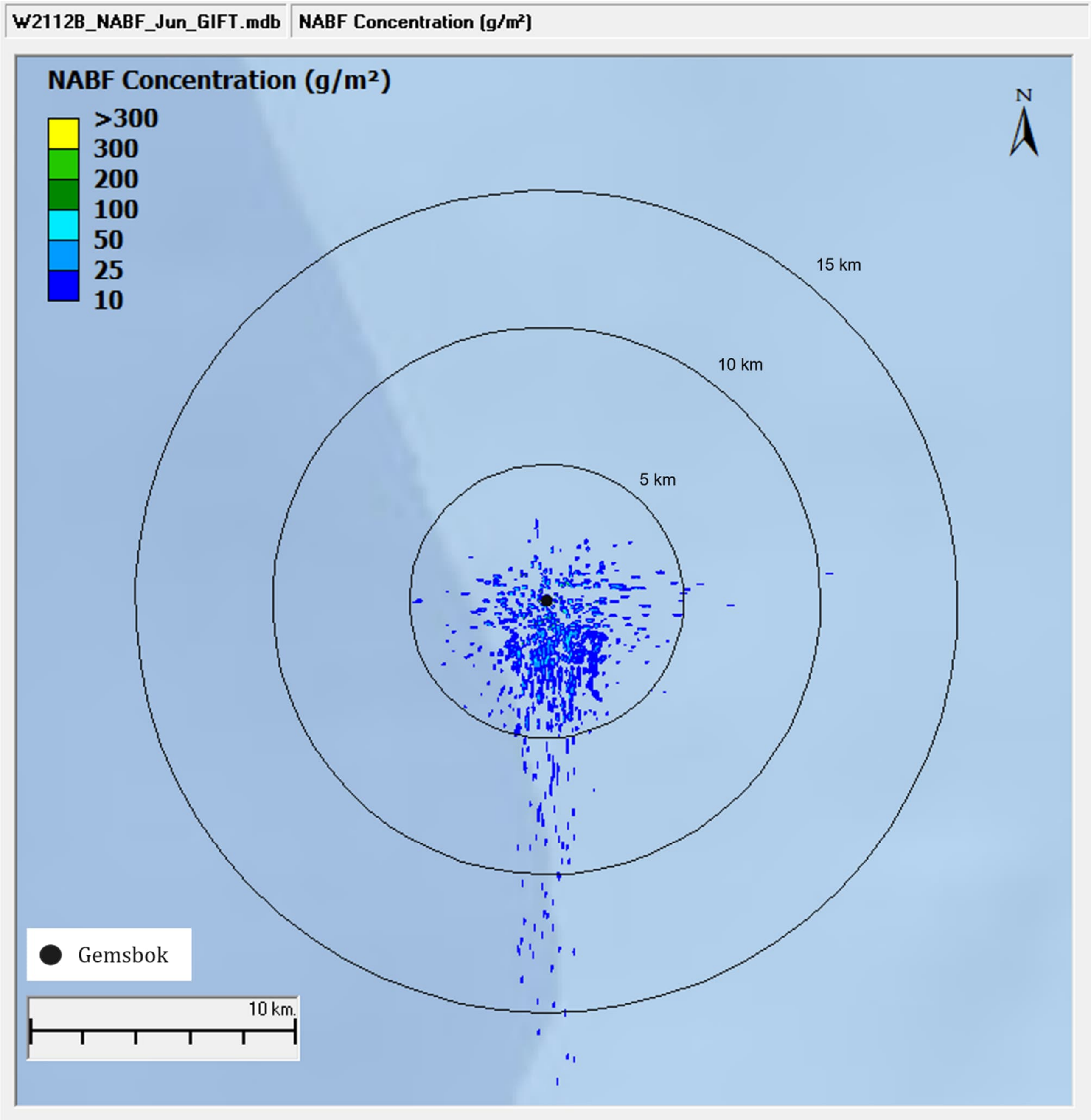


FIGURE 3-19 MAXIMUM NABF HYDROCARBON MASS ON SEABED IN SEPTEMBER FOR GEMSBOK WELL (BLOCK 2112B)

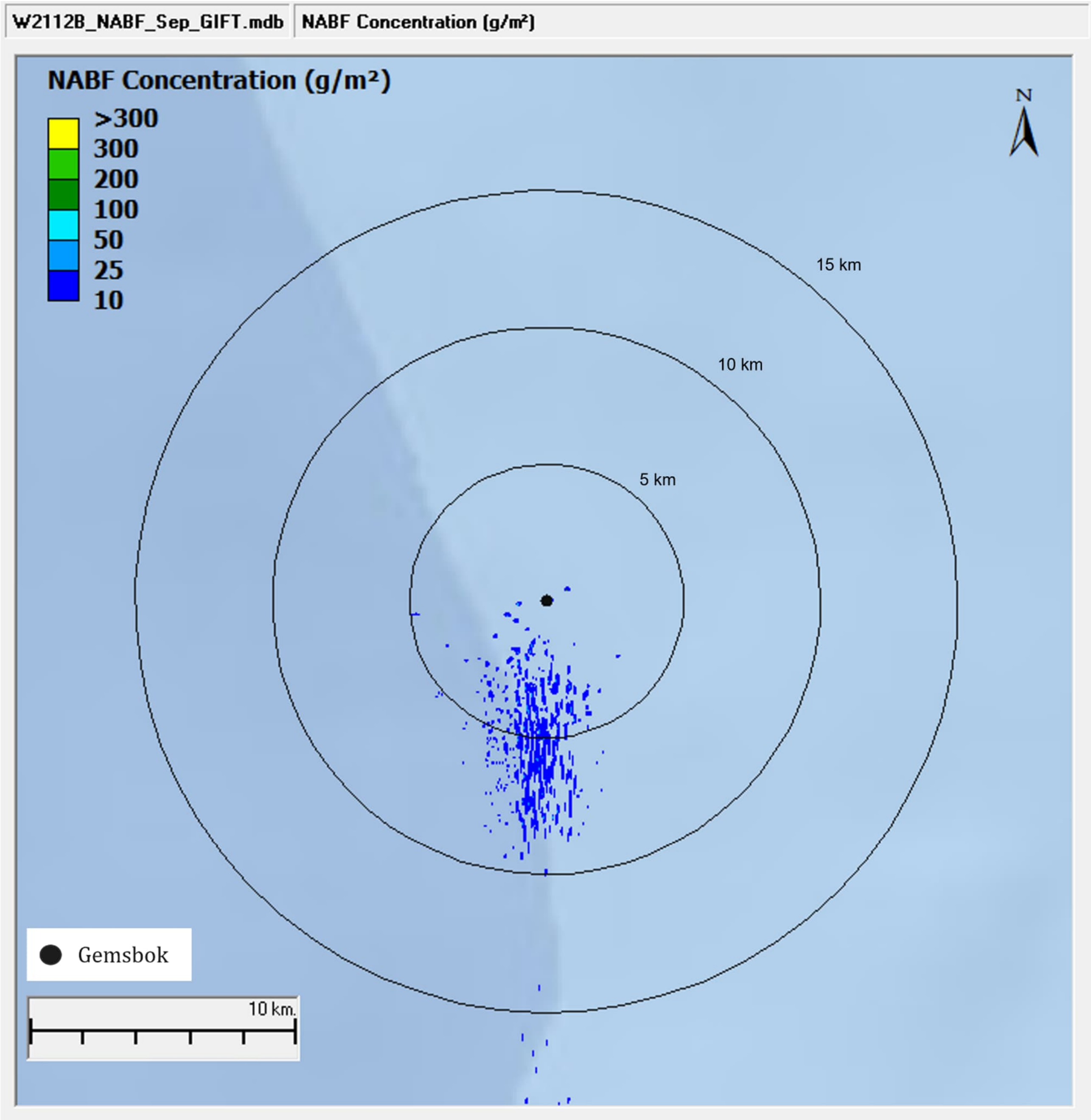
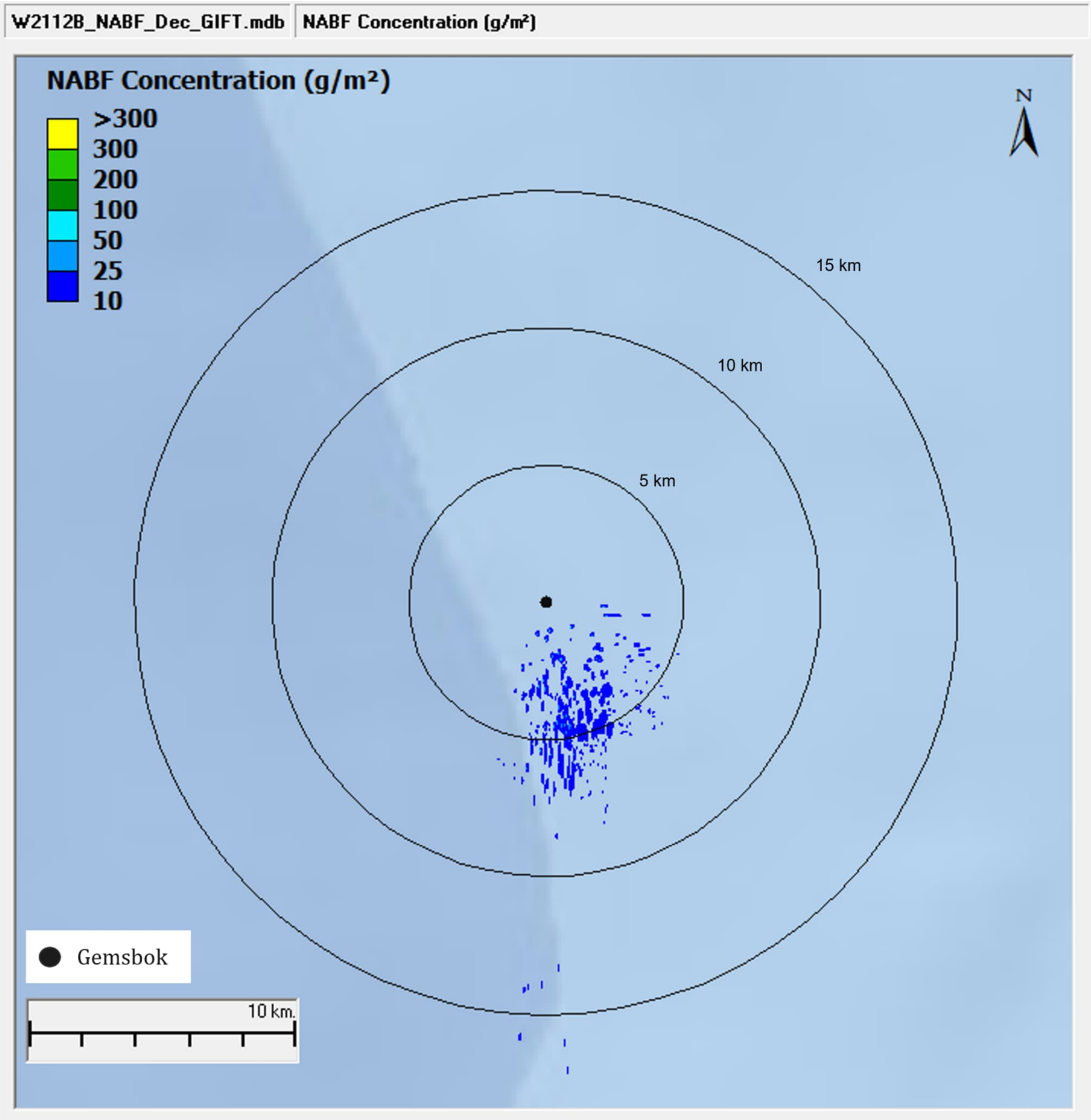


FIGURE 3-20 MAXIMUM NABF HYDROCARBON MASS ON SEABED IN DECEMBER FOR GEMSBOK WELL (BLOCK 2112B)



3.3.2 NABF HYDROCARBON MASS FROM POTENTIAL SECOND WELL LOCATION (BLOCK 2212A) DURING MARCH, JUNE, SEPTEMBER, AND DECEMBER

Figure 3-21, Figure 3-22, Figure 3-23, and Figure 3-24 show the accumulated hydrocarbons on the seabed at the end of the 21-day simulation period for the potential second well location in Block 2212A. The area where deposited hydrocarbon concentration exceeds 10 g/m^2 during March, June, September, and December scenarios for the potential second well location in Block 2212A are 5.128 km², 7.201 km², 2.965 km², and 2.943 km² respectively.

FIGURE 3-21 MAXIMUM NABF HYDROCARBON MASS ON SEABED IN MARCH FOR POTENTIAL SECOND WELL LOCATION (BLOCK 2212A)

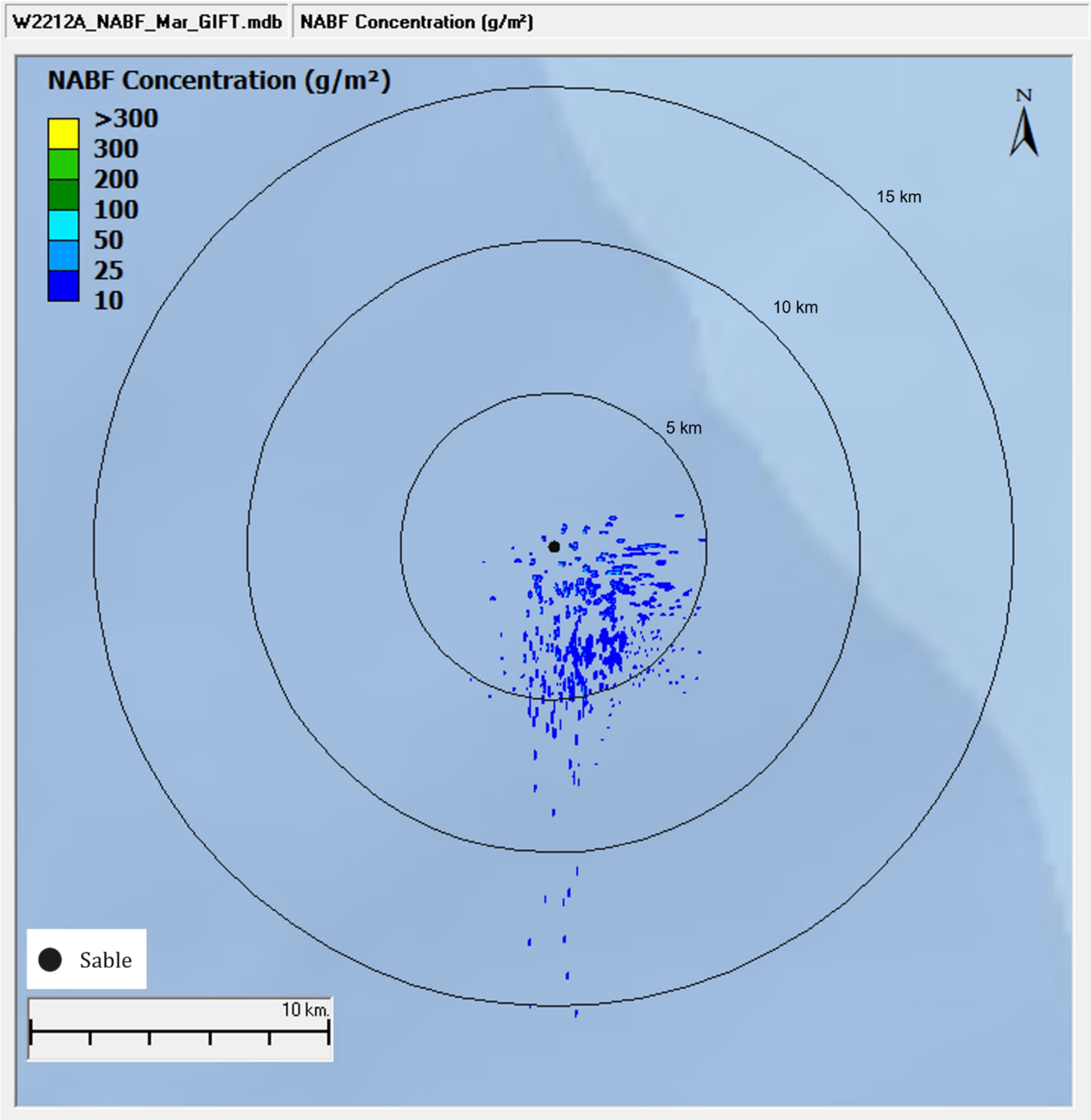


FIGURE 3-22 MAXIMUM NABF HYDROCARBON MASS ON SEABED IN JUNE FOR POTENTIAL SECOND WELL LOCATION (BLOCK 2212A)

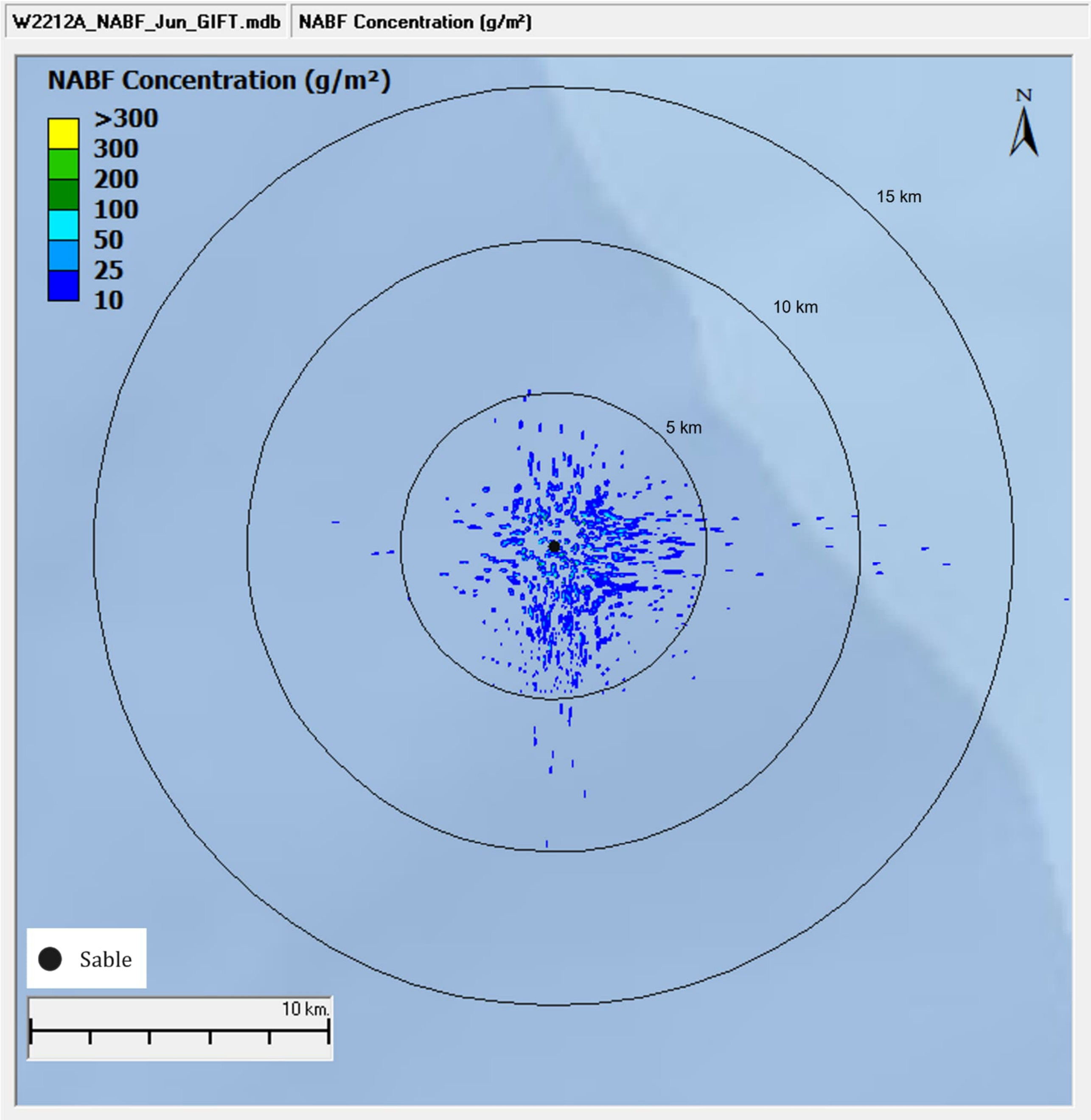


FIGURE 3-23 MAXIMUM NABF HYDROCARBON MASS ON SEABED IN SEPTEMBER FOR POTENTIAL SECOND WELL LOCATION (BLOCK 2212A)

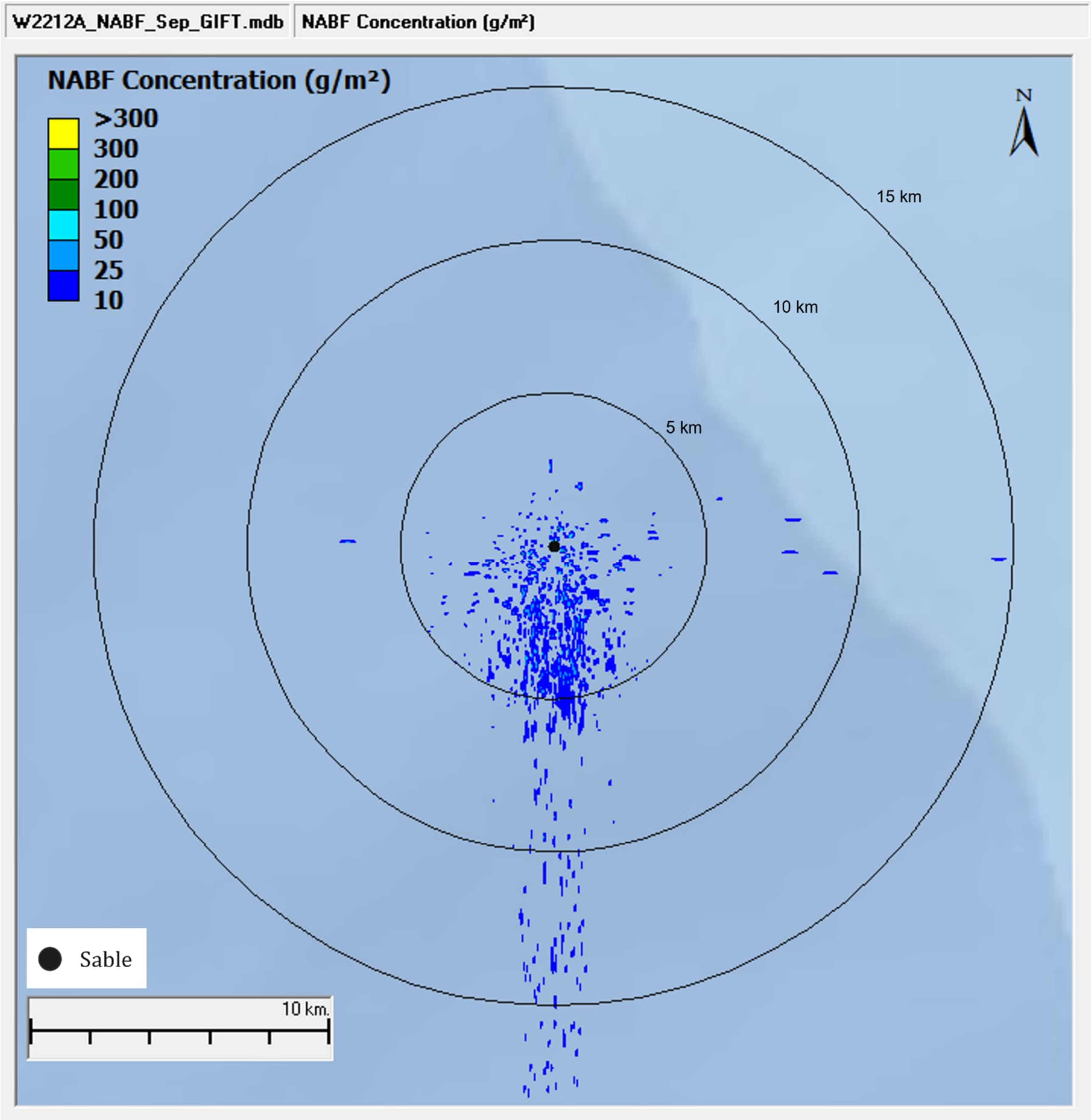
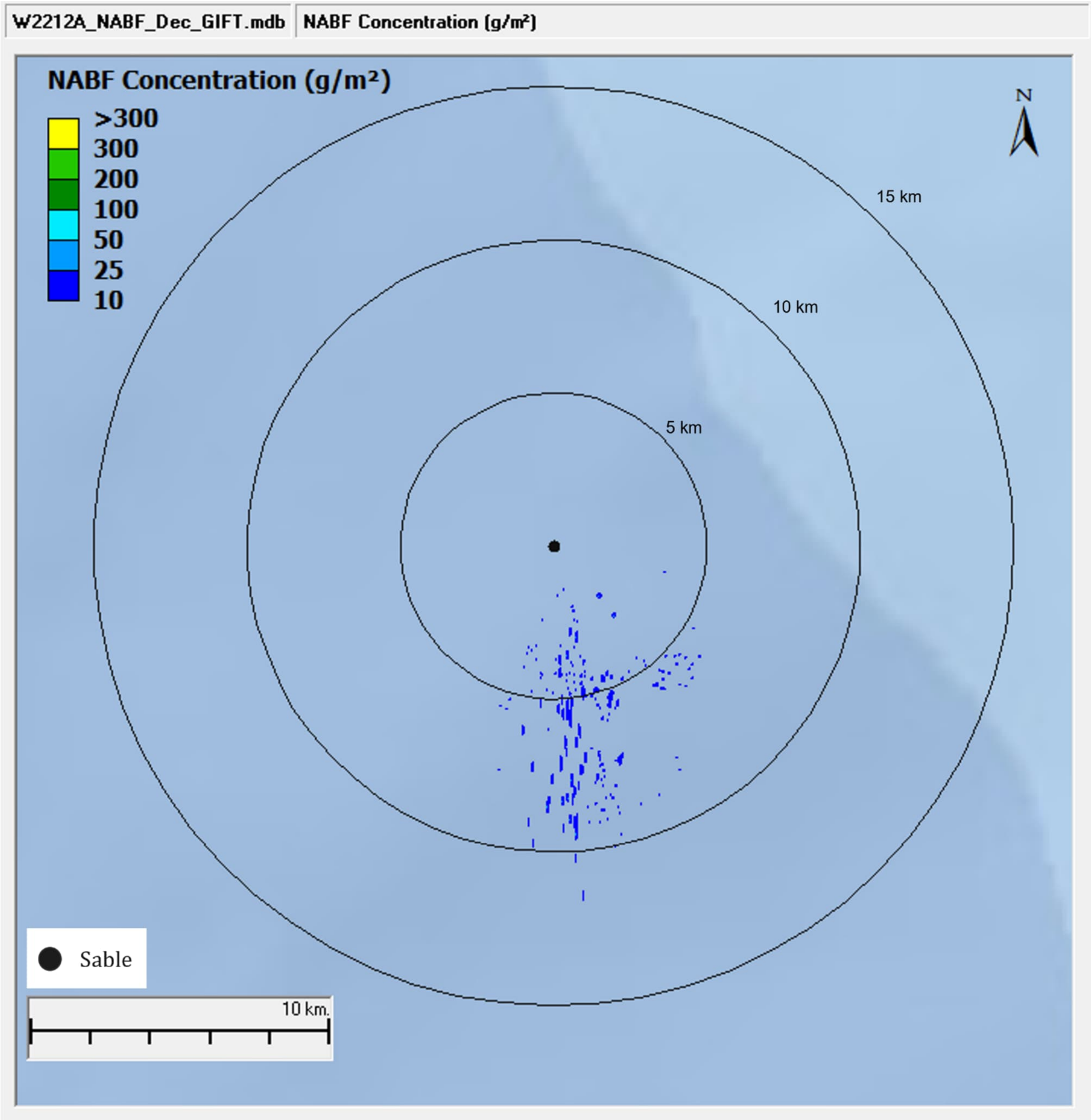


FIGURE 3-24 MAXIMUM NABF HYDROCARBON MASS ON SEABED IN DECEMBER FOR POTENTIAL SECOND WELL LOCATION (BLOCK 2212A)



3.3.3 SUMMARY

The total accumulated hydrocarbon concentration on the seabed was examined for the release of cuttings and muds using deterministic simulations of particle deposition. Table 3-3 summarizes the areas exceeding 10 g/m^2 (this is not a value related to any environmental threshold) for each scenario.

TABLE 3-3 SUMMARY OF NABF CONCENTRATION RESULTS FOR GEMSBOK WELL AND POTENTIAL SECOND WELL LOCATION IN BLOCK 2212A

Well	Month	Area (km^2) with NABF Concentration > 10 g/m^2
Gemsbok Well (in Block 2112B)	March	3.950
	June	6.860
	September	5.560
	December	0.619
Potential second well location (in Block 2212A)	March	5.128
	June	7.201
	September	2.965
	December	2.943

Source: ERM

4. CONCLUSIONS

The key findings from the dispersion and deposition modelling for the two wells (the Gemsbok Well and the potential second well location in Block 2212A) include:

- Suspended Solids – TSS concentrations exceeded the 35 mg/L threshold criterion near the seabed for both wells. However, the TSS concentration near the water surface did not exceed the 35 mg/L threshold during any of the four scenarios for either well location. The areas where TSS exceeds the 35 mg/L threshold for Gemsbok Well (in Block 2112B) are smaller compared to the respective areas for the potential second well location (in Block 2212A) in their respective scenarios.
- Depositional Thickness - The depositional thickness due to the discharge of drilling related discharges from both wells exceed both 6.3 mm and 5 cm threshold values. The area where deposition of cuttings and muds thickness is greater than 6.3 mm remained predominantly within a 50-meter radius of the Gemsbok Well location (except for the June scenario) and a 500-meter radius of the potential second well location in Block 2212A. The areas where depositional thickness exceeds the 6.3 mm and 5 cm thresholds for the Gemsbok Well are smaller compared to the respective areas for the potential second well location in Block 2212A.
- Mass of NABF Deposition - The total accumulated hydrocarbon concentration on the seabed was also examined for the release of cuttings and muds. Locations where hydrocarbon deposition is predicted were identified, but a clear determination of benthic impacts cannot be made at this stage.

5. REFERENCES

Brandsma M G, and Smith JP. 1999. Offshore Operators Committee Mud and Produced Water Discharge Model Report and User Guide Exxon Production Research Company December 1999.

Ellis, D., and C. Heim. 1985. “Submersible Surveys of Benthos near a Turbidity Cloud.” *Marine Pollution Bulletin.* Vol. 16(5), 197-203.

Fichera, M.J., and V.S. Kolluru. 2007. “GEMSS-GIFT: A comprehensive sediment discharge and transport modelling system.” SETAC North America 28th Annual Meeting, 11–15 November.

Fichera, M.J., V.S. Kolluru, C. Buahin, and C. Daviau, and C.A. Reid. 2013. “Comprehensive Modelling Approach for EIA Studies in the Oil and Gas Industry.” IAIA 2013.

GEBCO Compilation Group (2024) GEBCO 2024 Grid (doi:10.5285/1c44ce99-0a0d-5f4f-e063-7086abc0ea0f)

IFC. World Bank Group. 2007. Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities. April, 2007.

IMO. 2006. International Regulations (MARPOL 73/78). “Revised Guidelines on Implementation of Effluent Standards and Performance Tests for Sewage Treatment Plants.” Annex 26. Resolution MEPC.159(55). Adopted on 13 October 2006. MEPC 55/23.

Kolluru, V.S., and M.L. Spaulding. 1993. “SEASHELL—Software for the Simulation of Fate and Transport of pollutants in Coastal Waters.” In proceedings of the 3rd International Conference of Estuarine and Coastal Modelling, Oak Brook, Illinois, 8–10 September.

Kolluru, V.S., E.M. Buchak, and J.E. Edinger. 1998. “Integrated Model to Simulate the Transport and Fate of Mine Tailings in Deep Waters,” in the Proceedings of the Tailings and Mine Waste ’98 Conference, Fort Collins, Colorado, 26–29 January.

Malvern Instruments. Mastersizer 2000 application note. 2007. URL: http://www.malvern.com/common/downloads/campaign/MRK822-01.pdf; Last accessed April 2013.

MarLIN (Marine Life Information Network). 2023. Benchmarks for the Assessment of Sensitivity and Recoverability. The Marine Biological Association of the UK, Citadel Hill, Plymouth, Devon, U.K. Accessed: September 2023. Retrieved from: https://www.marlin.ac.uk/sensitivity/SNCB-benchmarks.

Neff, J.M. 2010. “Fate and Effects of Water Based Drilling Muds and Cuttings in Cold Water Environments.” Report to Shell Exploration and Production Company, Houston, TX. Neff & Associates LLC, Duxbury, MA. May 25, 2010.

OGP. 2003. “Environmental aspects of the use and disposal of non aqueous drilling fluids associated with offshore oil & gas operations.” Report No. 342. May 2003.

Prakash, S., and. V.S. Kolluru. 2014. “Implementation of Integrated Modelling Approach to Impact Assessment Applications for LNG Operations Using 3-D Comprehensive Modelling Framework.” Accepted for presentation at the 8th International Congress on Environmental Modelling and Software 2014.

Sanzone, D.M., J.M. Neff, D. Lewis. 2016. “Environmental Fates and Effects of Ocean Discharge of Drill Cuttings and Associated Drilling Fluids from Offshore Oil and Gas Operations.” International Association of Oil & Gas Producers. Report 543. March 2016.

Smit, M.G.D., J.E. Tamis, R.G. Jak, C.C. Karman, G. Kjeilen-Eilertsen, H. Trannum, and J. Neff. 2006. *Threshold levels and risk functions for non-toxic sediment stressors: burial, grain size changes and hypoxia. Summary.* TNO Built Environment and Geosciences. TNO Report no. 9; 2006-DH-0046/A. Accessed: September 2023. Retrieved from:

https://www.sintef.no/globalassets/project/erms/reports/erms-report-no-9_threshold-non-toxic-stressors_tno.pdf

Smit, M. G.D., K. I.E. Holthaus, H.C. Trannum, J. M. Neff. 2008. “Species Sensitivity Distributions for Suspended Clays, Sediment Burial, and Grain Size Change in the Marine Environment” Environmental Toxicology and Chemistry, Vol. 27, No. 4, pp. 1006–1012, 2008

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OIL SPILL MODEL REPORT

OIL SPILL MODELING FOR CHEVRON NAMIBIA

Draft Report | 100-WTR-T44620 | August 2025 | Version 2

Oil Spill Modeling Study
PEL 82 / Block 2112B & PEL 82 / Block 2212A
Chevron Namibia
Draft V2
August 7, 2025

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EXECUTIVE SUMMARY

Chevron Namibia Exploration Limited II (CNEL) contracted RPS Ocean Science, a Tetra Tech company, (“ROS”) to assess the trajectory and fate of hypothetical hydrocarbon spill events from three locations, Gemsbok, Potential Second Well, and Shallow Well, within the PEL 82 exploration license area, Block 2112B and Block 2212A, offshore Namibia This document presents the results of the oil fate and trajectory analysis.

This Executive Summary will provide an overview of the methods and the main findings from the oil spill modeling. This report is organized into three main sections and four Appendices following this Executive Summary.

1. **Introduction** – This section provides information on the study area, scenarios modeled and inputs to the model, including an analysis of the oil properties used.
2. **Oil Spill Modeling Results** – This section presents the oil spill modeling results for this study, including the oil weathering, near-field modeling, and far-field modeling, both stochastic and deterministic.
3. **Conclusions** – This section presents a summary of the modeling and results detailed in this report.
4. **Appendix A – Environmental Conditions and Data Analysis** – This section describes the environmental conditions present in the areas of interest and the data sets used for this study.
5. **Appendix B – OILMAP/SIMAP Oil Spill Modeling System – Description** – This section describes ROS’ Oil Spill Modeling System, OILMAP/SIMAP.
6. **Appendix C – Near-Field Blowout and Far-Field Modeling Descriptions** – This section describes the ROS Oil Spill Modeling Approach for both the near-field and the far-field. It provides details on the methods used in this study.
7. **Appendix D – References** – This section includes the full list of references.

Methods

Oil spill modeling scenarios were simulated using ROS’ OILMAP/SIMAP oil spill modeling system to evaluate the probable spill effects under varying environmental conditions in the near-field and the far-field. Representative “worst-case” events were analyzed to assess the potential impact of a Light Crude Oil release from subsurface blowouts at three sites within the PEL 82 exploration license area, Block 2112B and Block 2212A, on the nearby waters and shorelines. Each scenario was simulated for two seasons: Summer (November – April) and Winter (May – October). The scenarios modeled for this study are outlined in Table 2.

Blowout modeling was performed in two steps: 1) a near-field analysis, describing the vertical transport of the oil/gas plume driven by momentum from the release and the plume’s relative buoyancy, and 2) a far-field analysis, describing the long-term transport and weathering of the released oil mixture that is influenced by the environmental conditions (e.g., currents, winds).

The near-field analysis was conducted using ROS’ OILMAPDeep model to predict where the rising buoyant plume would entrain sufficient seawater to become neutrally buoyant such that the plume would trap in the water column. The OILMAP/SIMAP model was then used for the far-field analysis in stochastic mode to calculate the transport and fate of the oil in the subsurface, on the sea surface, and along the shoreline. This far-field model initialized the oil droplets at the trap depth calculated by the near-field model, and they were then transported by both currents and surface wind drift. Macro-scale factors, such as advection due to winds and currents or interaction with the coastline, were used to compute the overall transport of the oil in response to temporally- and spatially- varying meteorological and oceanographic (metocean) conditions in the study area.

The stochastic model computed surface trajectories for an ensemble of hundreds of individual cases for each spill scenario. This process sampled the variability in the regional and seasonal wind and current forcing by starting the simulation at different dates within the timeframe of interest. An individual trajectory with the largest cumulative surface area oiled was identified from the stochastic results as the representative “worst-case” deterministic model run. The OILMAP/SIMAP model was used in deterministic mode to further analyze the identified worst-case trajectory from each stochastic scenario.

Environmental Conditions Summary

The environmental conditions in the study area of offshore Namibia were analyzed based on the literature and the collected metocean datasets. Some key findings are highlighted below:

- The prevailing winds are primarily from the south-southeast. Wind direction varies depending on proximity to the coastline. Nearshore areas experience winds predominantly from the south to south-southeast, while offshore winds generally originate from the southeast. Wind speeds tend to increase during the Winter Season and decrease during the Summer.
- Annual average HYCOM surface current rose shows the influence of the Benguela Current along the Namibian coast.
- At Shallow Well, the wind-driven drift plays a more significant role than ocean currents in transporting oil spills, contributing most to the movement of surface-floating slicks.

General Oil Behavior

Based on the properties of the Light Crude Oil simulated in this study, the weathering model predicted that, once released, the oil evaporated within the first hours of the simulation with potential loss of up to 45.77%. At the lowest wind speeds, the released oil either remained on the surface as a slick (53.65%), evaporated (45.77%), or degraded due to natural/biological processes (0.58%). At the highest wind speeds, 53.96% of the Light Crude Oil entrained into the water column with the remaining oil lost to evaporation (31.36%) or to degradation (8.58%) due to natural/biological processes. Only 6.11% of the oil remained on the surface as a slick.

Results Summary

Based on the stochastic results (Section 2.3), it can be summarized that releases from the PEL 82 exploration license area, Block 2112B and Block 2212A, resulted in no simulations reaching the shoreline, regardless of the season. The stochastic surface footprint was oriented to the northwest of the release location with total hydrocarbons in the water column remaining local to the spill site. Although the scenario volumes were identical, the release depths of the subsurface blowouts ranged from 300 m (Shallow Well) to 1,200 m (Gemsbok). This variation led to different trap heights, which in turn affected the transport of oil both below the surface and at the surface. Due to these differences in the near field, the Shallow Well resulted in slightly larger stochastic surface footprints when compared to the other two release locations. During the Summer Season, the surface oil footprints exceeding 10 g/m^2 were larger compared to the Winter Season.

Representative worst-case trajectories were selected from each stochastic scenario based on the individual trajectory that resulted in the largest cumulative floating oil footprint. The mass balance results for the representative scenarios predicted that, for all scenarios, the largest percentages of oil evaporated (~35-50%), while approximately 13 to 35% of the oil remained on the surface at the end of the simulation, depending on the winds during each specific simulation duration. The trajectories moved mainly northwest and did not reach the shorelines, while the total hydrocarbons in the water column remained concentrated near the release location.

1 INTRODUCTION

1.1 Study Background and Methodology

Chevron Namibia Exploration Limited II (CNEL) contracted RPS Ocean Science, a Tetra Tech company, ("ROS") to assess the trajectory and fate of hypothetical hydrocarbon spill events from three locations, Gemsbok, Potential Second Well, and Shallow Well, within the PEL 82 exploration license area, Block 2112B and Block 2212A, offshore Namibia (Figure 1). Table 1 contains the coordinates of the hypothetical release locations modeled in this study.

This document presents the modeling methodology, model inputs, and the results of the oil spill fate and trajectory modeling. To support the modeling, the environmental conditions in the study area were analyzed based on the literature and the collected and modeled meteorological and oceanographic (metocean) datasets. This analysis is provided in Section 4.1.

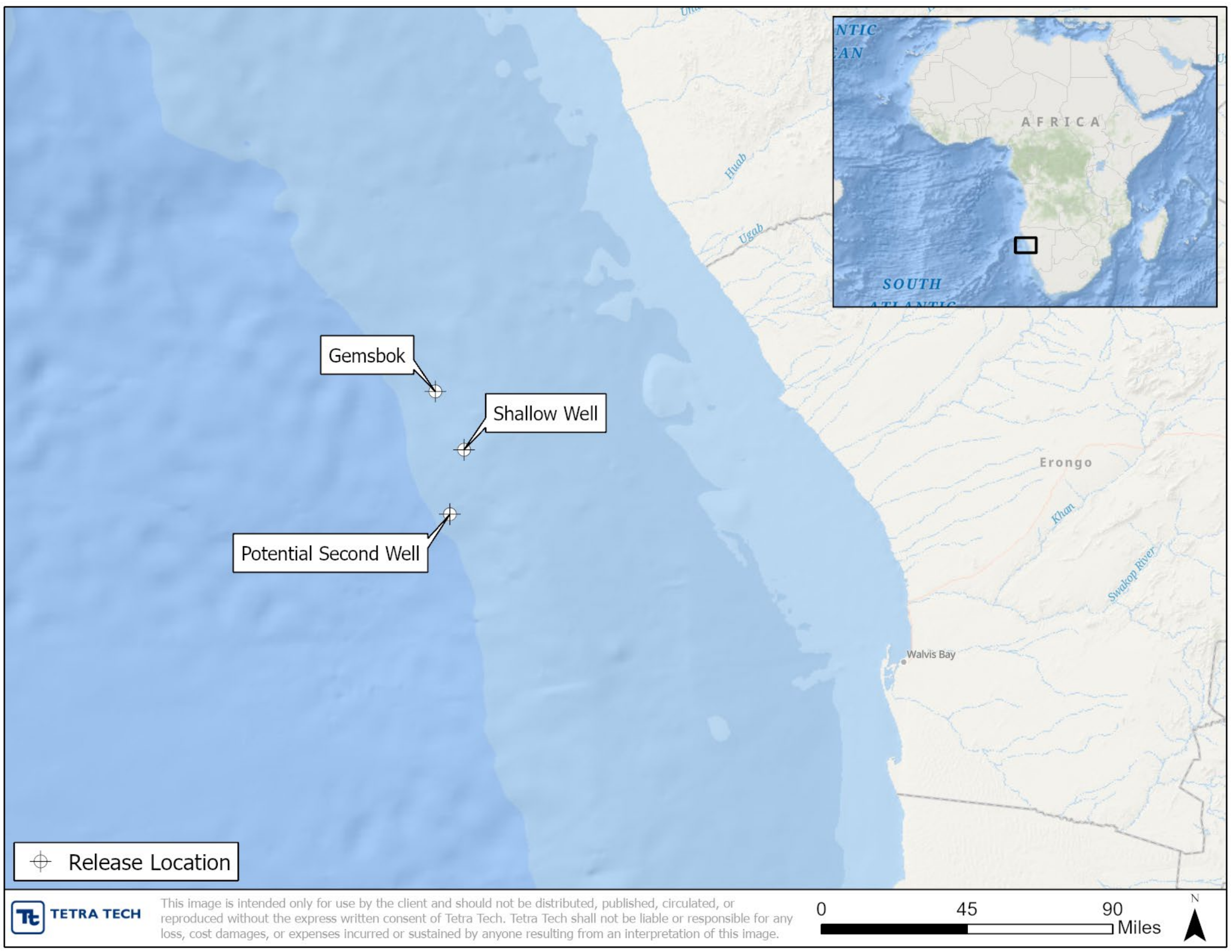


Figure 1. Location of the hypothetical subsurface release sites modeled.

Table 1. Coordinates of the hypothetical subsurface release sites modeled.

Site Name	Block	Latitude (°S)	Longitude (°E)	Water Depth (m)
Gemsbok	PEL 82 / Block 2112B	21.74606	12.41583	1,000
Potential Second Well	PEL 82 / Block 2212A	22.29390	12.48089	1,200
Shallow Well	PEL 82 / Block 2112B	22.00588	12.54335	300

This modeling study simulated six scenarios involving three representative oil spill events to assess the potential impact of a subsurface release on nearby waters and shorelines during two distinct seasonal periods: Summer (November – April) and Winter (May – October) (Table 2). Each scenario assumed a continuous 30-day subsurface blowout releasing 18,668 barrels per day (bbl/day), totaling 560,040 barrels of Light Crude Oil. Each scenario was simulated for 60 days – covering the 30-day release period plus an additional 30 days to monitor the fate and trajectory of the oil after the release was contained.

Table 2. Summary of the oil spill scenarios.

ID	Release Location	Oil Type	Release Type	Season	Release Rate (bbl/day)	Release Duration (days)	Total Spilled Volume (bbl)	Simulation Duration (days)
1	Gemsbok	Light Crude Oil	Subsurface Blowout	Summer	18,668	30	560,040	60
2	Gemsbok	Light Crude Oil	Subsurface Blowout	Winter	18,668	30	560,040	60
3	Potential Second Well	Light Crude Oil	Subsurface Blowout	Summer	18,668	30	560,040	60
4	Potential Second Well	Light Crude Oil	Subsurface Blowout	Winter	18,668	30	560,040	60
5	Shallow Well	Light Crude Oil	Subsurface Blowout	Summer	18,668	30	560,040	60
6	Shallow Well	Light Crude Oil	Subsurface Blowout	Winter	18,668	30	560,040	60

Blowout modeling was performed in two steps: 1) a near-field analysis, describing the vertical transport of the oil/gas plume driven by momentum from the release and the plume's relative buoyancy, and 2) a far-field analysis, describing the long-term transport and weathering of the released oil mixture that is influenced by the environmental conditions (e.g., currents, winds). The near-field model results provide the initial conditions for both the stochastic and deterministic modes of the far-field modeling.

Table 3 summarizes the blowout parameters used in the near-field modeling.

Table 3. Summary of blowout parameters used in the modeling.

Release Location	Water Depth (m)	Gas to Oil Ratio (scf/stb)	Pipe Diameter (inch)	Release Temperature of Oil/Gas Mixture (°C)
Gemsbok	1,000			
Potential Second Well	1,200	1,155	12.25	101
Shallow Well	300			

A probabilistic (i.e., stochastic) analysis was performed to assess the natural variability across environmental conditions that might occur at the time of release. This analysis provided two types of information: 1) the probability footprints of surface oiling, total hydrocarbon concentration (THC) in the water column, and shoreline lengths impacted above specified thresholds, and 2) the minimum time required for oil to reach any location within the areas predicted to be oiled (Section 2.3). To properly sample the variability of wind and current conditions within the 5-year metocean record datasets (2020-2024), up to four trajectories per month were simulated for the stochastic analysis. This corresponds to a total of 240 individual trajectories with 120 trajectories per season. Results of the stochastic analysis are provided in Section 2.3.

Based on the results from the stochastic analysis, one individual (i.e., deterministic) trajectory/fate simulation was selected as a "worst-case" spill event and was analyzed in further detail. The worst-case scenarios were selected based on the simulation that resulted in the largest cumulative surface area oiled, as there was no shoreline oiling predicted to occur in the stochastic assessment. Characterizations of trajectory and fate associated with each worst-case scenario are provided in Section 2.4 of this report. Additional information on the oil transport and fate model and stochastic modeling approach can be found in Sections 4.2 and 4.3.

1.2 Oil Properties

The movement and behavior of oil spilled in the environment is dependent on chemical and physical properties of the oil and the environmental conditions under which the release occurs. The transport and weathering of oil is affected by its density, viscosity, the chemical composition (e.g. boiling point distribution), and its tendency to form stable or meso-stable water-in-oil emulsions. The Light Crude Oil (API 37.3) used in this assessment has a low initial viscosity, but it does have the potential to form stable emulsions with large amounts of water (Table 4). The Client provided ROS with a portion of the chemical and physical parameters associated with the oil properties. However, more information is required to model this product in SIMAP, and ROS identified a well-characterized proxy oil with similar parameters to define the remaining properties necessary to run the oil spill model. These properties were based on chemical and physical characterizations of numerous oils from the Environmental Technology Centre of Environment Canada.

Table 4. Summary of the oil properties used in the modeling.

Oil Type	API Gravity	Density (g/cm^3 at 25°C)	Viscosity (cP at 25°C)	Interfacial Tension (dyne/cm)	Emulsion Maximum Water Content (%)
Light Crude Oil	37.3	0.832	4.84	24.9	64

Viscosity and surface tension affect the degree of spreading of the oil, which in turn influences the rates of evaporation, dissolution, dispersion, and photo-oxidation. The maximum water content is a laboratory measurement of the tendency of the oil to form emulsions. Oils that form water-in-oil emulsions tend to be more persistent in the marine environment, as they are less likely to be dissolved and/or evaporated. This property increases their potential for reaching the shoreline.

To classify oil products from a weathering point of view, crude oils and hydrocarbon mixtures can be broken down into distillation cuts based on their boiling points. Total hydrocarbon concentrations (THC) in the oil weathering model include both aromatic (soluble) and aliphatic (insoluble) components. In general, the lighter aromatic compounds such as Monocyclic and Polycyclic Aromatic Hydrocarbons (MAHs and PAHs, respectively) tend to rapidly evaporate to the atmosphere unless the product gets mixed into the water column. If oil is released below the water surface or gets entrained before it has weathered and lost the lower molecular weight aromatics to the atmosphere, dissolved MAHs and PAHs can reach concentrations where they can affect water column organisms or bottom communities (French McCay and Payne, 2001).

Residual oil fractions are composed of non-volatile and insoluble compounds that remain in the “weathered whole oil” and can spread on the water surface, become stranded on shorelines, and disperse into the water column as oil droplets. This fraction typically comprises black oil, mousse, and sheen. The percentages of the components of the oils used in this modeling study that fall into each distillation category are presented in Table 5 and Figure 2.

Table 5. Chemical components of the oil product used in the modeling study.

Distillation Cut	Boiling Point (°C)	Chemical Characteristics of Soluble (aromatics) and Insoluble (aliphatic) compounds		Fraction by Weight (including both aromatic and aliphatic compounds)
		Aromatics (MAH and PAH)	Aliphatics	Light Crude Oil
THC - 1	< 180	Volatile and Highly Soluble	Volatile	18.5%
THC - 2	180 – 265	Semi-volatile and Soluble	Semi-volatile	17.7%
THC - 3	265 – 380	Low Volatility and Slightly Soluble	Low Volatility	17.7%
Residual - 4	> 380	Residual oil fraction (non-volatile and very low solubility)		46.1%
		Total Aromatics (includes both MAH and PAH)		53.9%

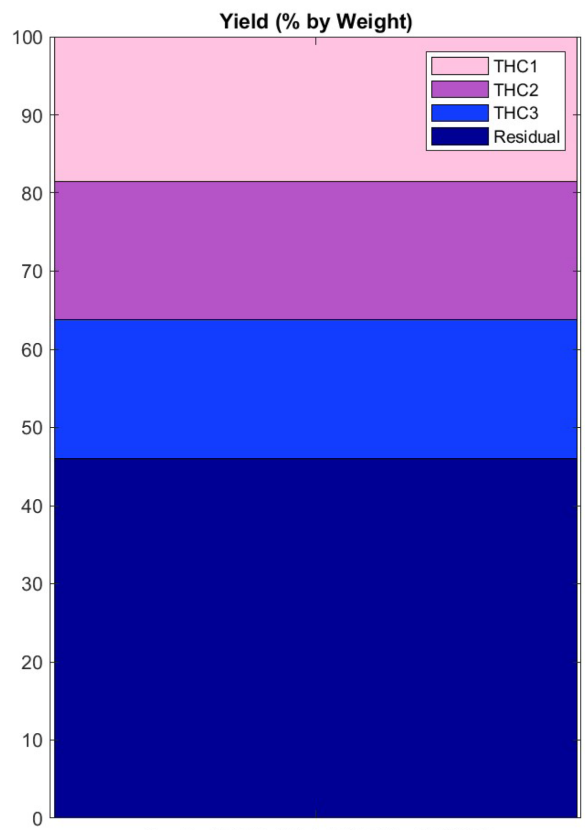


Figure 2. Percent composition by weight of the components of the Light Crude Oil used in the modeling study. The boiling point ranges for different distillation cuts were assumed to be < 180°C for THC1, 180 – 265°C for THC2, 265 – 380°C for THC3, and > 380°C for residuals.

2 OIL SPILL MODELING RESULTS

ROS' proprietary oil spill modeling framework, OILMAP/SIMAP, was used for all simulations performed in this study. The model quantifies the transport and fate of different components of hydrocarbon mixtures through different compartments of the marine environment over time. The modeling system uses a three-dimensional Lagrangian model where each component of the spilled oil (floating, dispersed in the water column, shoreline, etc.) is represented by an ensemble of independent mathematical particles or "spillets". Each spillet comprises a subset of the total mass of hydrocarbons spilled and is transported by both currents and surface wind drift. Additional information on the modeling system and its validation is contained in Section 4.2. This section describes the modeling results for the weathering tests and the subsurface blowout scenarios (near-field and far-field). Descriptions of near-field blowout modeling and far-field modeling, including the purpose and methodology of conducting both stochastic and deterministic simulations, are provided in Section 4.3.

2.1 Oil Weathering Results

To understand how the Light Crude Oil weathers once it is released into the marine environment, several test cases were simulated assuming different representative environmental conditions expected in the area of interest. Basic release scenarios using the Light Crude Oil were simulated for 10 days under three steady wind conditions (5th, 50th, and 95th percentile wind speed), assuming annual average water temperature (17°C).

Table 6. Oil weathering tests: model-predicted mass balance summary at the end of the simulation, for each different wind speed.

Oil Type	Wind Speed Percentile	Surface (%)	Evaporated (%)	Water Column (%)	Degraded (%)
Light Crude Oil	5th (2.43 m/s)	53.65	45.77	0.00	0.58
	50th (7.32 m/s)	27.32	39.62	30.52	2.54
	95th (11.32 m/s)	6.11	31.36	53.96	8.57

2.43 m/s (5% winds)

7.32 m/s (50% winds)

11.32 m/s (95% winds)

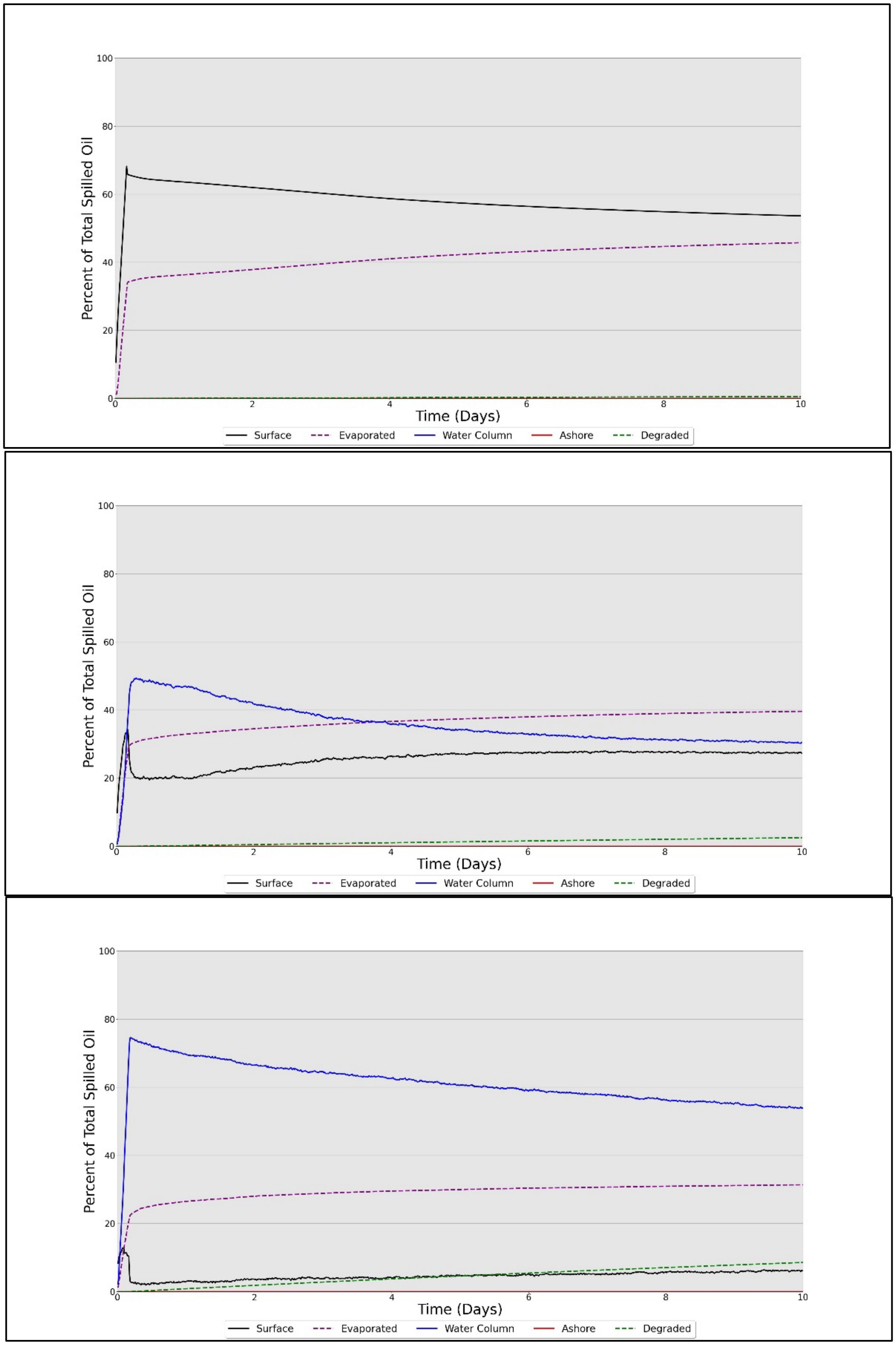


Figure 3. Light Crude Oil weathering test cases – Predicted 10-day mass balances assuming 3 different wind speeds: 5th (Top: 2.43 m/s), 50th (Middle: 7.32 m/s), and 95th (Bottom: 11.32 m/s) percentile.

Based upon the above-described results, the following conclusions can be highlighted:

- Most of the volatile components of the oil evaporated within the first hours of the simulation, with the least evaporation occurring with the 95th percentile winds and the highest occurring at the 5th percentile winds.
- The amount of Light Crude Oil entrained in the water column was also sensitive to the wind speed, with higher wind speeds leading to more entrainment. This increased entrainment decreased the amount of oil on the surface available to evaporate.
- Lower wind speeds resulted in more oil remaining on the surface at the end of the simulation. Comparatively, higher wind speeds led to higher entrainment and, therefore, less surface oiling.
- Degradation increased with increasing wind speed due to wind-forced entrainment of the oil.

2.2 Near-Field Analysis – Blowout Model Results

Near-field modeling provides two critical pieces of information used to initialize the far-field modeling: (1) the height at which the plume becomes neutrally buoyant (i.e., the trap height) or reaches the water surface; and (2) characterization of the oil droplet size distribution generated by the blowout. Before the plume reaches its trap height or surfaces, the transport is driven by the momentum induced by the blowout conditions (e.g., flow rate, orifice opening, gas to oil ratio (GOR)) and buoyant forces (e.g., density differential between ambient seawater and the plume). Once the plume traps or reaches the surface, the plumes fate and transport are then simulated using the far-field model.

The predicted droplet size distribution influences the fate and transport of oil as the droplet size dictates how long an oil droplet will remain suspended in the water column and the rate of dissolution. Large droplets will reach the surface faster, potentially generating a floating oil slick that will drift away from the source due to surface winds and currents. Small droplets will remain in the water column longer, increasing the potential for dissolution and biodegradation, and be subjected to subsurface advection-diffusion transport. As the oil is transported by subsurface currents away from the well site, natural dispersion of the oil droplets quickly reduces component concentrations in the water column, with decreasing concentrations at increasing distances away from the well site. However, lower rise velocities of the oil particles correspond to longer residence times of oil suspended in the water column and may increase the potential for larger volumes of affected water and longer durations of exposure of aquatic organisms to whole oil droplets and dissolved components.

From a response perspective, a turbulent blowout that results in the formation of very small oil droplets acts as a natural dispersant mechanism, as these smaller size particles effectively keep the oil from surfacing. On the other hand, with large particle sizes from a less turbulent blowout, the oil will surface quickly, which will limit the subsurface area exposed to oil but result in a larger surface oil slick and higher concentrations of volatile organic compounds at the surface. Further detail of near-field blowout modeling and the expected behavior of a blowout release in the subsurface environment is provided in Section 4.3.

The particle size distribution predicted by the Li et al. (2017) model, is primarily influenced by the exit velocity of the discharged mixture of oil and gas which is an indicator of the energy associated with the release (i.e., the destructive forces). The exit velocity is influenced by the orifice opening size, the flow rate of oil, and the gas to oil ratio of the release. Additionally, the physical properties of the oil effect the droplet size distribution. For example, the interfacial tension between oil and seawater and the viscosity of the oil also influences the predicted distribution as these properties control the resistance of oil to droplet break apart during a turbulent release.

The near-field model was initialized at the mudline for each release location, corresponding to water depths of 1,000 m for Gemsbok, 1,200 m for Potential Second Well, and 300 m for Shallow Well. The plume became neutrally buoyant at trap depths of 765 m, 978 m, and 66 m below the surface for Gemsbok, Potential Second Well, and Shallow Well, respectively. The near-field modeling resulted in median droplet sizes of 6,785 µm (6.79 mm) for Gemsbok, 7,163 µm (7.16 mm) for Potential Second Well, and 4,364 µm (4.36 mm) for Shallow Well. Due to these large droplet sizes (>1 mm), the oil in the far-field model surfaced rapidly at each location.

Figure 4 to Figure 6 present the OILMAPDeep modeling results for the specified blowout scenarios, including:

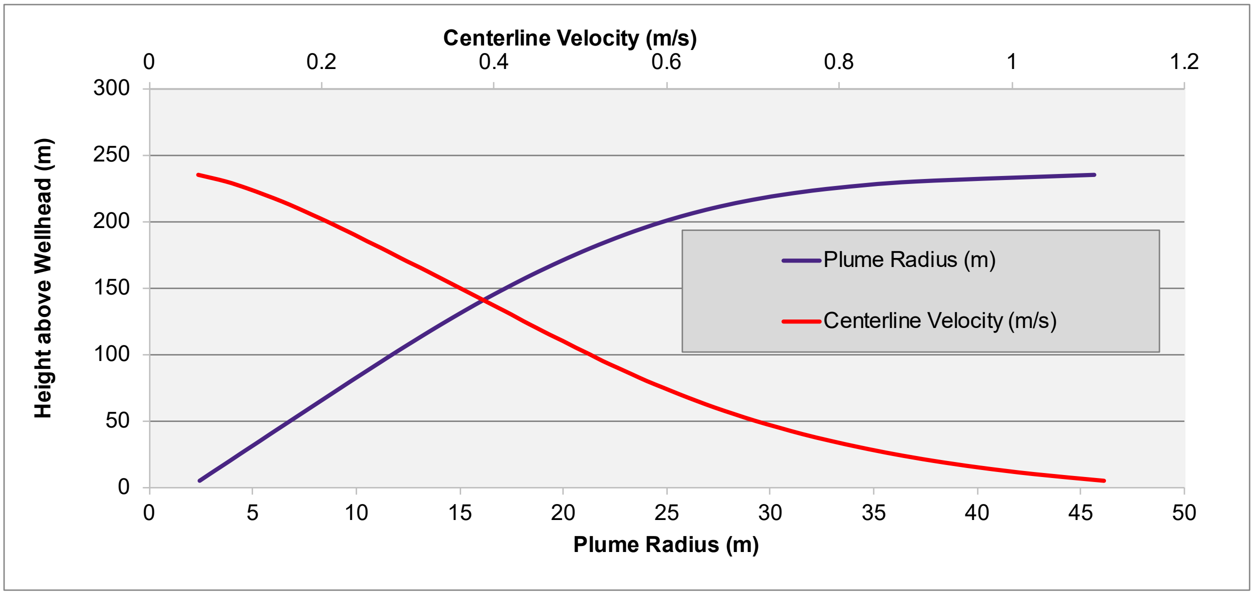
- Top: plume radius plotted as a function of the height above the sea floor (well-head) and plume centerline velocity which describes the vertical speed along the centerline of the plume (mixture of gas, oil, and water).
- Bottom: predicted droplet size distribution and droplet rise times to the surface with respect to diameter.

The figures show that, for annualized blowout events of this sort, as the plume continues to rise and entrain more ambient seawater, the centerline velocity gradually decreases and approaches zero at the trap height. From this trap height, gas and oil droplets will ascend to the water surface under free rise velocities determined by Stokes' law or, depending on their size, remain entrained in the water column. The figures also illustrate the model-estimated droplet size distributions and associated droplet rise times to surface from the trap height for the simulated blowout scenarios. Table 7 summarizes the trap heights, droplet size ranges, and rise times to the surface after the initial release for the modeled blowout scenarios.

Table 7. Nearfield results summary for the modeled blowout scenarios.

Release Location	Trap Depth* (m)	Minimum Oil Droplet D_{min} Size (microns)	Median Oil Droplet D_{50} Size (microns)	Maximum Oil Droplet D_{max} Size (microns)	Maximum Rise Time for Smallest Particles (hours)	Minimum Rise Time for Largest Particles (hours)
Gemsbok Site	765	3,349	6,785	12,073	2.10	0.92
Potential Second Well	978	3,535	7,163	12,070	2.59	1.18
Shallow Well	66	2,154	4,364	9,305	0.25	0.09

*Note these values are measured as the distance below the water surface.



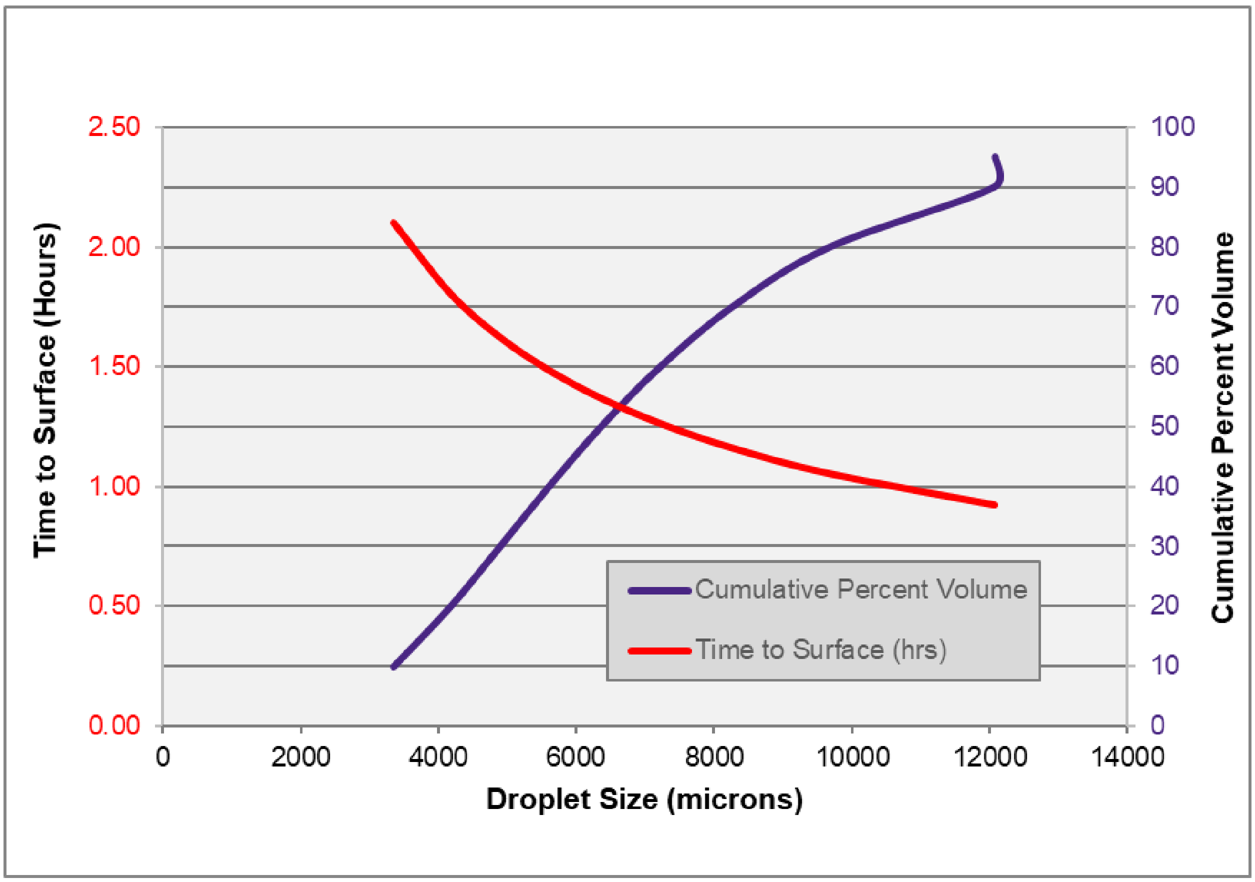
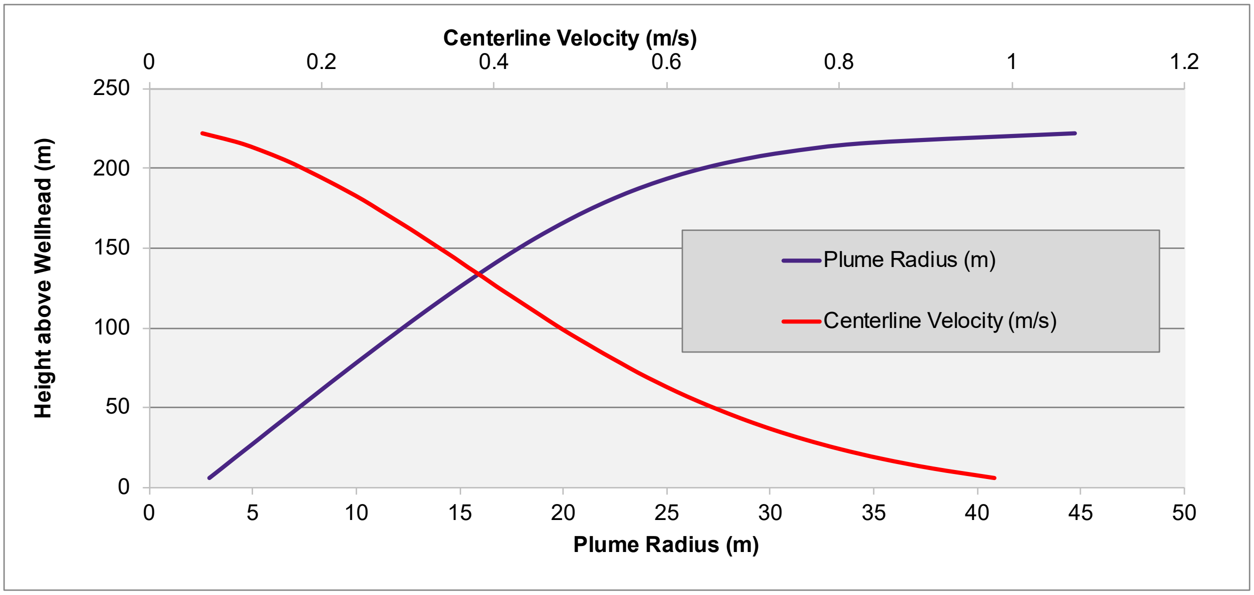


Figure 4. Gemsbok Site Blowout Event – Predicted blowout plume centerline velocity and plume radius versus elevation above wellhead (top) and predicted droplet size distribution and droplet rise times to the surface (bottom).



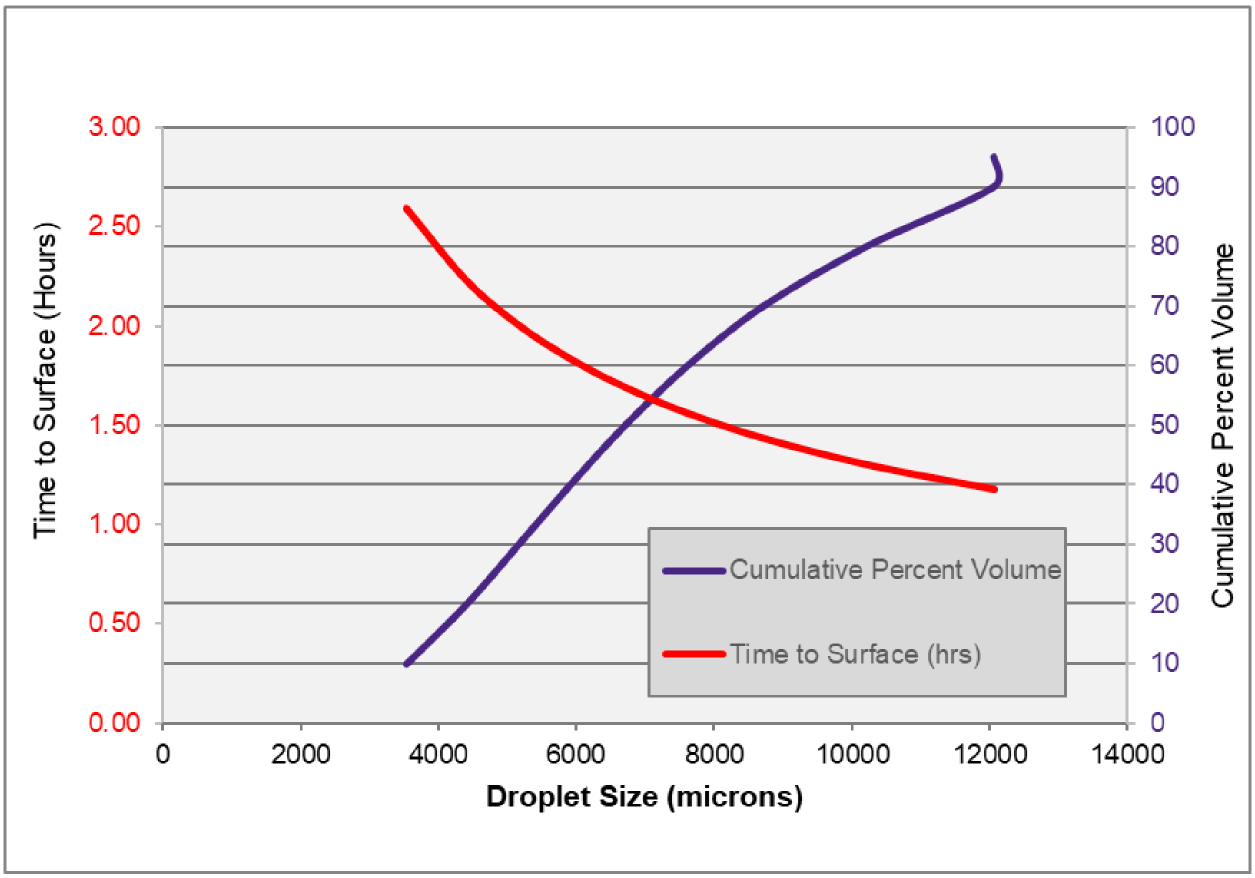
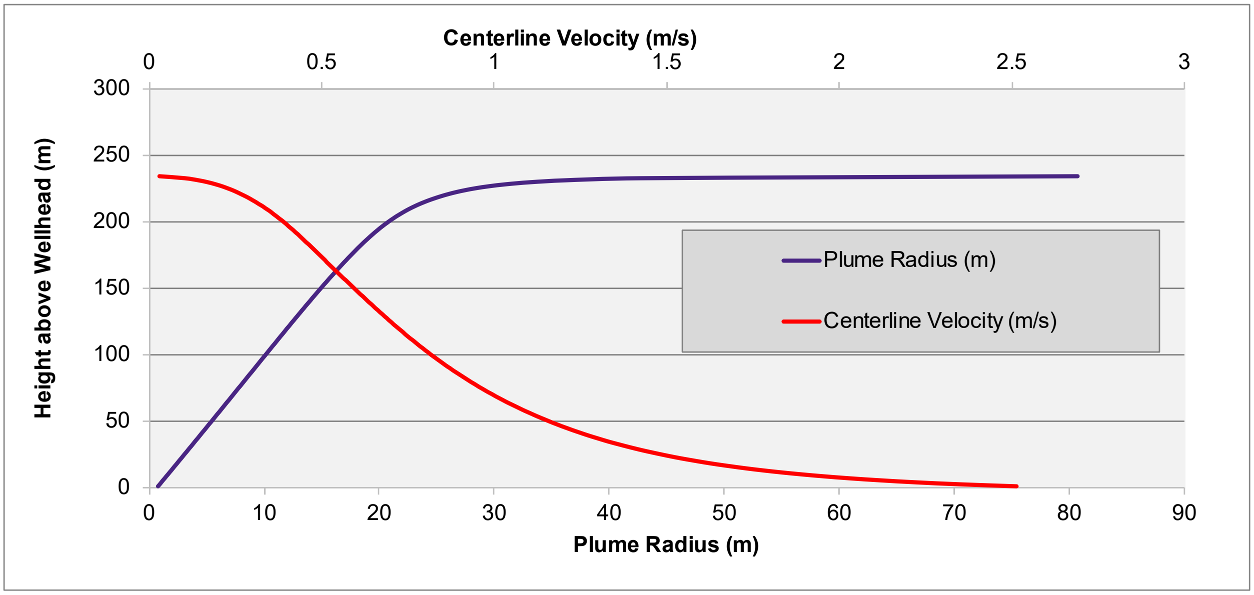


Figure 5. Potential Second Well Blowout Event – Predicted blowout plume centerline velocity and plume radius versus elevation above wellhead (top) and predicted droplet size distribution and droplet rise times to the surface (bottom).



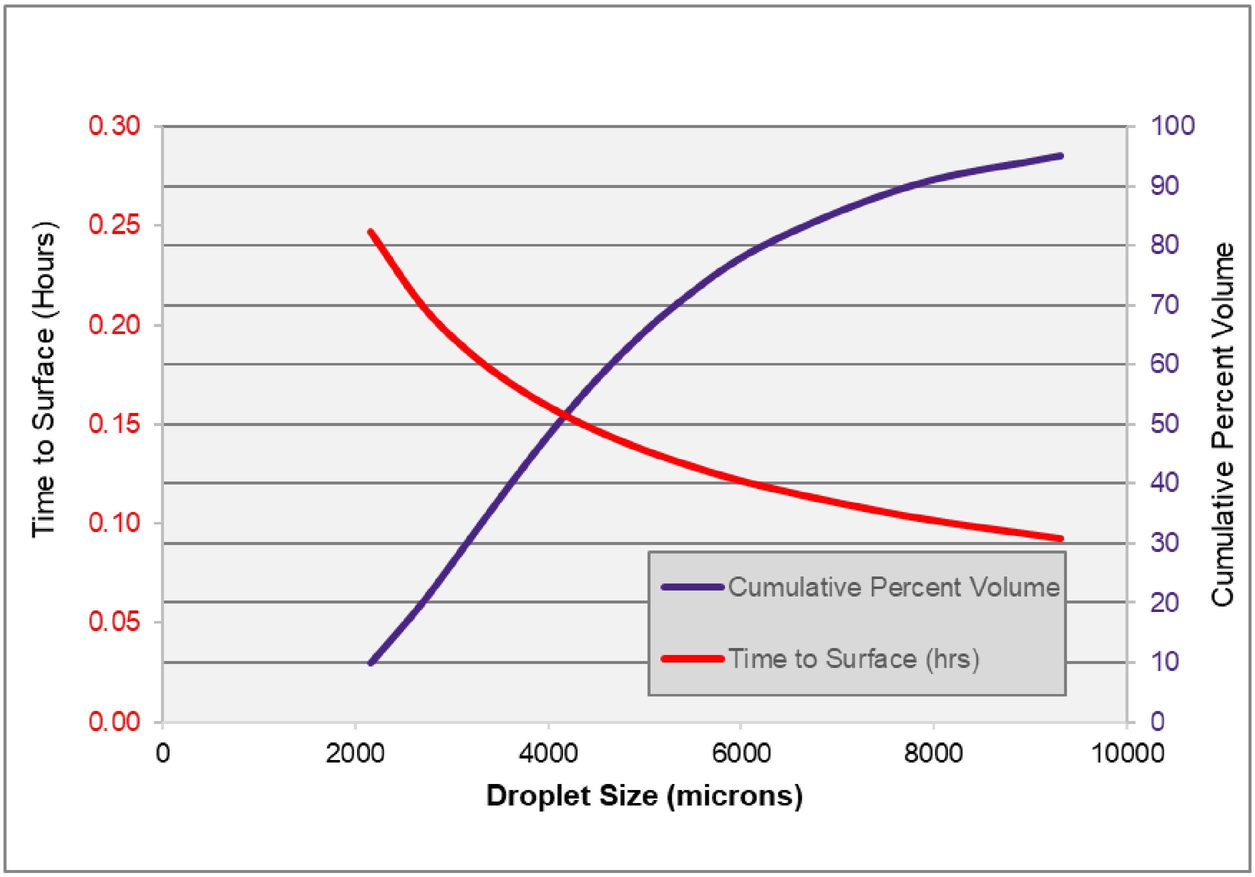


Figure 6. Shallow Well Blowout Event – Predicted blowout plume centerline velocity and plume radius versus elevation above wellhead (top) and predicted droplet size distribution and droplet rise times to the surface (bottom).

2.3 Stochastic Modeling Results

The stochastic result figures below illustrate the spatial extent of surface, shoreline, and water column (THC) oiling probabilities and the associated minimum travel times to reach any point within the probability footprint. To determine the probability or likelihood of potential exposure in a stochastic analysis, specific thresholds for surface, shoreline, and water column oil concentrations were required (Table 8). Above these ecological thresholds, previous studies identified that there is the potential for acute mortality. Results in this section are only presented above the thresholds identified.

Table 8. Thresholds used in the stochastic analysis.

	Surface Oiling	Shoreline Oiling	Water Column Oiling
Threshold	10 g/m^2 (10 µm or 0.01 mm)	10 g/m^2 (10 µm or 0.01 mm)	1,000.0 µg/L (1 ppm or 1 mg/L)
Rationale	Mortality of birds on water has been observed at and above this threshold. Sublethal effects on marine mammals, sea turtles, and floating Sargassum communities are of concern.	This threshold provides a conservative screening threshold for potential sublethal ecological effects on shoreline fauna. Assumed as a sublethal effects threshold for birds on the shoreline.	THC lethal effects levels of 28-300 mg/L (28-300 ppm) were found for a range of crude oils for species from all geographical areas globally (Bejarano et al. 2017). An exposure concentration of 1,000 ppb (1 ppm or 1 mg/L) of measurable TPH was deemed a low level of concern for sensitive life stages in marine organisms by Kraly et al. (2001). In reviews by NRC (2005) and NASEM (2020), 1,000 ppb (1 mg/L) was found to be at the low end of the range where sub-lethal impacts from acute exposure have been observed.
Visual Appearance	Fresh oil at this thickness corresponds to a slick being a dark brown or metallic sheen.	May appear as dark brown coat or opaque/black oil.	N/A
References	French et al., 1996; French McCay, 2009 (based on review of Engelhardt, 1983, Clark, 1984, Geraci and St. Aubin 1988, and Jenssen 1994 on oil effects on aquatic birds and marine mammals); French McCay et al., 2011; French McCay et al., 2012; French McCay, 2016; French McCay et al., 2018, 2022	French et al., 1996; French McCay, 2009; French McCay, 2016	Bejarano et al., 2017; Kraly et al., 2001; NRC, 2005; NASEM, 2020

For each stochastic scenario, two types of figures are presented within the section below (Figure 8 to Figure 25):

1. **Probability of surface, shoreline, and water column oiling**: The map defines the area in which sea surface, shoreline, or water column oiling (THC) may be expected and the associated probability of oiling based on analysis of the resulting trajectories from the ensemble of individual simulations run for each spill scenario. The map does not imply that the entire contoured area would be covered with oil in the event of a spill. The map also does not provide any information on the quantity of oil in a given area.
2. **Minimum travel times:** The footprint on this map corresponds to the probability map and illustrates the shortest time required for oil to reach any point within the footprint. These results are also based on the ensemble of all individual simulations.

It is important to note that the probability of an individual trajectory passing through a certain water surface area and the probability of a spill trajectory hitting a shoreline segment near that water surface area are different. For example, in the schematic in Figure 7, there are a total of four trajectories, which do not overlap near the shore. Thus, the surface oiling probability at a surface water grid cell near the shore (yellow cell) is 25%, since only 1 out of 4 trajectories crosses that grid cell. However, the probability of shoreline oiling within the green bracketed segment near the yellow surface water cell is 75%, since 3 out of 4 trajectories intercept that particular shoreline segment. Where 2 of the 4 trajectories do overlap within a surface water grid cell, the probability of oiling is 50% (purple cell).

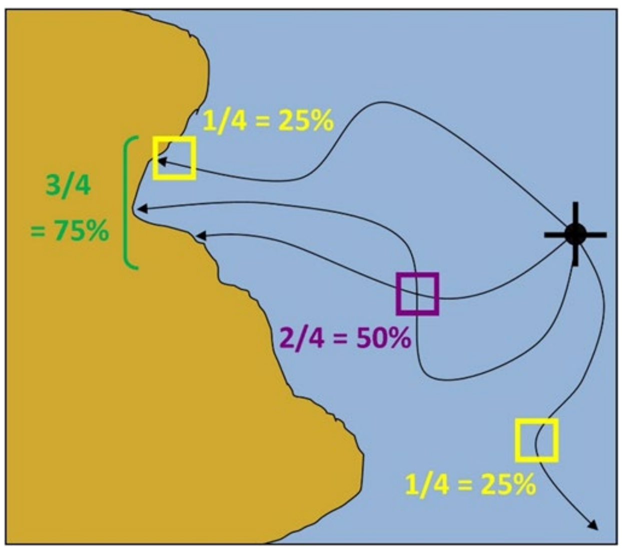


Figure 7. Illustration of the difference between surface and shoreline oiling probabilities. Surface probabilities in yellow and purple, shoreline probabilities in green.

Based on the stochastic analyses outlined, the following conclusions can be highlighted:

- For all scenarios, the surface oiling footprints exceeding the 10 g/m^2 threshold were oriented to the northwest of the release locations due to the dominant currents transporting oil offshore.
- For all scenarios, the surface oiling footprints were larger in the Summer than the Winter, with the Summer footprints extending approximately 1,500 km to the northwest.
- There was no shoreline oiling exceeding the 10 g/m^2 threshold predicted for any stochastic scenario.
- The water column oiling exceeding the 1,000 ppb threshold remained within 10 km of each release location for all scenarios.

2.3.1 Gemsbok Site

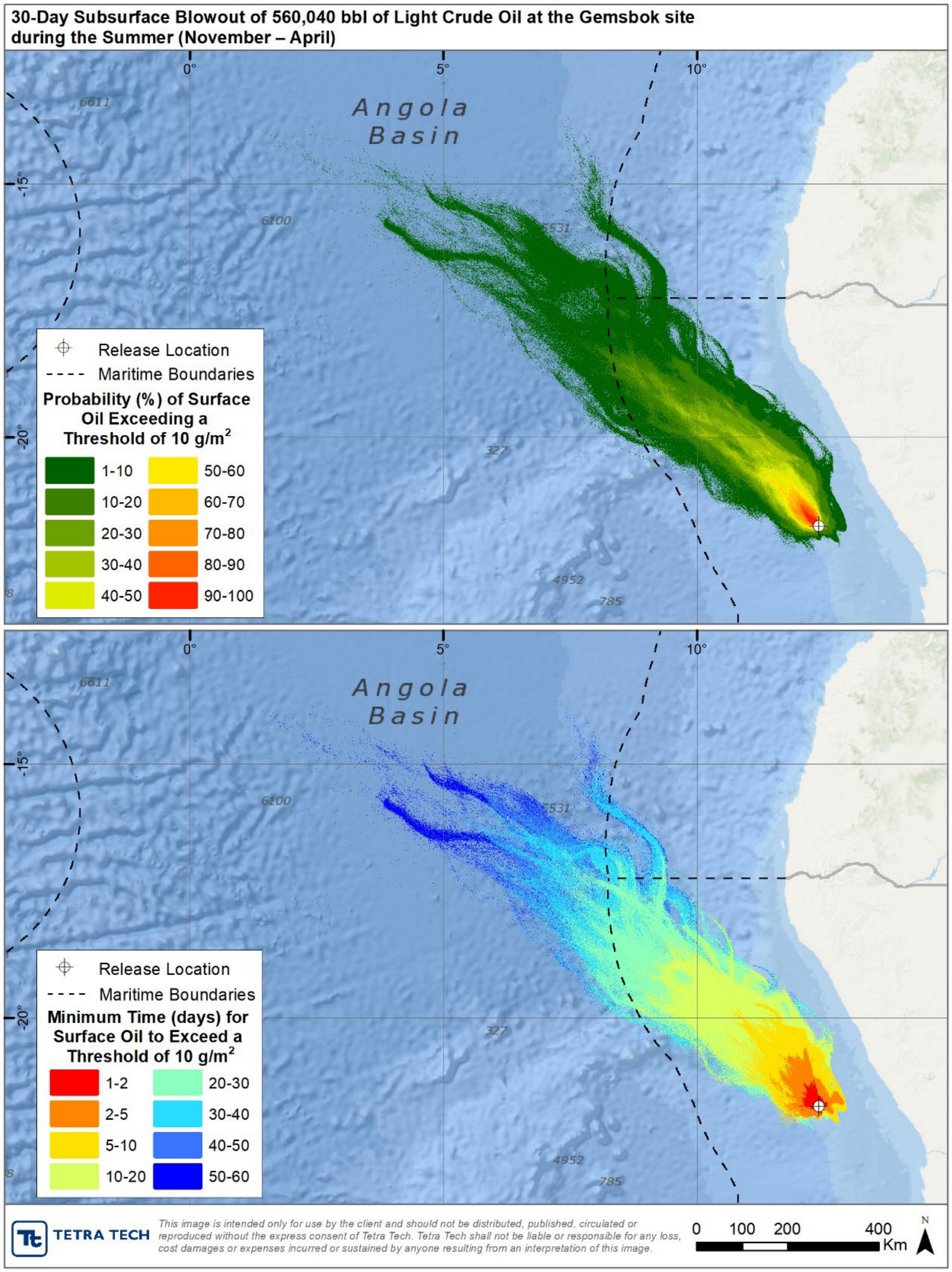


Figure 8. Surface oiling probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Summer (November – April) at the Gemsbok Site using a surface oil thickness threshold of 10 g/m² (0.01 mm).

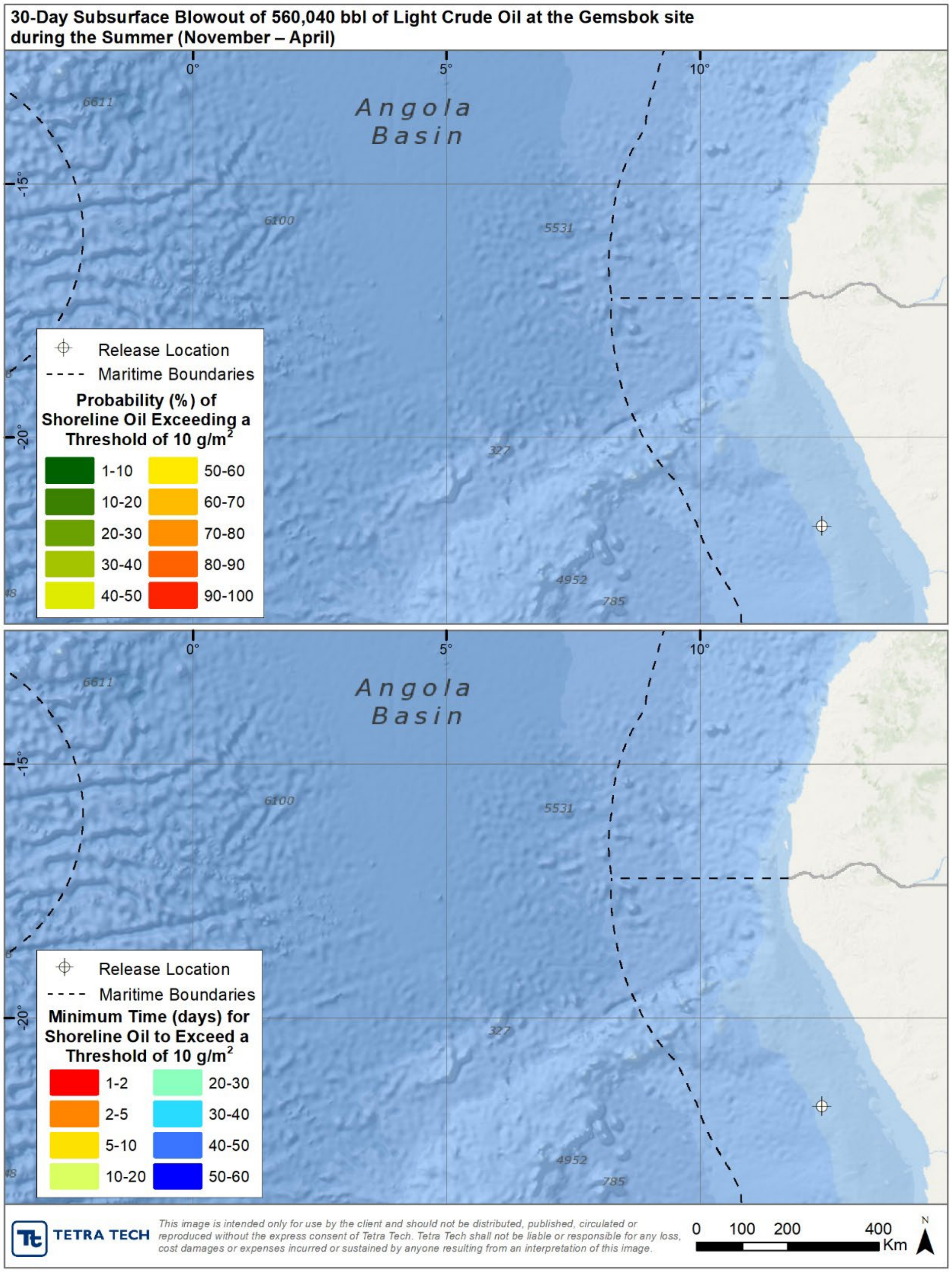


Figure 9. Shoreline oiling probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Summer (November – April) at the Gemsbok Site using a shoreline oil thickness threshold of 10 g/m² (0.01 mm).

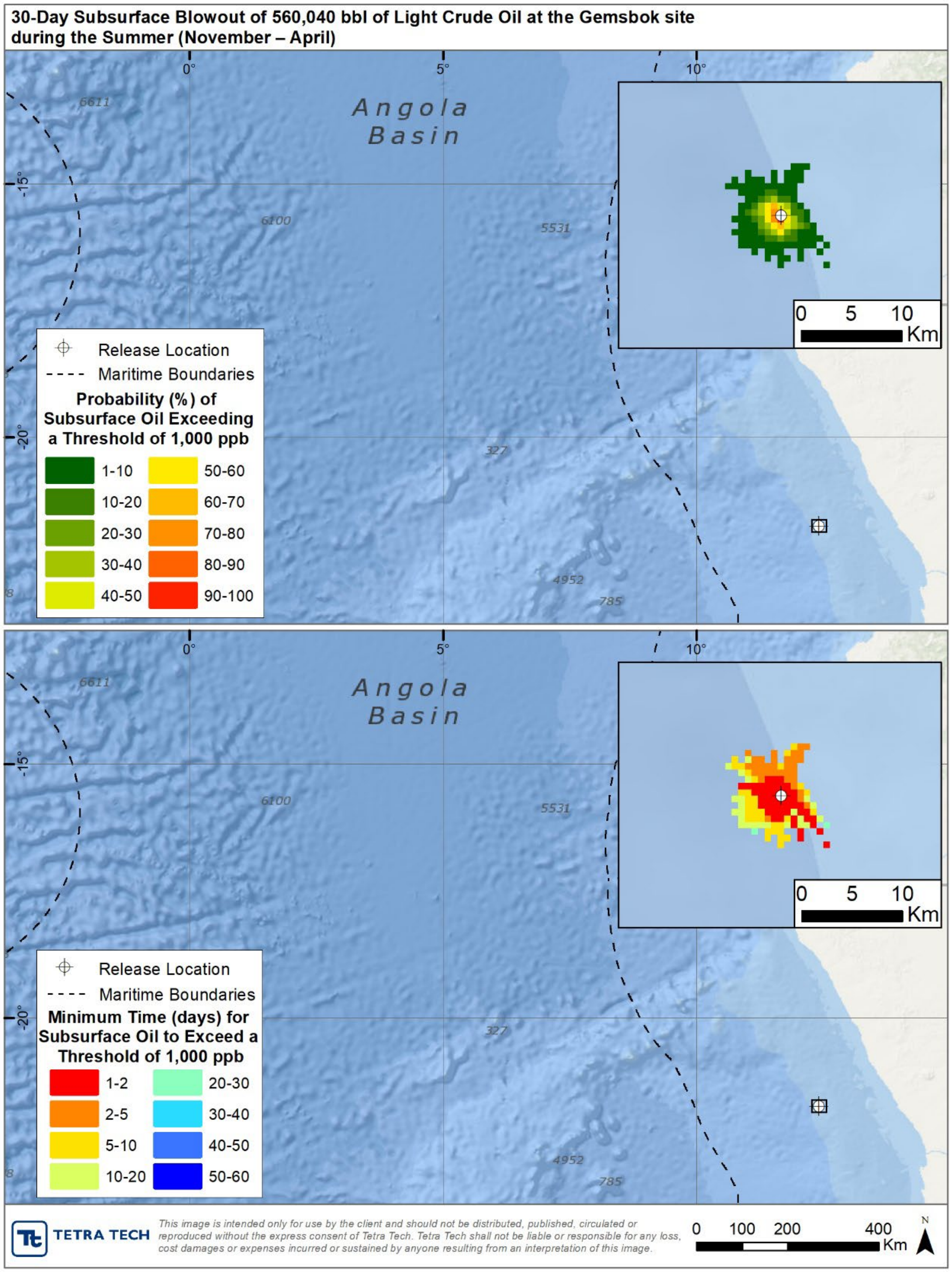


Figure 10. Water column oiling (THC) probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Summer (November – April) at the Gemsbok Site using a water column oil threshold of 1,000 ppb (1,000 µg/L).

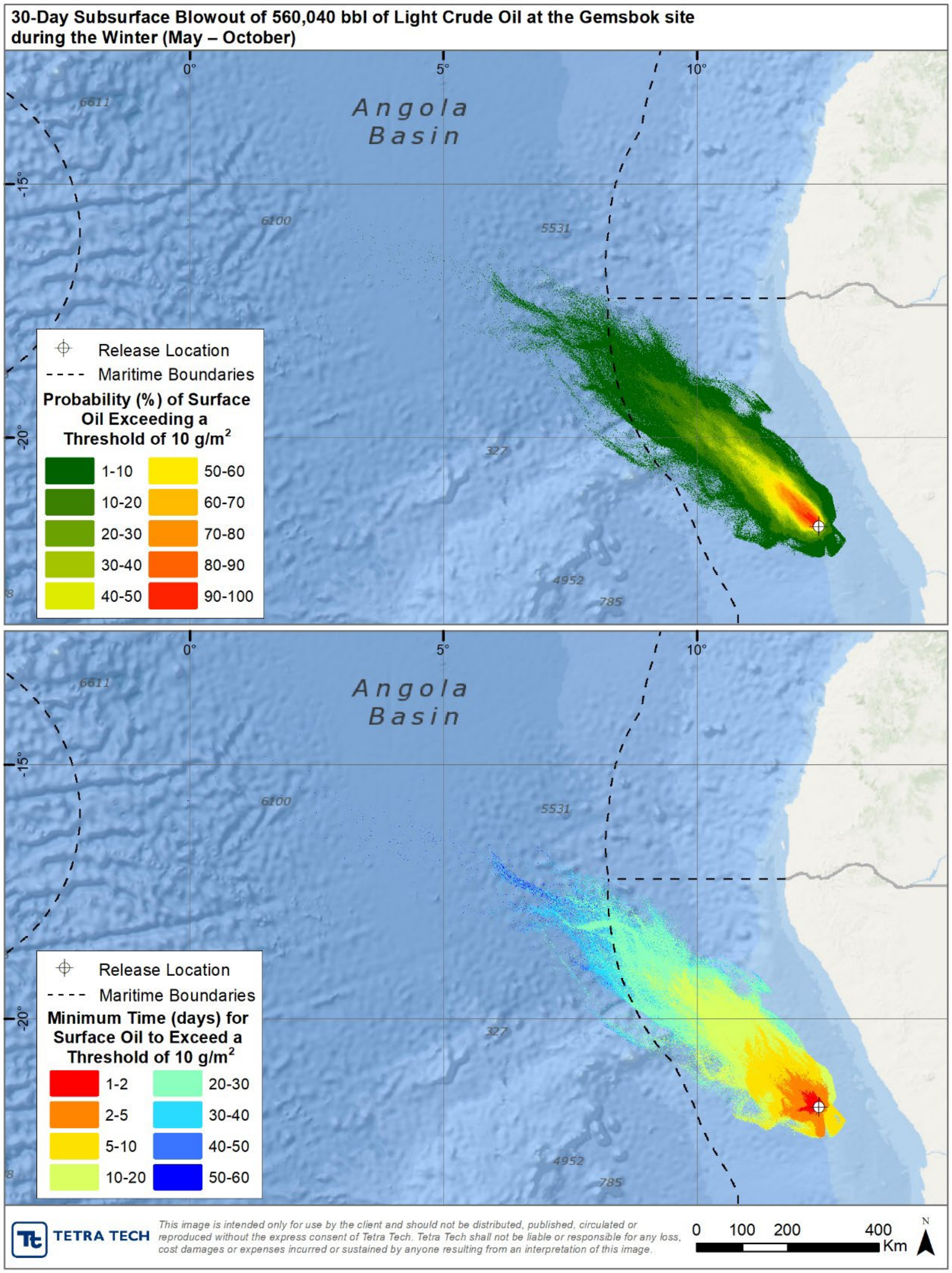


Figure 11. Surface oiling probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Winter (May – October) at the Gemsbok Site using a surface oil thickness threshold of 10 g/m² (0.01 mm).

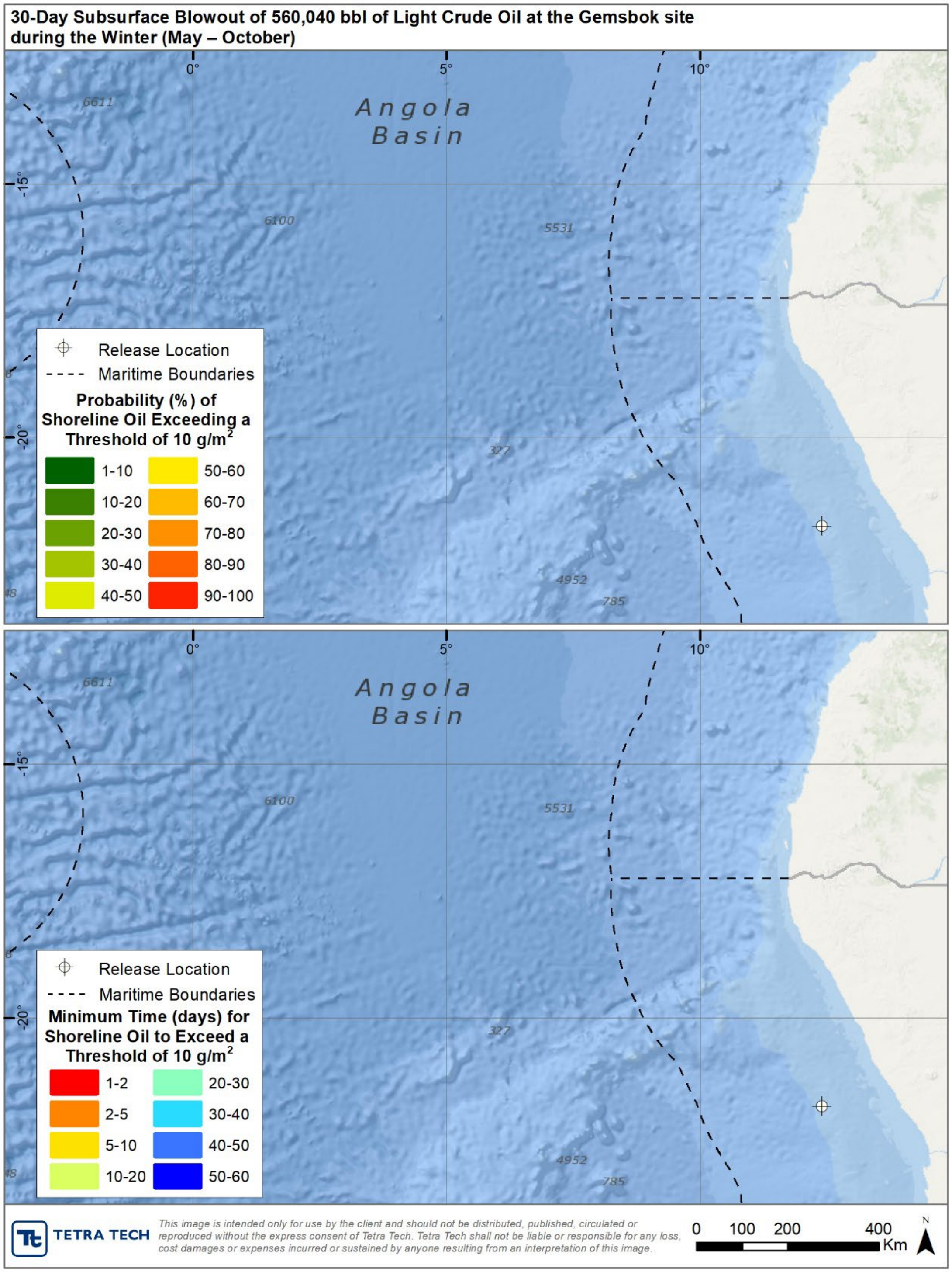


Figure 12. Shoreline oiling probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Winter (May – October) at the Gemsbok Site using a shoreline oil thickness threshold of 10 g/m² (0.01 mm).

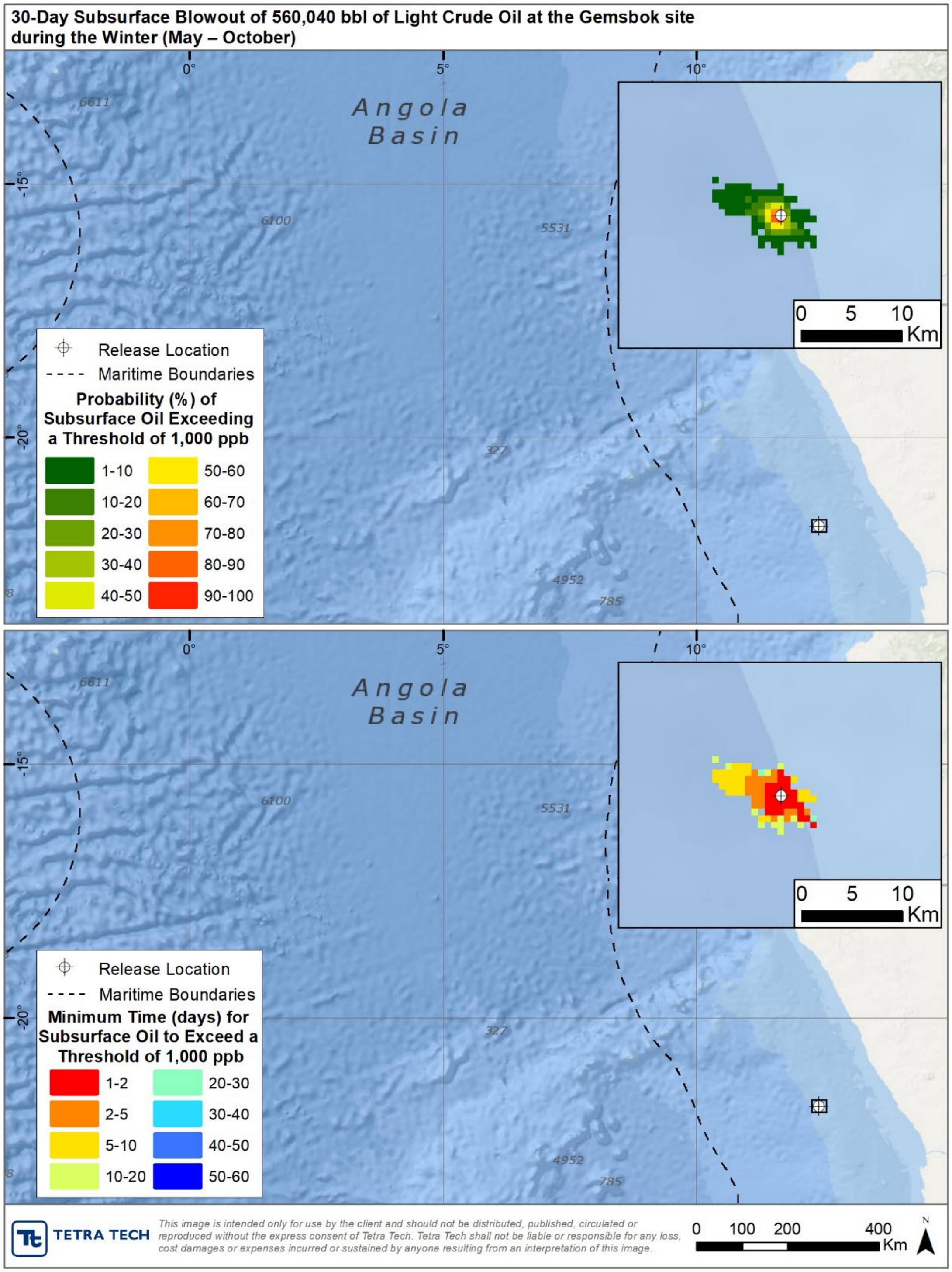


Figure 13. Water column oiling (THC) probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Winter (May – October) at the Gemsbok Site using a water column oil threshold of 1,000 ppb (1,000 µg/L).

2.3.2 Potential Second Well

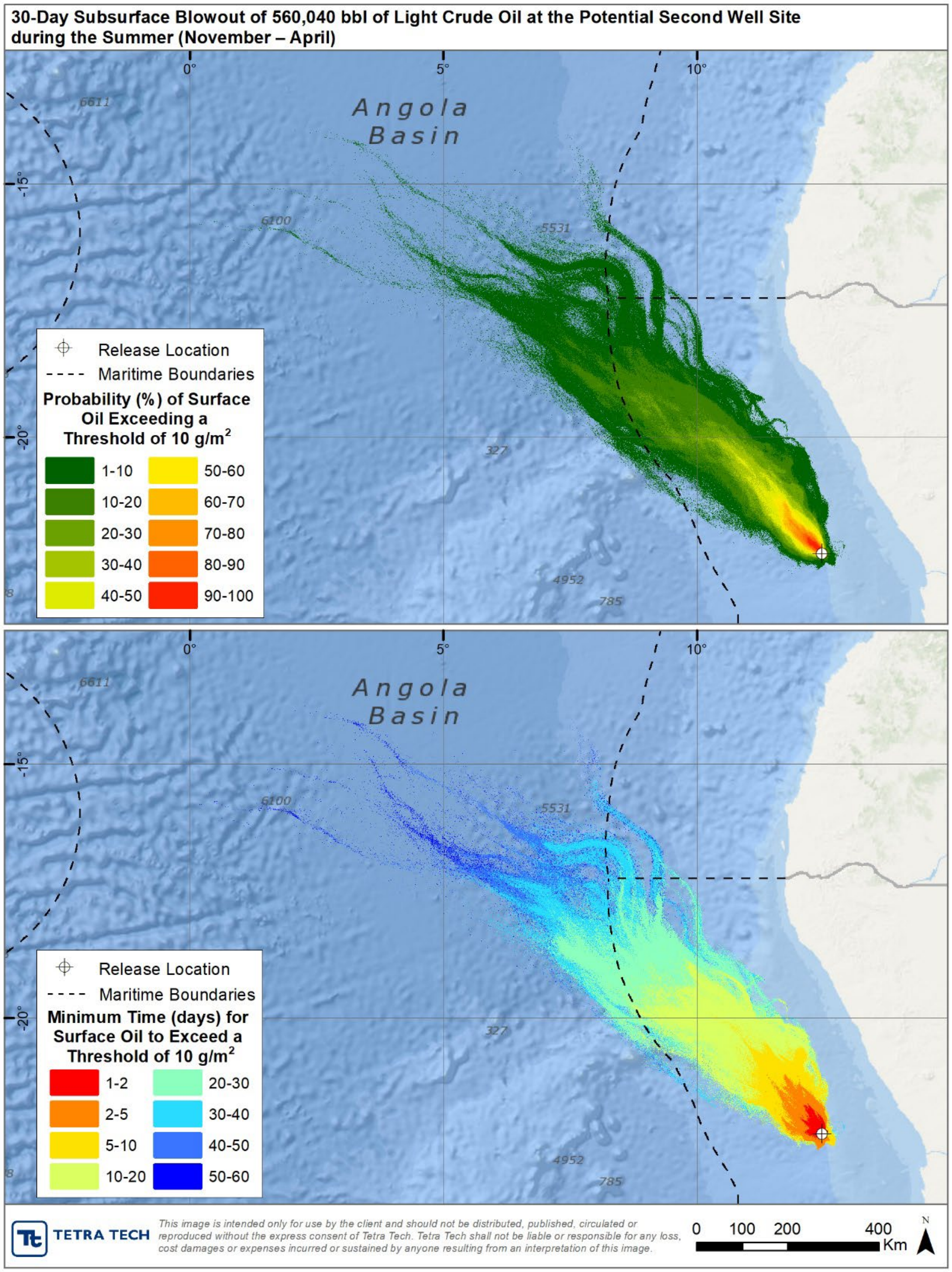


Figure 14. Surface oiling probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Summer (November – April) at the Potential Second Well using a surface oil thickness threshold of 10 g/m² (0.01 mm).

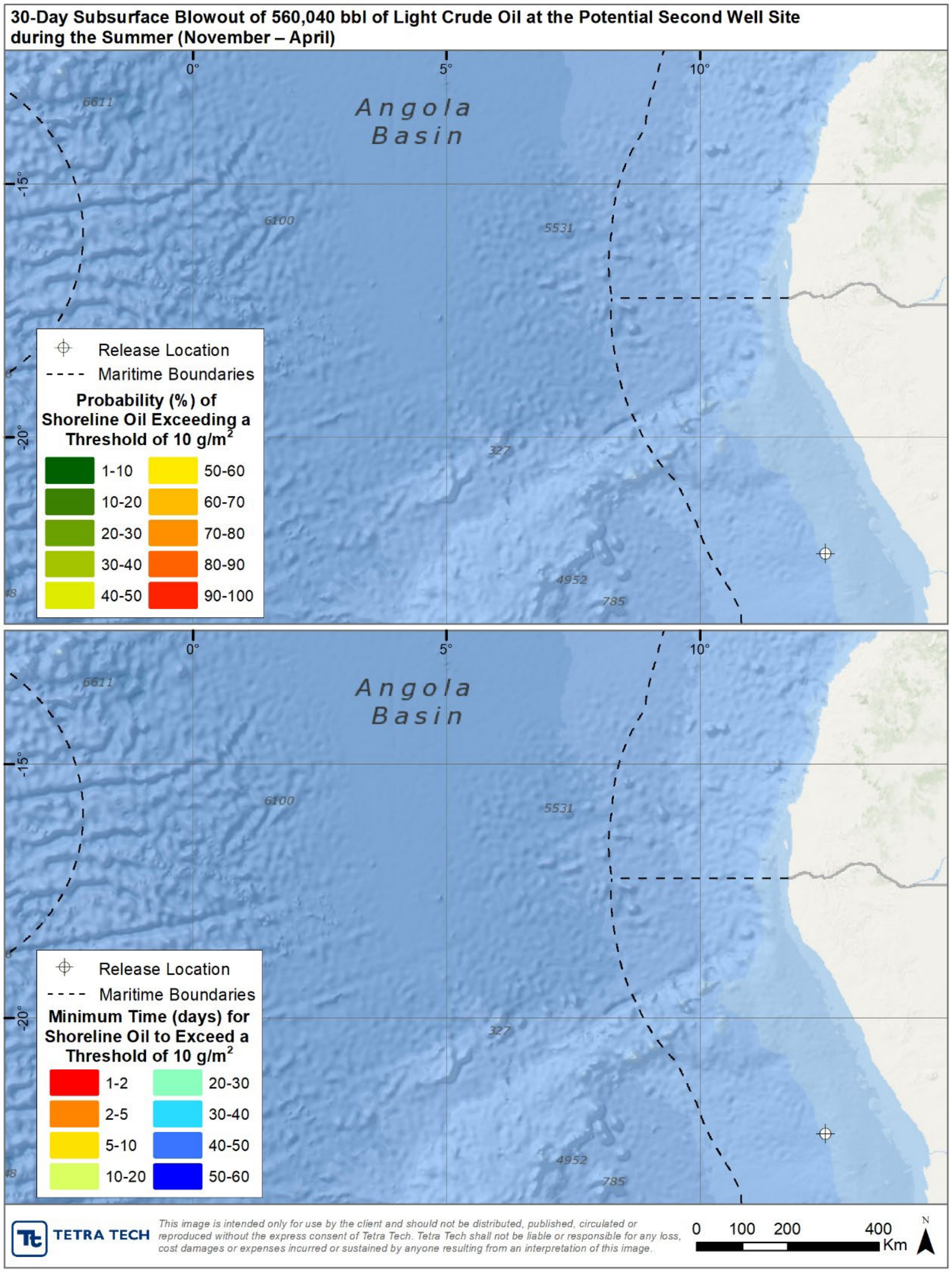


Figure 15. Shoreline oiling probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Summer (November – April) at the Potential Second Well using a shoreline oil thickness threshold of 10 g/m² (0.01 mm).

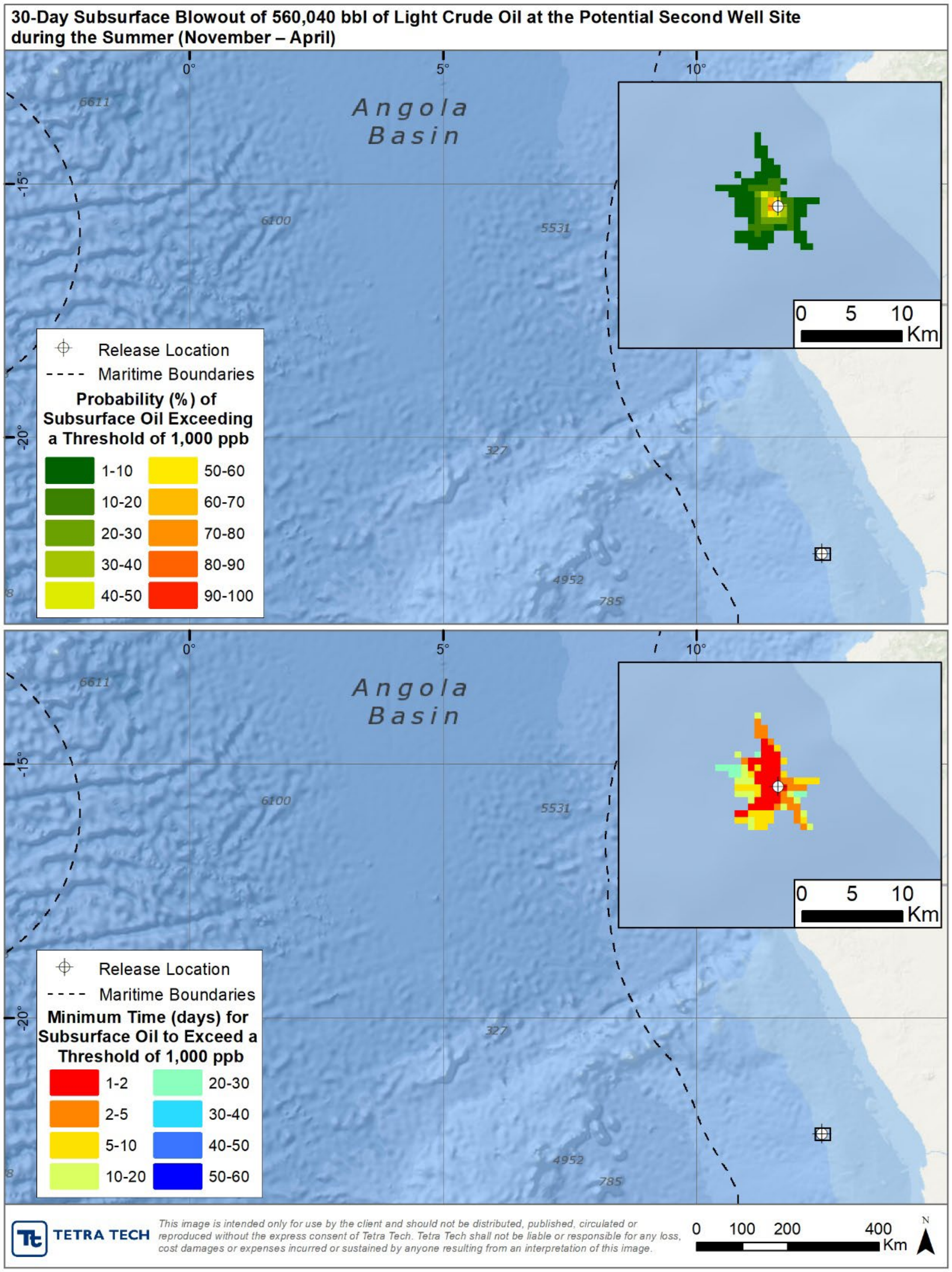


Figure 16. Water column oiling (THC) probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Summer (November – April) at the Potential Second Well using a water column oil threshold of 1,000 ppb (1,000 µg/L).

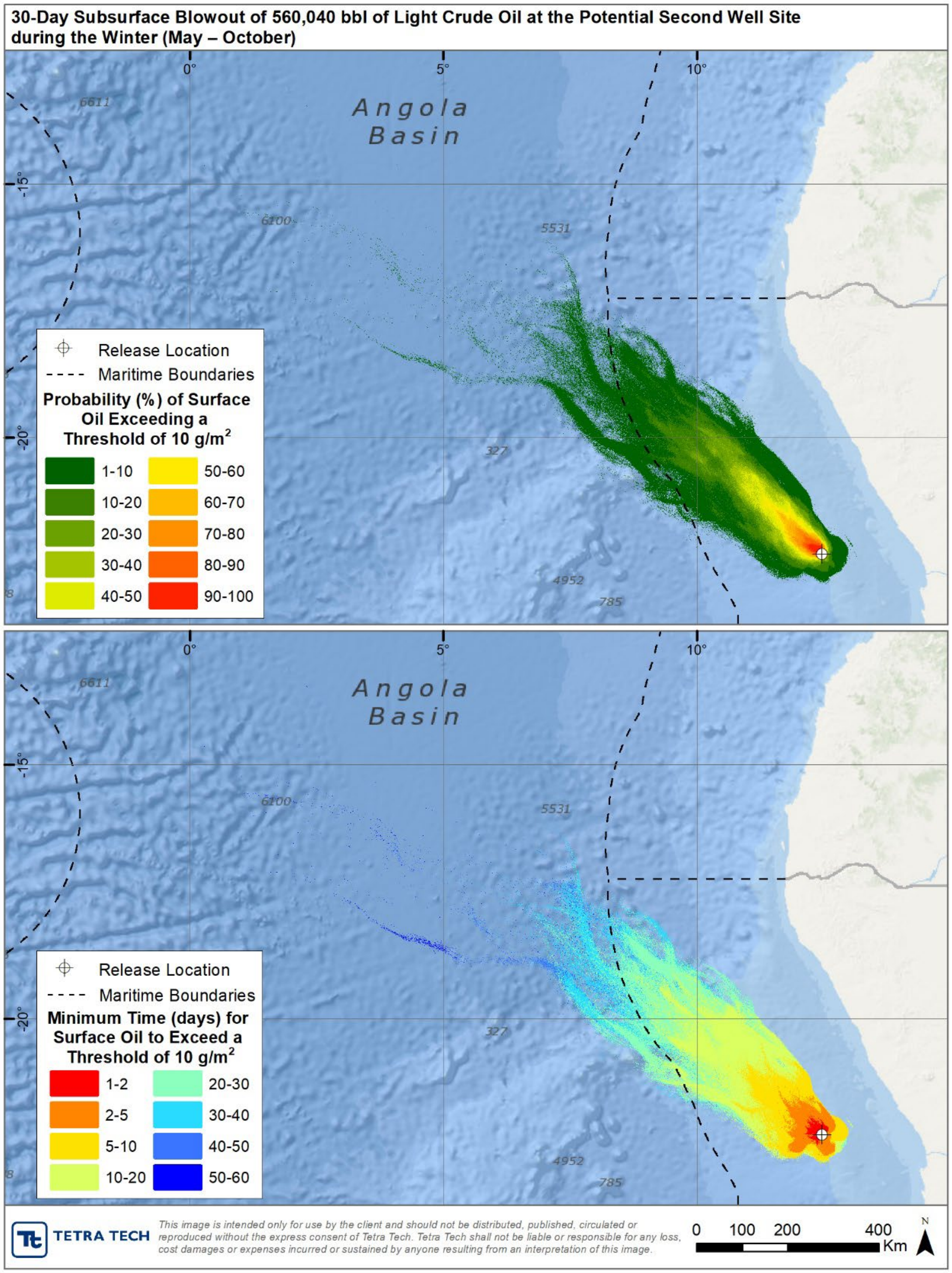


Figure 17. Surface oiling probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Winter (May – October) at the Potential Second Well using a surface oil thickness threshold of 10 g/m² (0.01 mm).

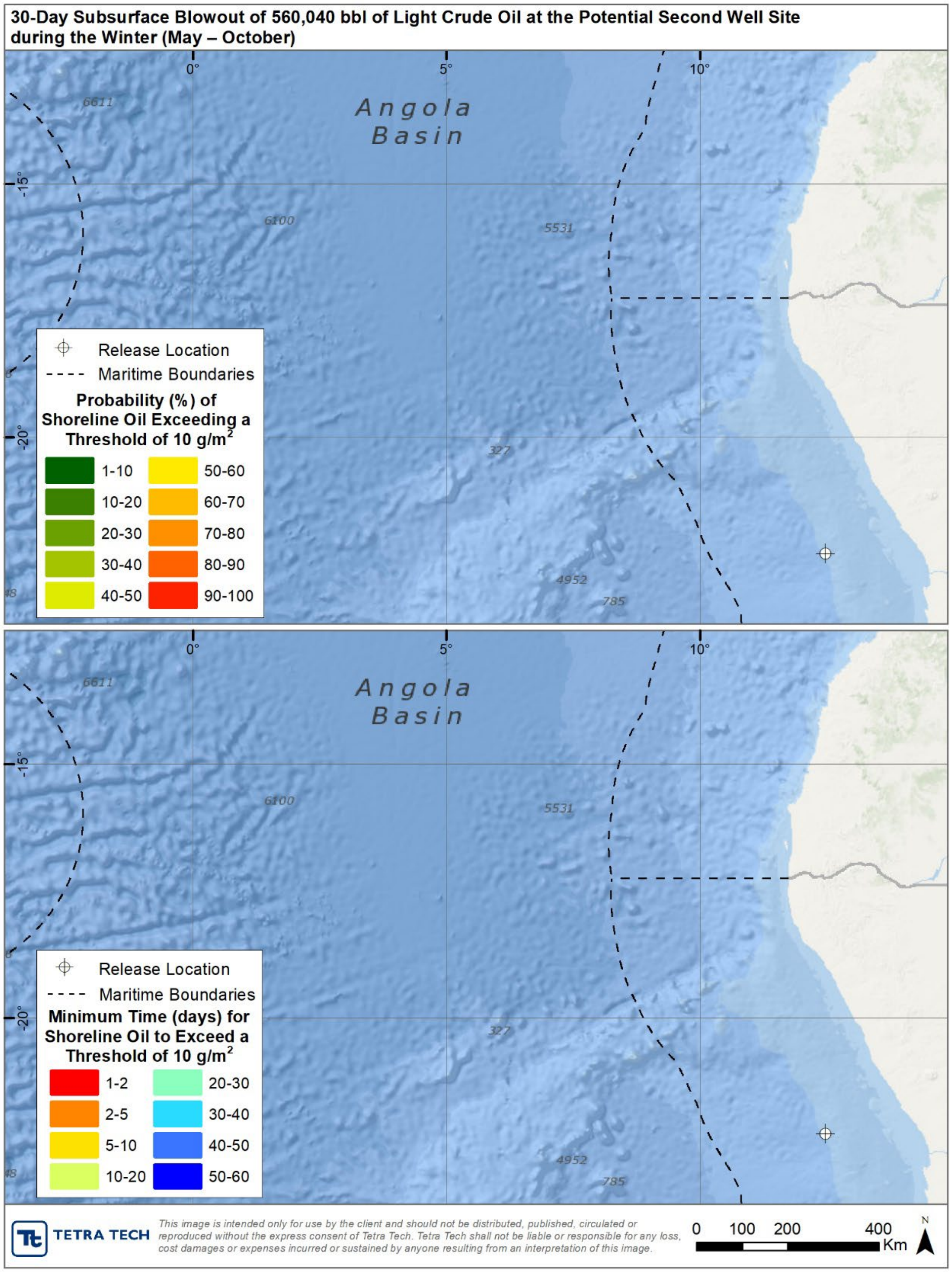


Figure 18. Shoreline oiling probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Winter (May – October) at the Potential Second Well using a shoreline oil thickness threshold of 10 g/m² (0.01 mm).

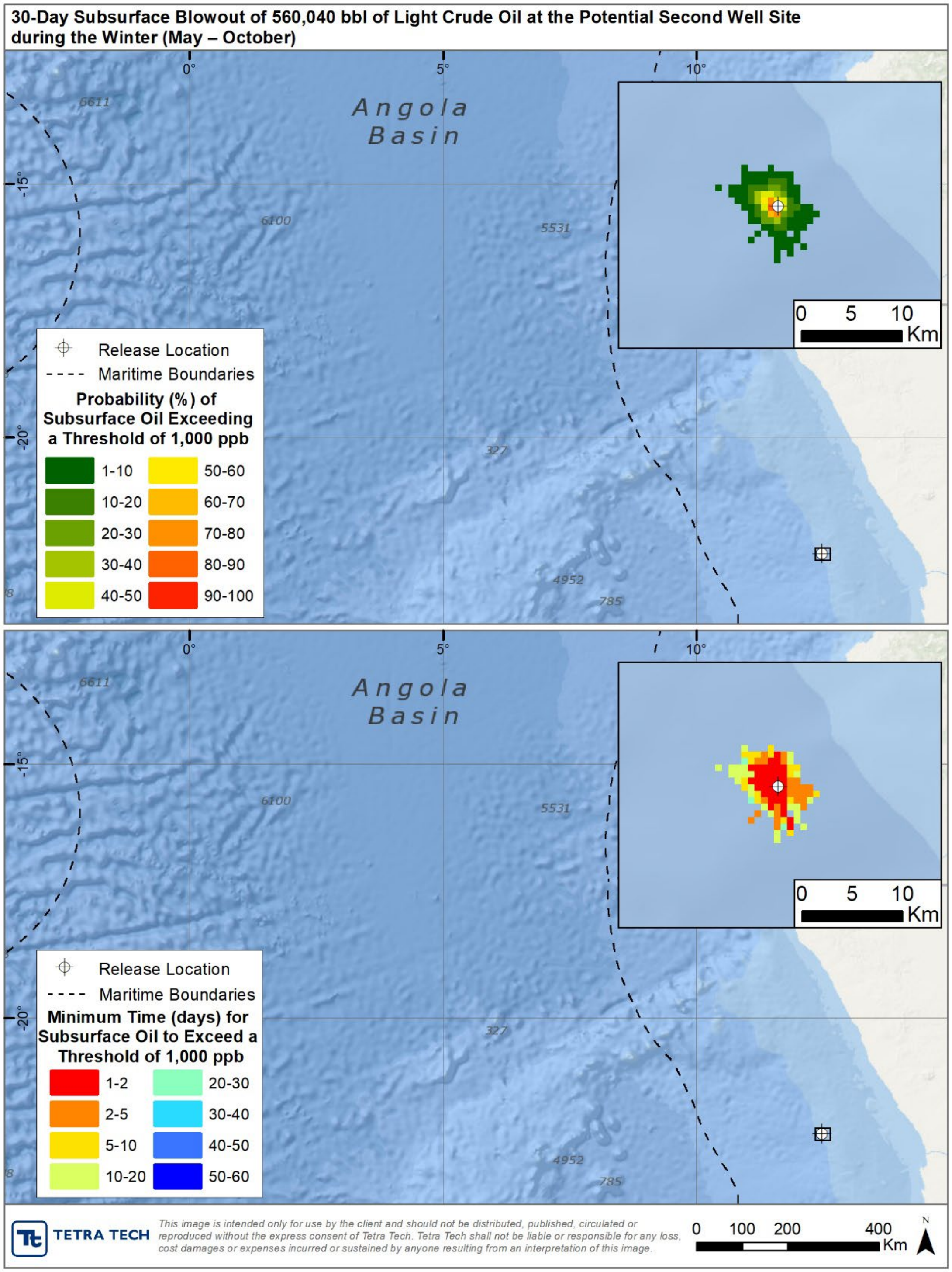


Figure 19. Water column oiling (THC) probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Winter (May – October) at the Potential Second Well using a water column oil threshold of 1,000 ppb (1,000 µg/L).

2.3.3 Shallow Well

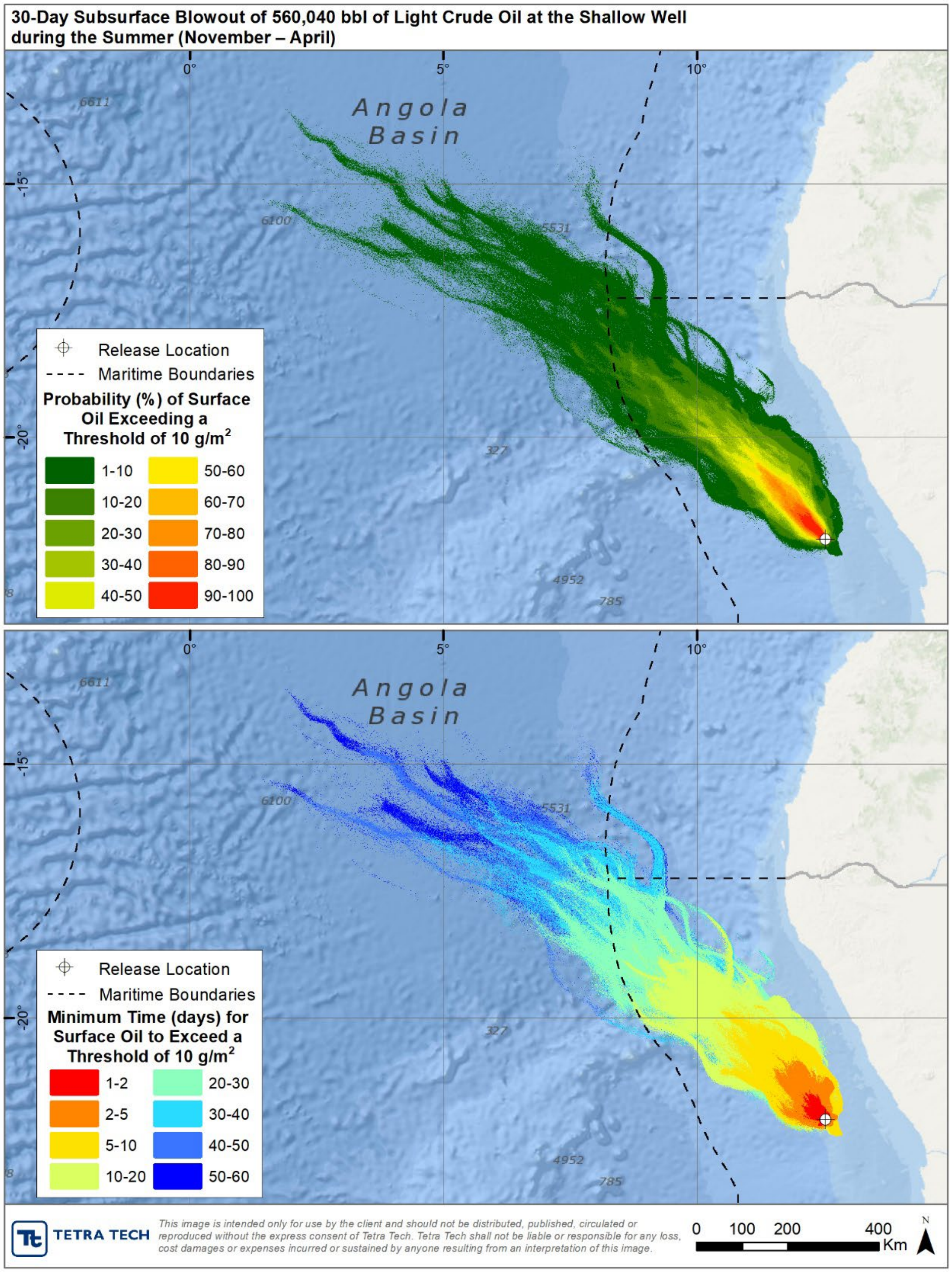


Figure 20. Surface oiling probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Summer (November – April) at the Shallow Well using a surface oil thickness threshold of 10 g/m² (0.01 mm).

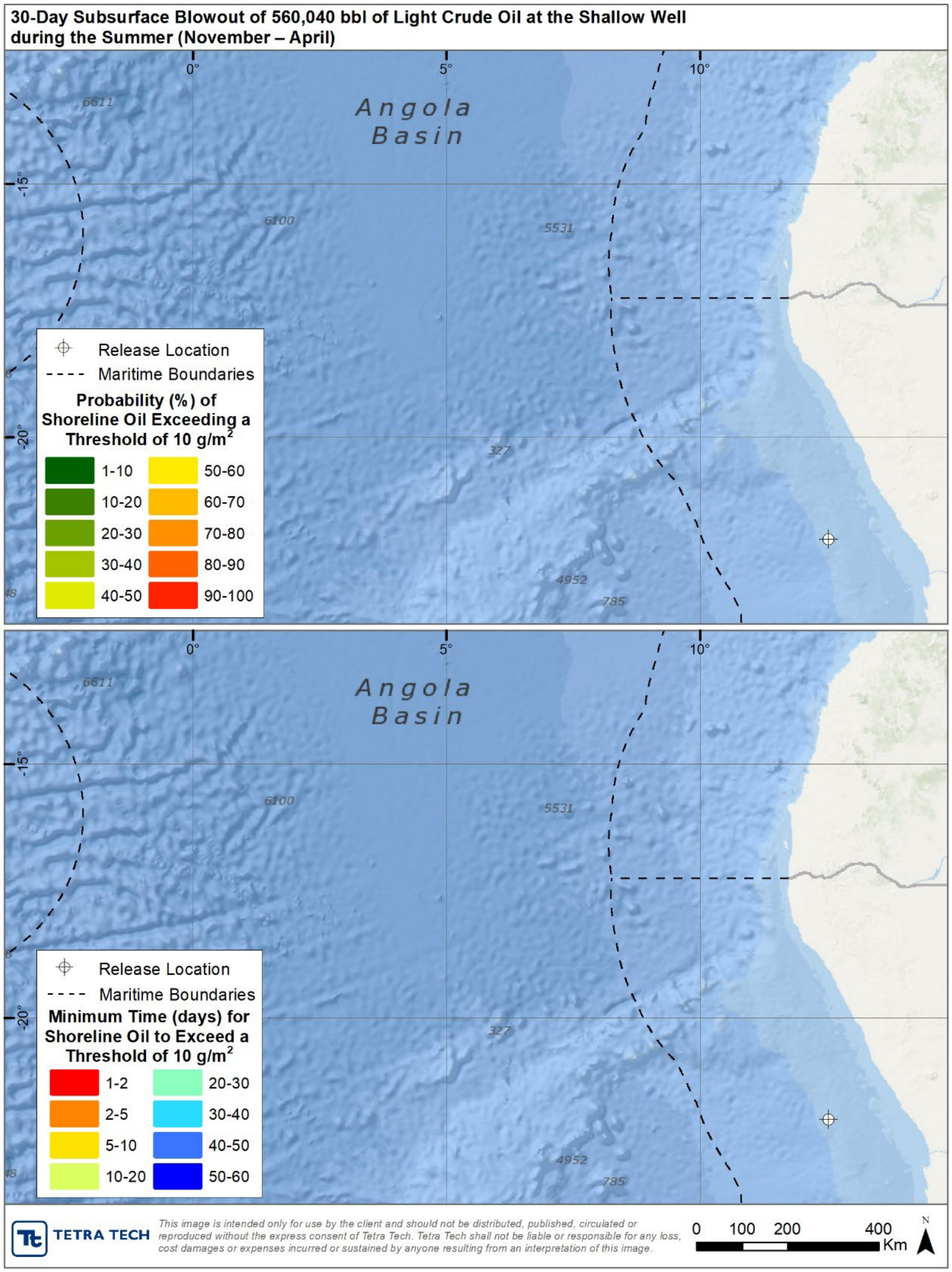


Figure 21. Shoreline oiling probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Summer (November – April) at the Shallow Well using a shoreline oil thickness threshold of 10 g/m² (0.01 mm).

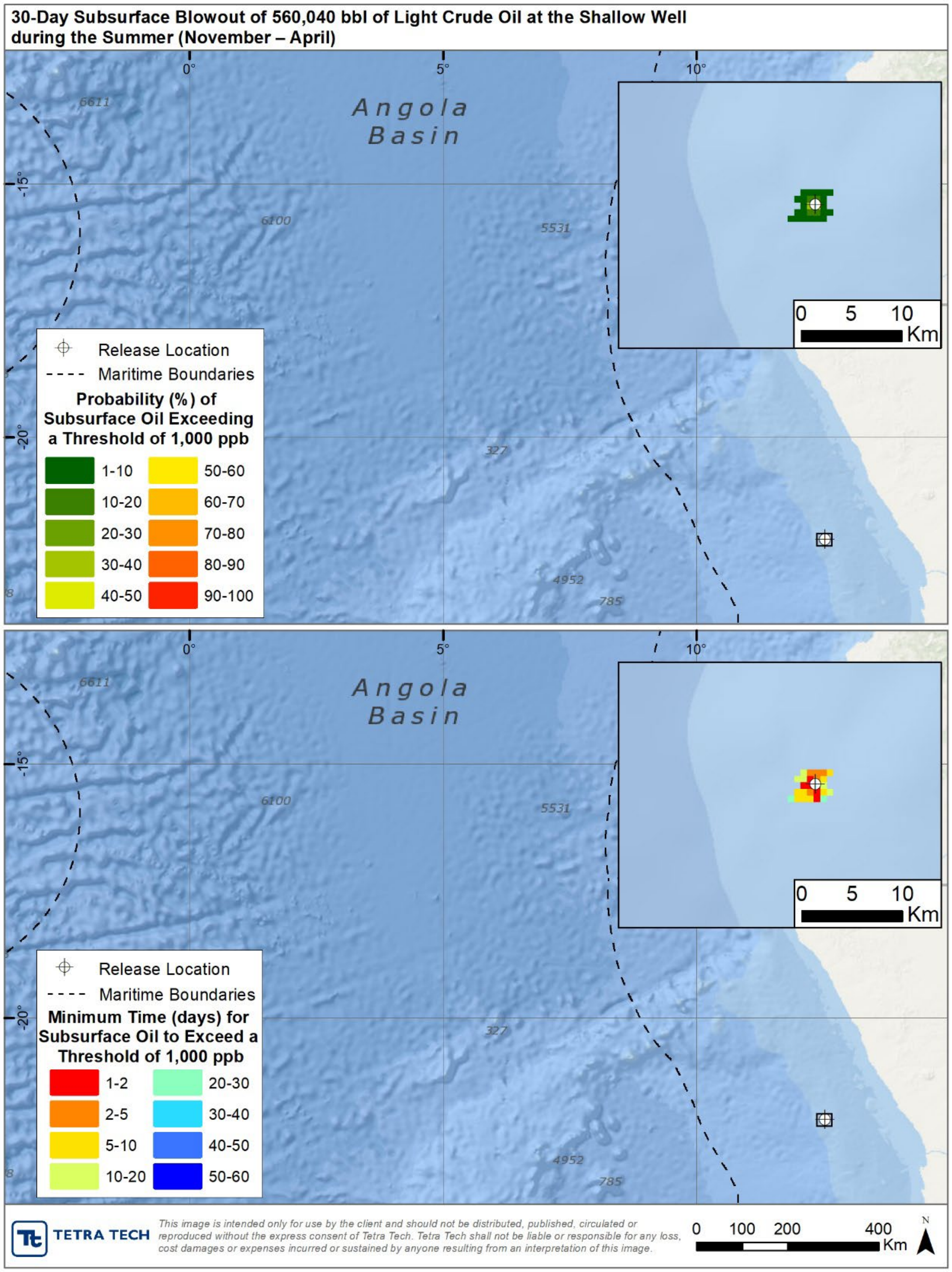


Figure 22. Water column oiling (THC) probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Summer (November – April) at the Shallow Well using a water column oil threshold of 1,000 ppb (1,000 µg/L).

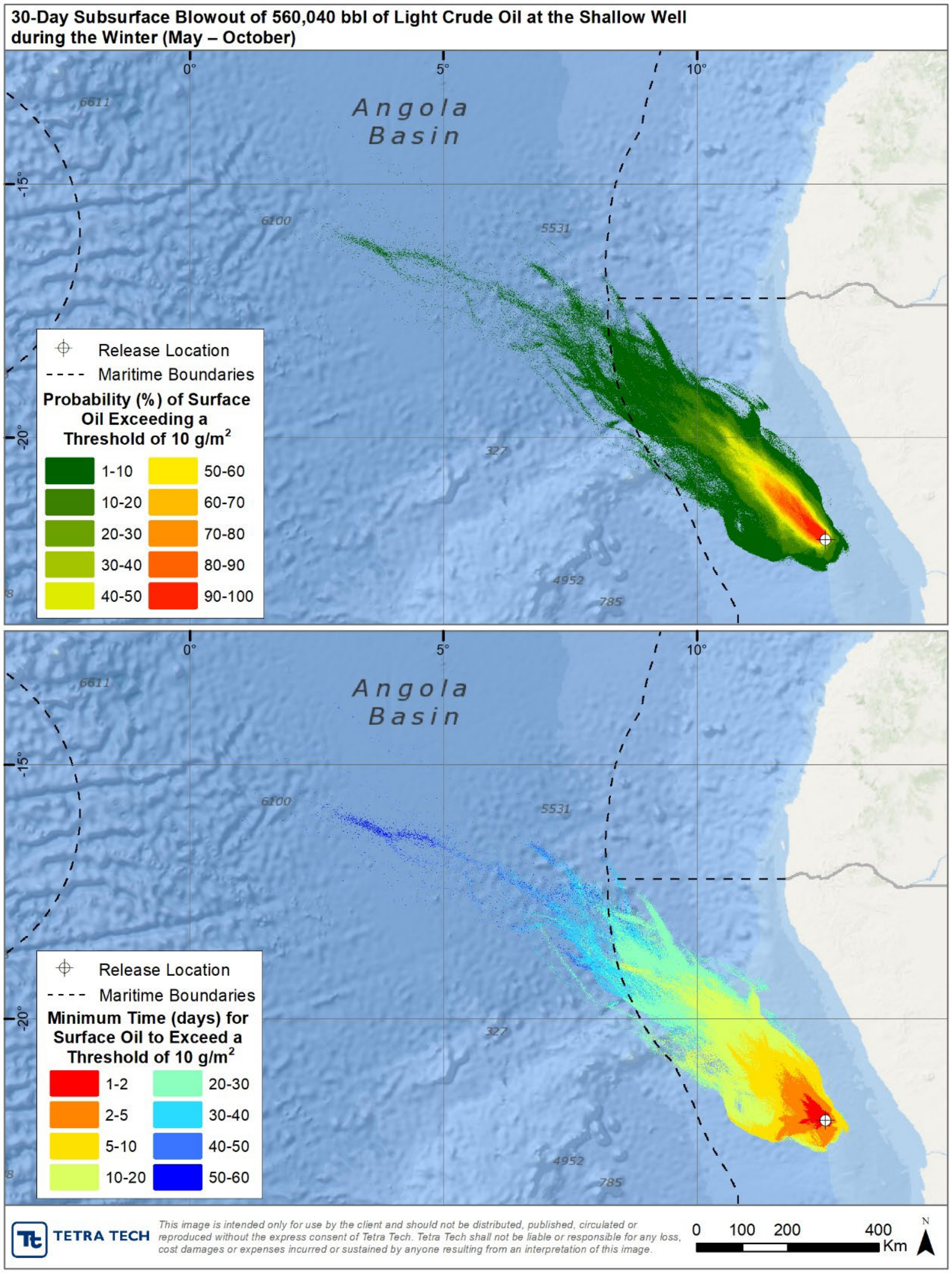


Figure 23. Surface oiling probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Winter (May – October) at the Shallow Well using a surface oil thickness threshold of 10 g/m² (0.01 mm).

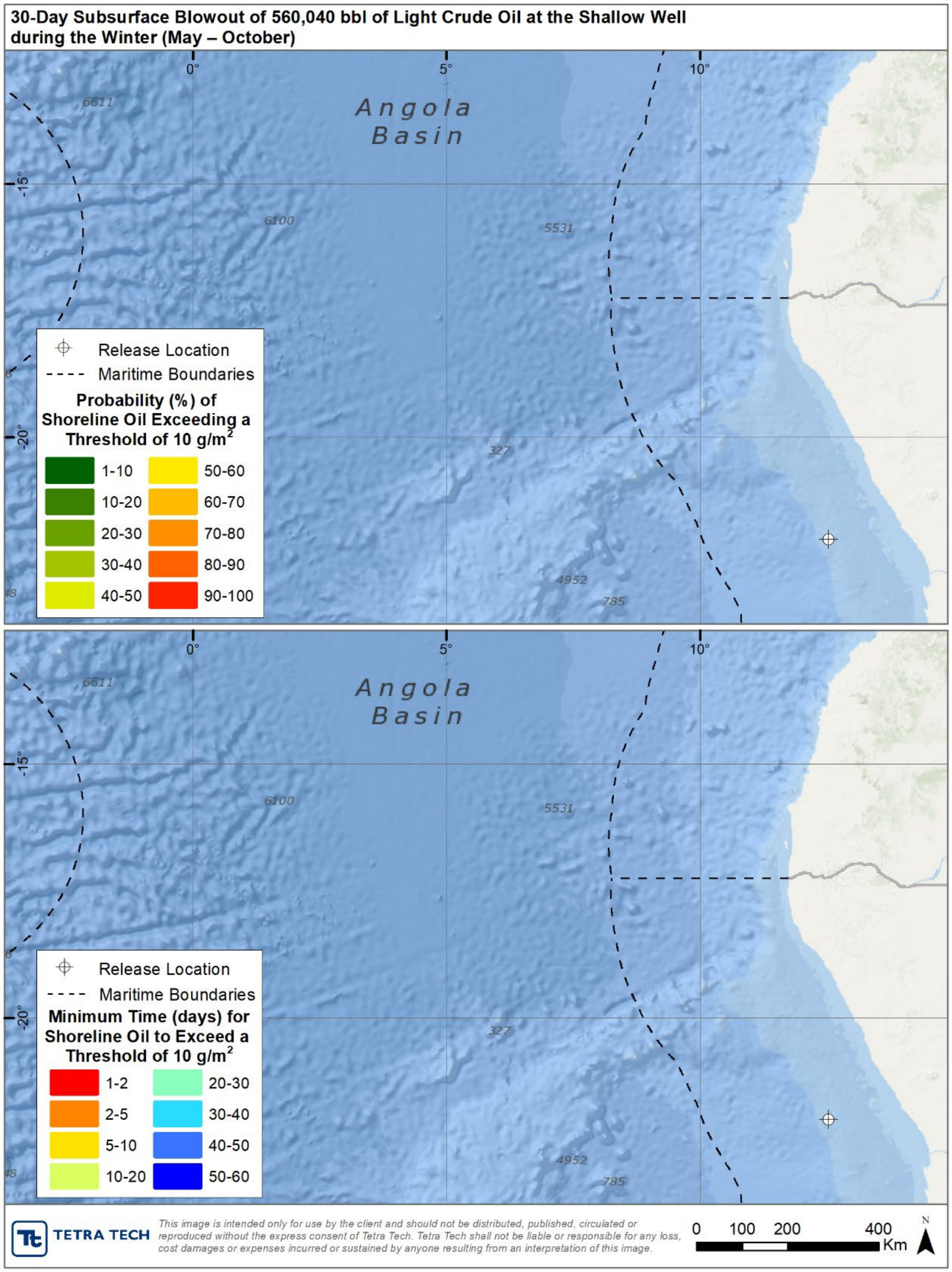


Figure 24. Shoreline oiling probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Winter (May – October) at the Shallow Well using a shoreline oil thickness threshold of 10 g/m² (0.01 mm).

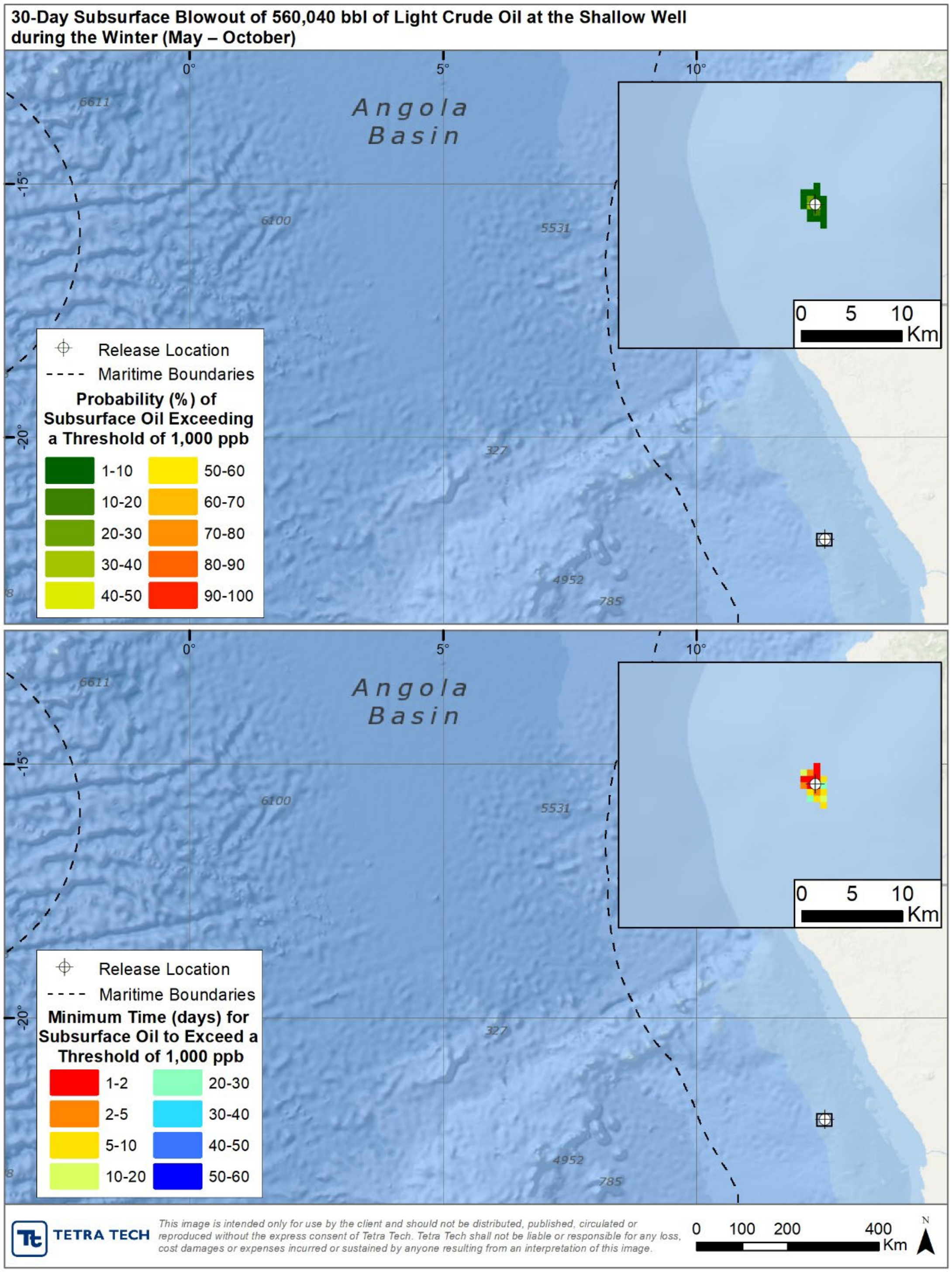


Figure 25. Water column oiling (THC) probabilities (top) and minimum travel times (bottom) – Subsurface Blowout of 560,040 bbl of Light Crude Oil during Winter (May – October) at the Shallow Well using a water column oil threshold of 1,000 ppb (1,000 µg/L).

2.4 Representative 'Worst-Case' Modeling Results

For each stochastic scenario, the standard approach by ROS is to select a worst-case trajectory based on the degree of shoreline oiling. Due to the lack of shoreline oiling, the individual trajectory with the largest cumulative floating oil footprint was selected for the representative worst-case deterministic modeling from each stochastic scenario. All trajectory/fate simulations were run using the same variable winds and currents used for the corresponding stochastic simulation from which it was selected. Table 9 identifies the specific start dates of the selected worst-case scenarios.

Table 9. Selected worst case deterministic runs for each spill scenario.

ID	Release Location	Release Type	Season	Total Oil Released (bbl)	Date of Selected Deterministic Case
1	Gemsbok Site	Subsurface Blowout	Summer (November – April)	560,040	December 30th, 2021
2	Gemsbok Site	Subsurface Blowout	Winter (May – October)	560,040	October 5th, 2023
3	Potential Second Well	Subsurface Blowout	Summer (November – April)	560,040	January 12th, 2022
4	Potential Second Well	Subsurface Blowout	Winter (May – October)	560,040	May 15th, 2022
5	Shallow Well	Subsurface Blowout	Summer (November – April)	560,040	December 30th, 2021
6	Shallow Well	Subsurface Blowout	Winter (May – October)	560,040	May 21st, 2022

For each deterministic scenario, the following figures (Figure 28 to Figure 48) present maximum surface oil concentrations and presence of shoreline oil, dispersed oil in the water column, and the associated mass balances for each spill scenario:

1. **Maximum surface oil concentration**: These maps depict the maximum concentration (thickness) of oil on the water surface throughout the duration of the simulation. The shoreline oiled during the simulation would be highlighted with a dark red contouring. This representation does not distinguish between degrees of shoreline oiling.
2. **Maximum total hydrocarbon concentration (THC) in the water column**: These maps depict the vertical maximum of total hydrocarbon concentration in the water column throughout the duration of the simulation.
3. **Predicted mass balance:** This graph shows the degree of weathering that the oil undergoes during the period of the simulation as predicted by the model. Components of the oil tracked over time include the amount of oil remaining on the sea surface, evaporating into the atmosphere, coming ashore, entraining in the water column as whole oil droplets, and degrading via both photo-oxidation and biodegradation.
4. **Vertical Cross-Section views of water column oiling on day 2**: These figures present water column oiling contamination, combining plan view (vertical maximum THC concentration) and vertical cross section at day 2 of the spill simulation. The section views provide detailed spatial distribution information of total hydrocarbons, or other tracked components along a selected

transect, allowing visualization of how the oil plume evolves below the surface at this specific time point.

The deterministic mass balance results for all spill scenarios are summarized in Table 10. These results portray the degree of weathering as the percentage of the total mass broken down through different pathways in the environment at the end of each simulation.

Table 10. Worst-case scenario mass balance at the end of the simulation (% of the total mass of oil released).

ID	Release Location	Season	Total Oil Released (bbl)	Surface (%)	Evaporated (%)	Ashore (%)	Water Column (%)	Degraded (%)
1	Gemsbok Site	Summer	560,040	29.29	36.93	0.00	12.41	21.37
2	Gemsbok Site	Winter	560,040	24.16	34.27	0.00	13.59	27.98
3	Potential Second Well	Summer	560,040	34.60	39.21	0.00	8.43	17.76
4	Potential Second Well	Winter	560,040	19.93	35.18	0.00	17.38	27.51
5	Shallow Well	Summer	560,040	26.52	49.71	0.00	13.30	10.47
6	Shallow Well	Winter	560,040	12.49	49.18	0.00	22.95	15.38

*Important to note these values are not indicative of the maximum amount of oil in each compartment, but instead show the final amount of oil in each compartment.

The trajectory and fate associated with each worst-case deterministic scenario, as well as any predicted impacts to shoreline, can be characterized from the model results depicted in the associated figures. Table 11 provides a summary of this characterization.

Table 11. Summary of worst-case deterministic modeling results.

ID	Release Location	Release Type	Season	Total Oil Released (bbl)	Fate	Trajectory	Shore Impacts
1	Gemsbok Site	Subsurface Blowout	Summer (Nov – Apr)	560,040	• Throughout the scenario, oil evaporated steadily over the first 30 days before plateauing. Approximately 37% of the release was predicted to evaporate by the end of the simulation. • Degradation increased gradually, reaching 21% by Day 60. • Due to wind events and a relatively light oil, there was an oscillation between surface and water column oil resulting in ~30% remaining on the surface at the end of the simulation. • No shoreline oiling was predicted.	• Surface oil was transported northwest approximately 350 km. • The total hydrocarbons in the water column were transported northwest, remaining within 50 km of the release location.	• N/A
2	Gemsbok Site	Subsurface Blowout	Winter (May – Oct)	560,040	• Throughout the scenario, oil evaporated steadily over the first 30 days before plateauing. Approximately 34% of the release was predicted to evaporate by the end of the simulation. • Degradation increased gradually reaching 28% by Day 60. • Due to wind events and a relatively light oil, there was an oscillation between surface and water column oil resulting in ~24% remaining on the surface at the end of the simulation. • No shoreline oiling was predicted.	• Surface oil was transported northwest approximately 175 km. • The total hydrocarbons in the water column were transported northwest, remaining within 50 km of the release location.	• N/A

ID	Release Location	Release Type	Season	Total Oil Released (bbl)	Fate	Trajectory	Shore Impacts
3	Potential Second Well	Subsurface Blowout	Summer (Nov – Apr)	560,040	• Throughout the scenario, oil evaporated steadily over the first 30 days before plateauing. Approximately 40% of the release was predicted to evaporate by the end of the simulation. • Degradation increased gradually reaching 18% by Day 60. • Due to wind events and a relatively light oil, there was an oscillation between surface and water column oil resulting in ~35% remaining on the surface at the end of the simulation. • No shoreline oiling was predicted.	• Surface oil was transported northwest approximately 500 km. • The total hydrocarbons in the water column were transported northwest, remaining within 25 km of the release location.	• N/A
4	Potential Second Well	Subsurface Blowout	Winter (May – Oct)	560,040	• Throughout the scenario, oil evaporated steadily over the first 30 days before plateauing. Approximately 35% of the release was predicted to evaporate by the end of the simulation. • Degradation increased gradually reaching 28% by Day 60. • Due to wind events and a relatively light oil, there was an oscillation between surface and water column oil resulting in ~20% remaining on the surface at the end of the simulation. • No shoreline oiling was predicted.	• Surface oil was transported west-northwest approximately 175 km. • The total hydrocarbons in the water column were transported northwest, remaining within 50 km of the release location	• N/A

ID	Release Location	Release Type	Season	Total Oil Released (bbl)	Fate	Trajectory	Shore Impacts
5	Shallow Well	Subsurface Blowout	Summer (Nov – Apr)	560,040	• Approximately 50% of the release was predicted to evaporate over the 60-day simulation. • Compared to the other scenarios, there was less degradation (10%) due to oil remaining on the surface (~27%) and not entraining into the water column as readily. • No shoreline oiling was predicted.	• Surface oil was transported northwest approximately 350 km. • The total hydrocarbons in the water column were transported predominantly north, remaining within 25 km of the release location	• N/A
6	Shallow Well	Subsurface Blowout	Winter (May – Oct)	560,040	• Approximately 50% of the release was predicted to evaporate over the 60-day simulation. • Due to wind events and a relatively light oil, there was an oscillation between surface and water column oil resulting in ~13% remaining on the surface at the end of the simulation. • No shoreline oiling was predicted.	• Surface oil was transported northwest and west approximately 300 km. • The total hydrocarbons in the water column were transported predominantly west, remaining within 15 km of the release location.	• N/A

2.4.1 Gemsbok Site

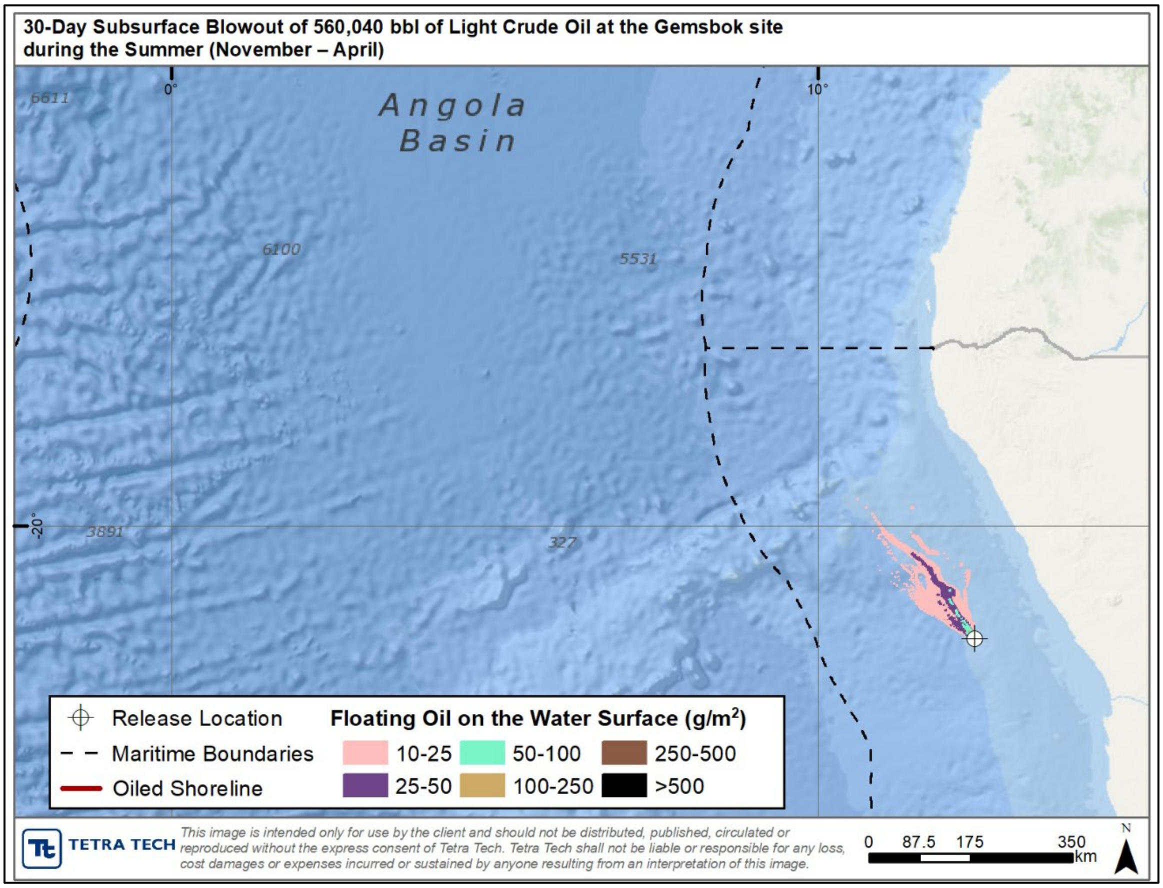


Figure 26. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Gemsbok Site during the Summer (November – April) – Maximum Surface Oil Concentrations (>10 g/m^2) averaged over a grid cell and Associated Shoreline Oiling.

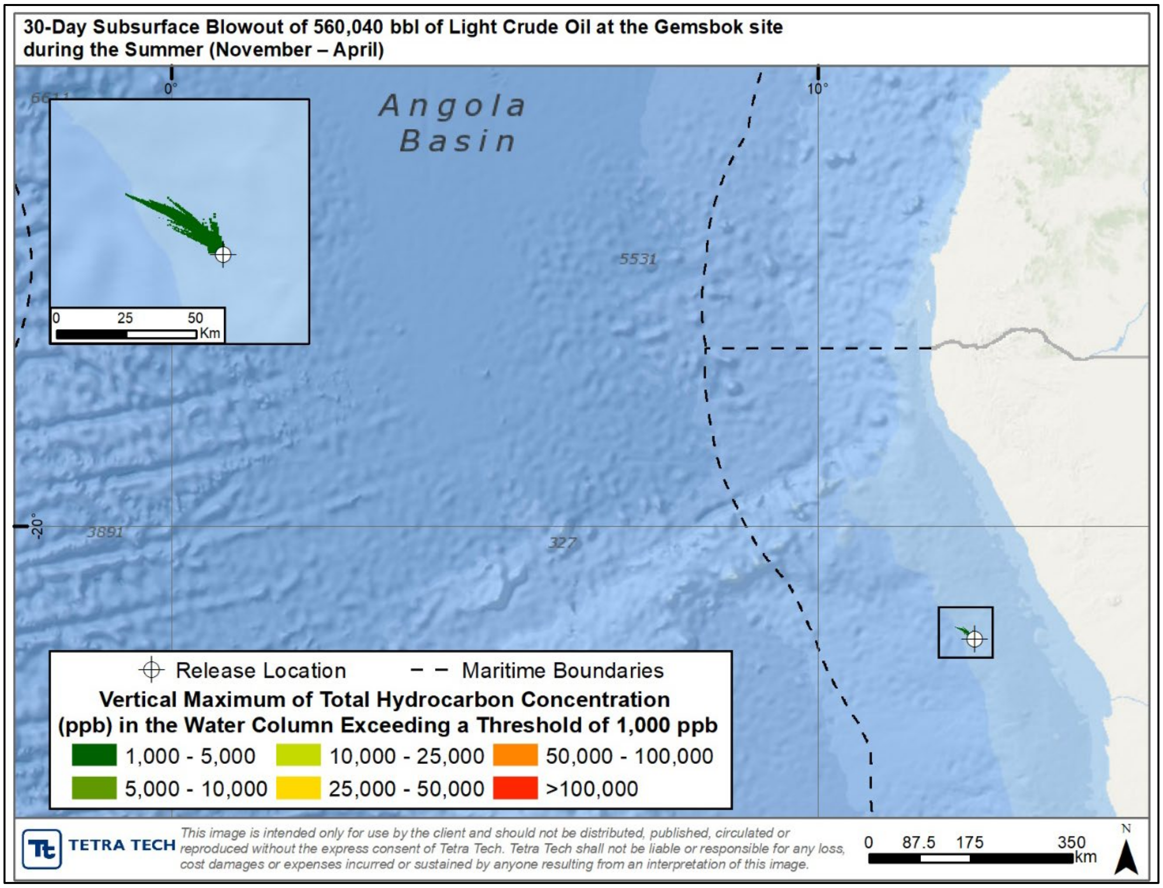


Figure 27. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Gemsbok Site during the Summer (November – April) – Vertical Maximum Water Column Oil Concentrations (>1,000 ppb) averaged over a grid cell.

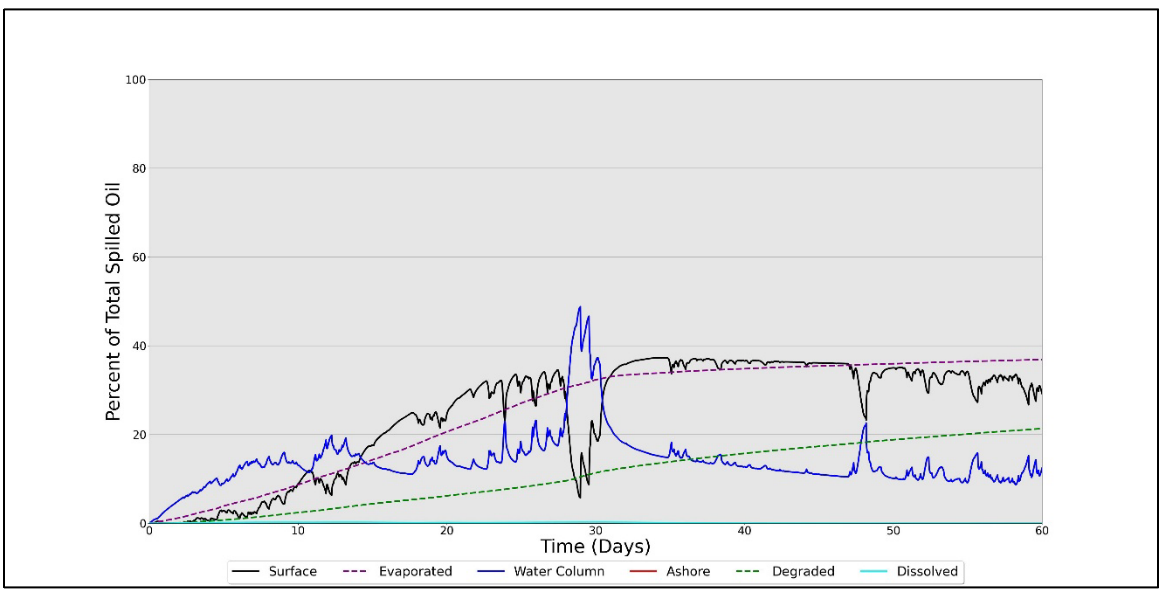


Figure 28. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Gemsbok Site during the Summer (November – April) – Mass Balance Results.

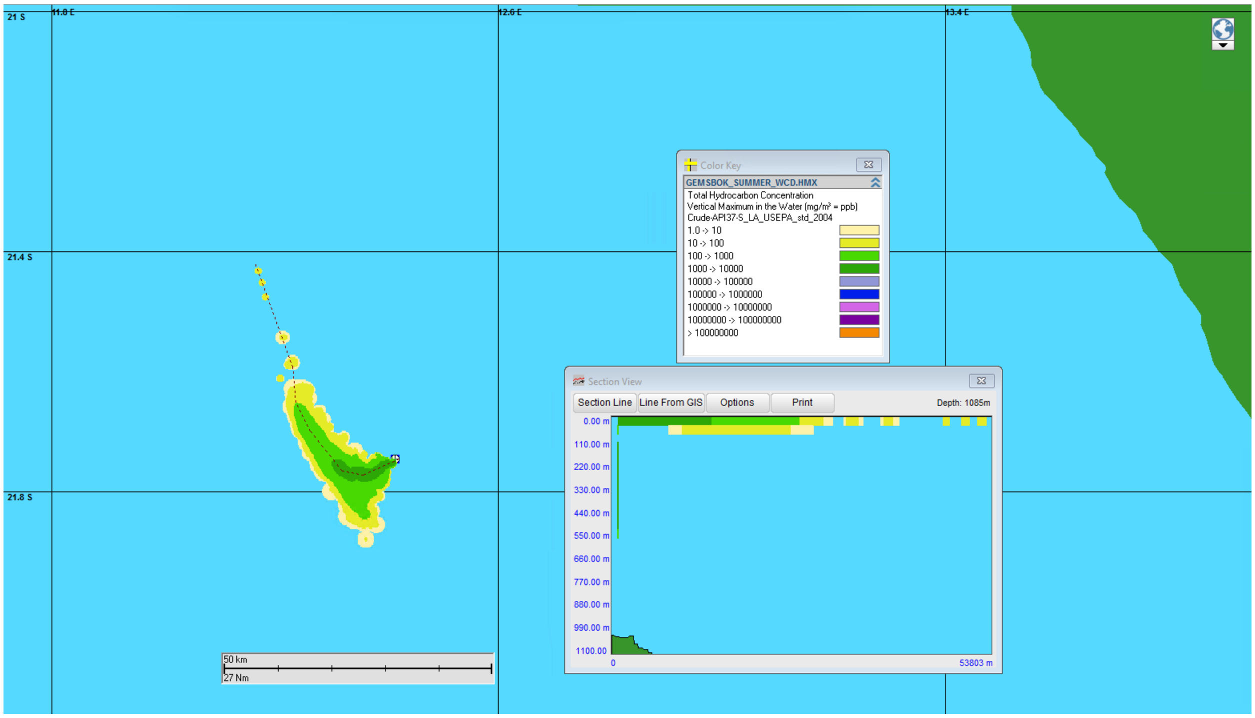


Figure 29. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Gemsbok Site during the Summer (November – April) – Section view of water column data on day 2.

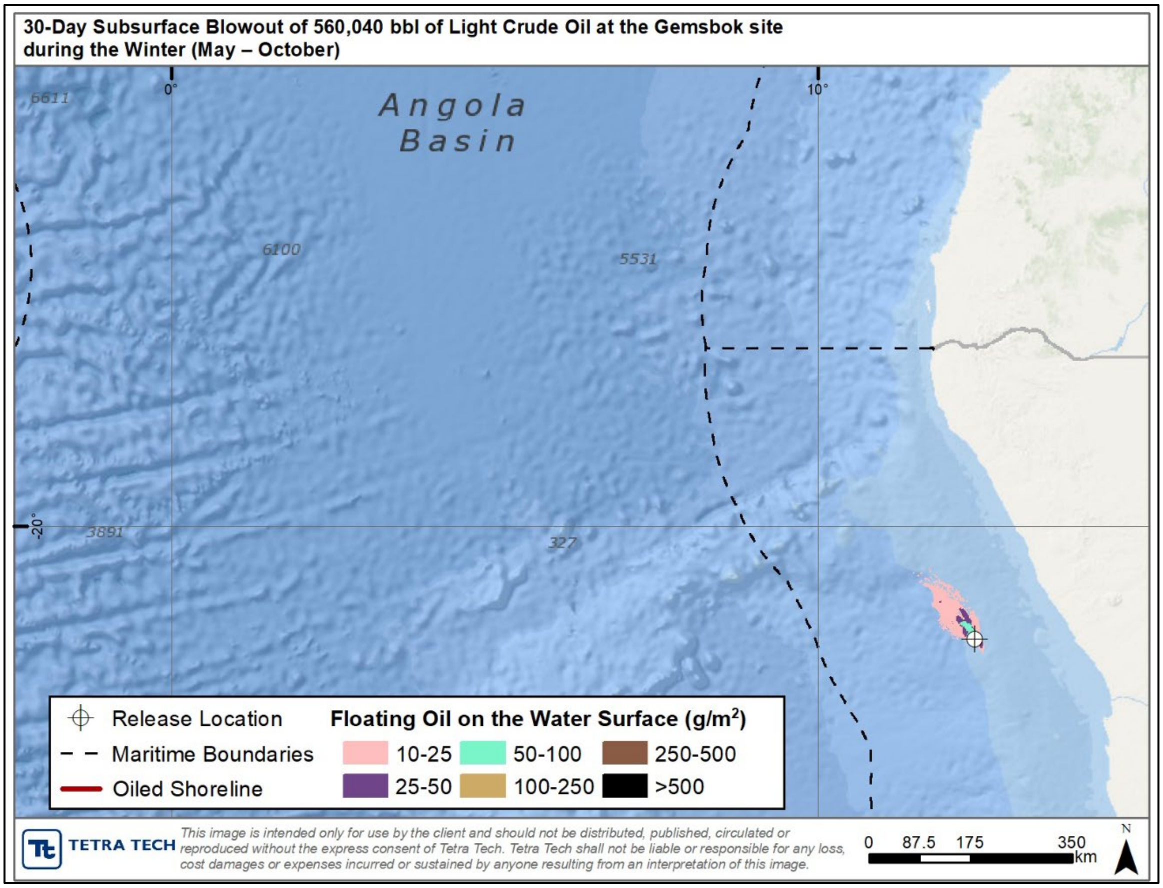


Figure 30. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Gemsbok Site during the Winter (May – October) – Maximum Surface Oil Concentrations (>10 g/m^2) averaged over a grid cell and Associated Shoreline Oiling.

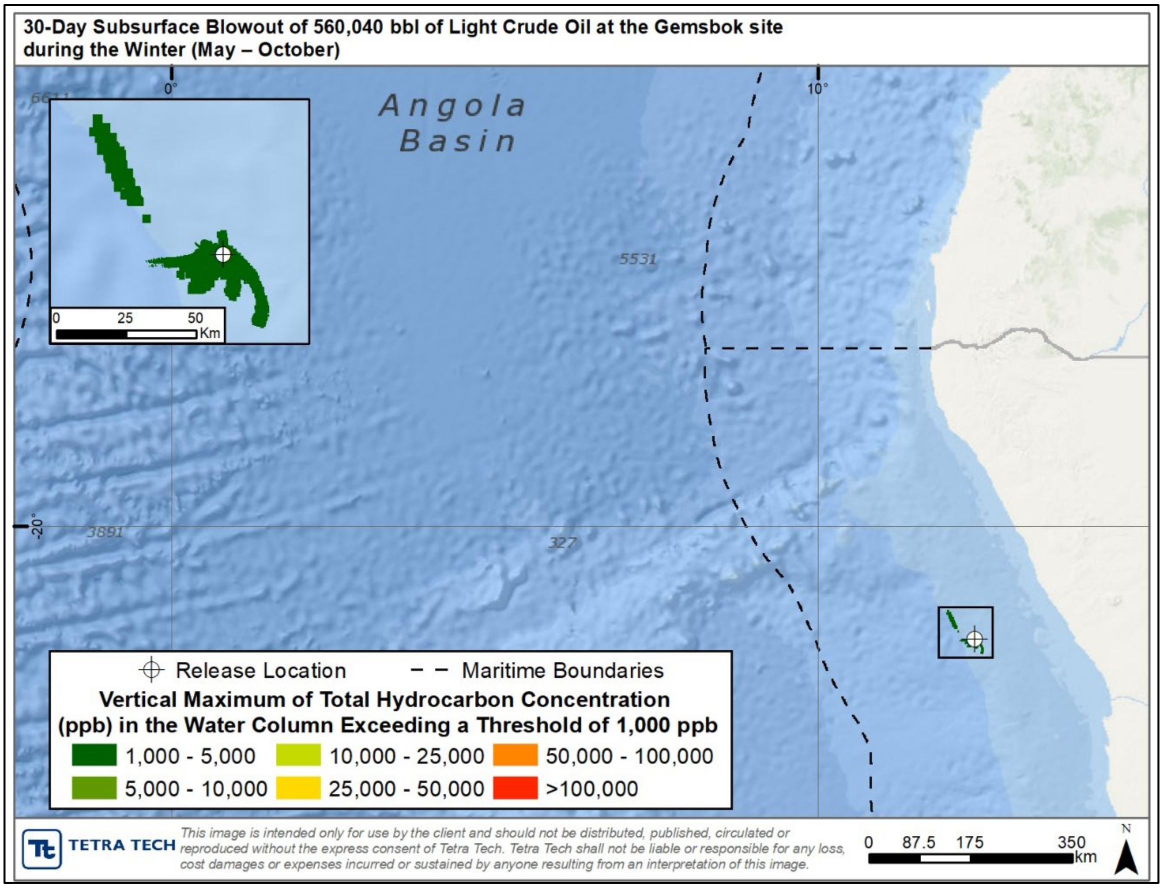


Figure 31. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Gemsbok Site during the Winter (May – October) – Vertical Maximum Water Column Oil Concentrations (>1,000 ppb) averaged over a grid cell.

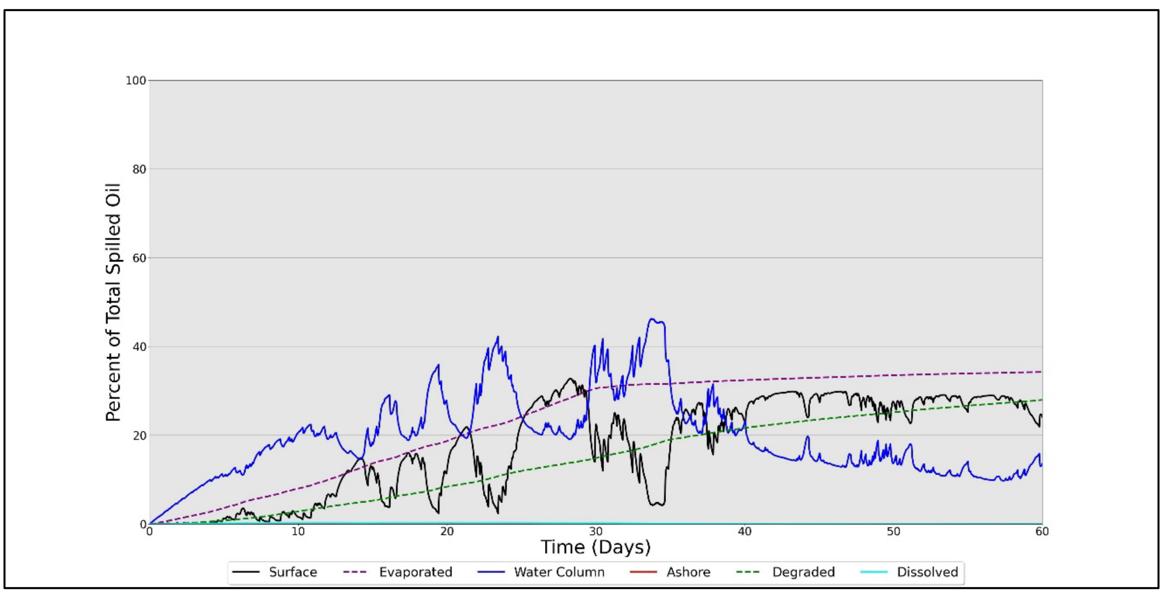


Figure 32. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Gemsbok Site during the Winter (May – October) – Mass Balance Results.

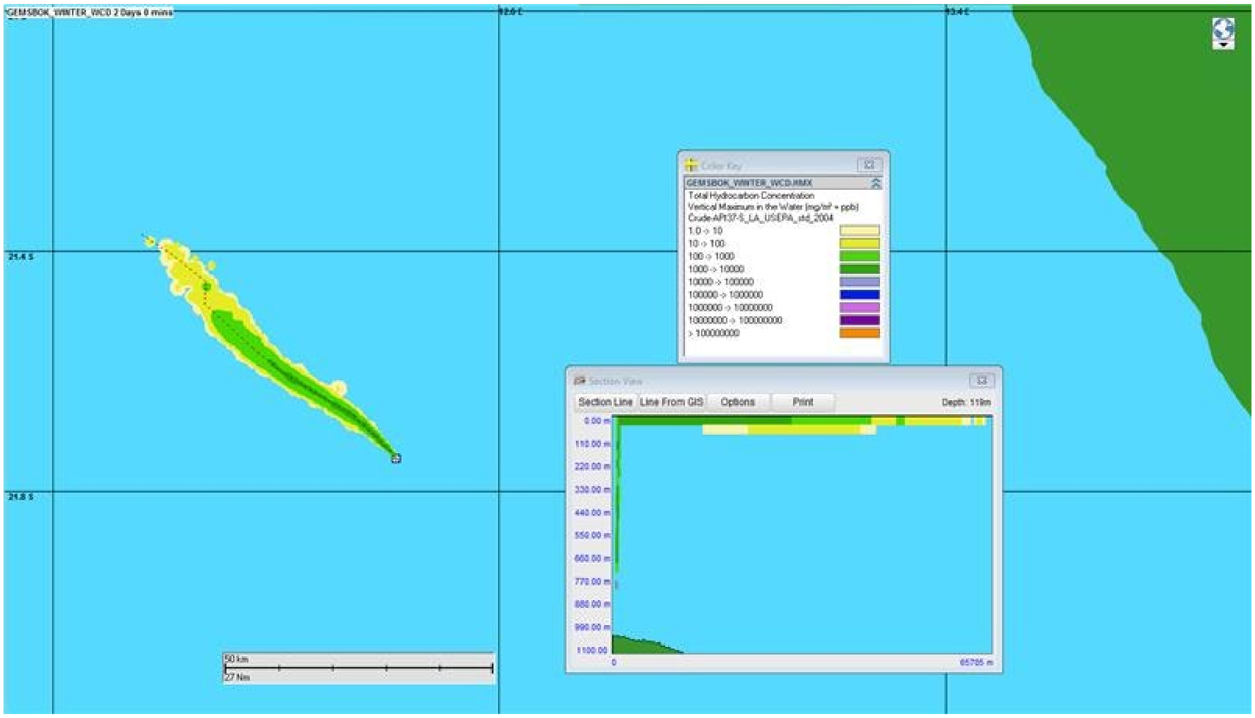


Figure 33. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Gemsbok Site during the Winter (May – October) – Section view of water column data on day 2.

2.4.2 Potential Second Well

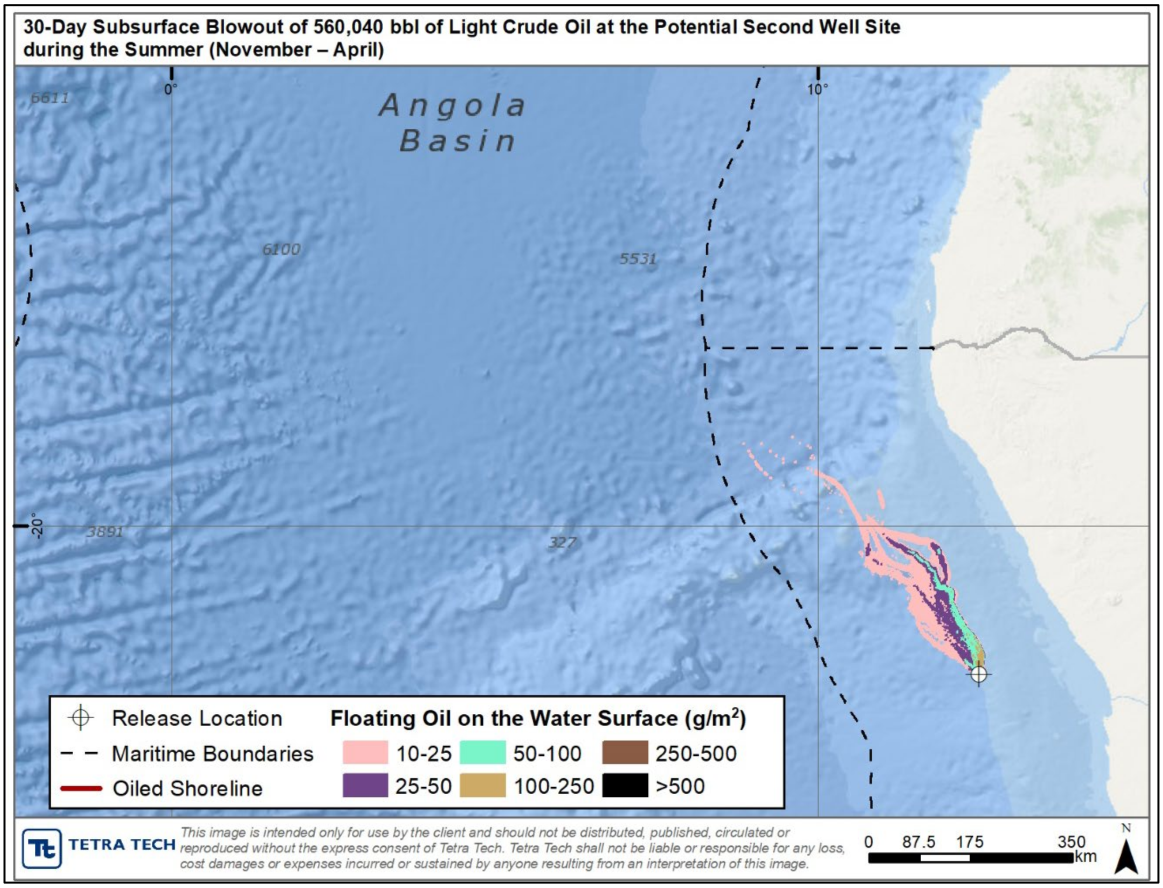


Figure 34. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Potential Second Well during the Summer (November – April) – Maximum Surface Oil Concentrations (>10 g/m^2) averaged over a grid cell and Associated Shoreline Oiling.

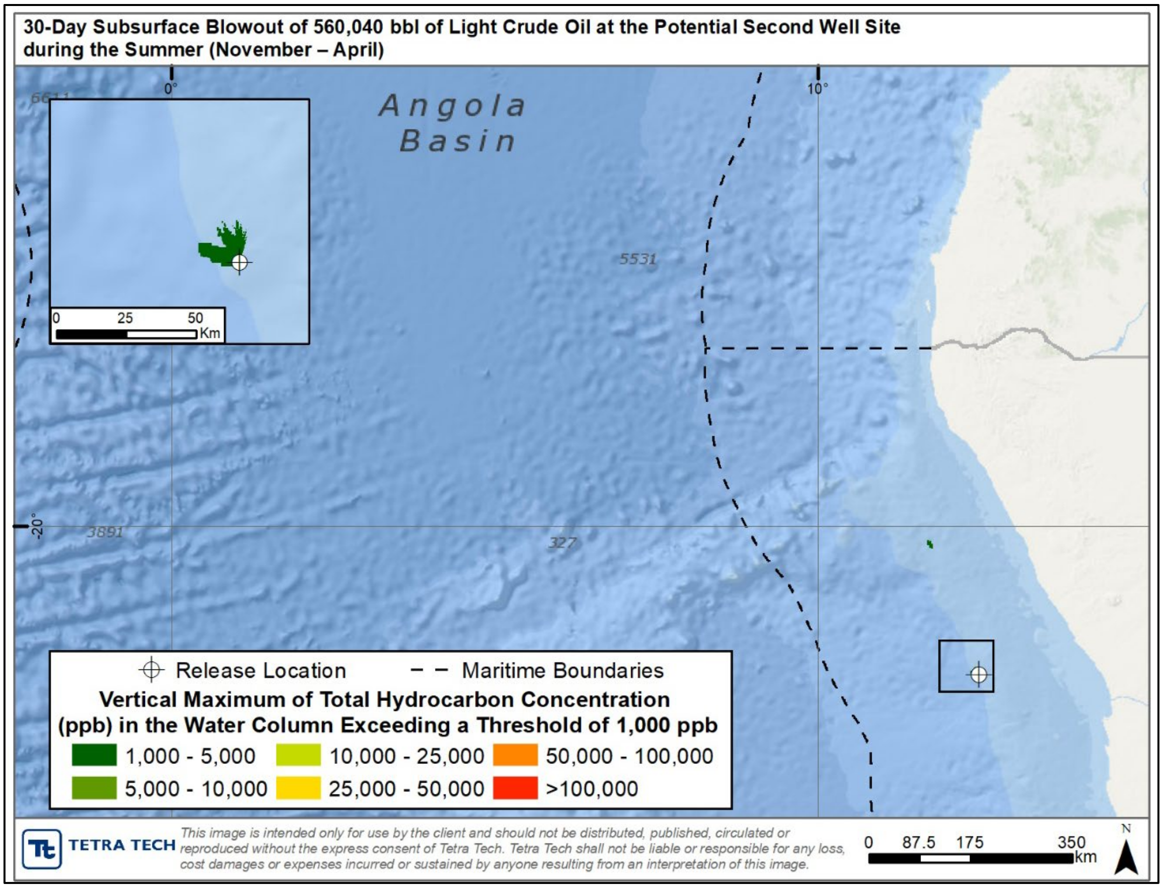


Figure 35. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Potential Second Well during the Summer (November – April) – Vertical Maximum Water Column Oil Concentrations (>1,000 ppb) averaged over a grid cell.

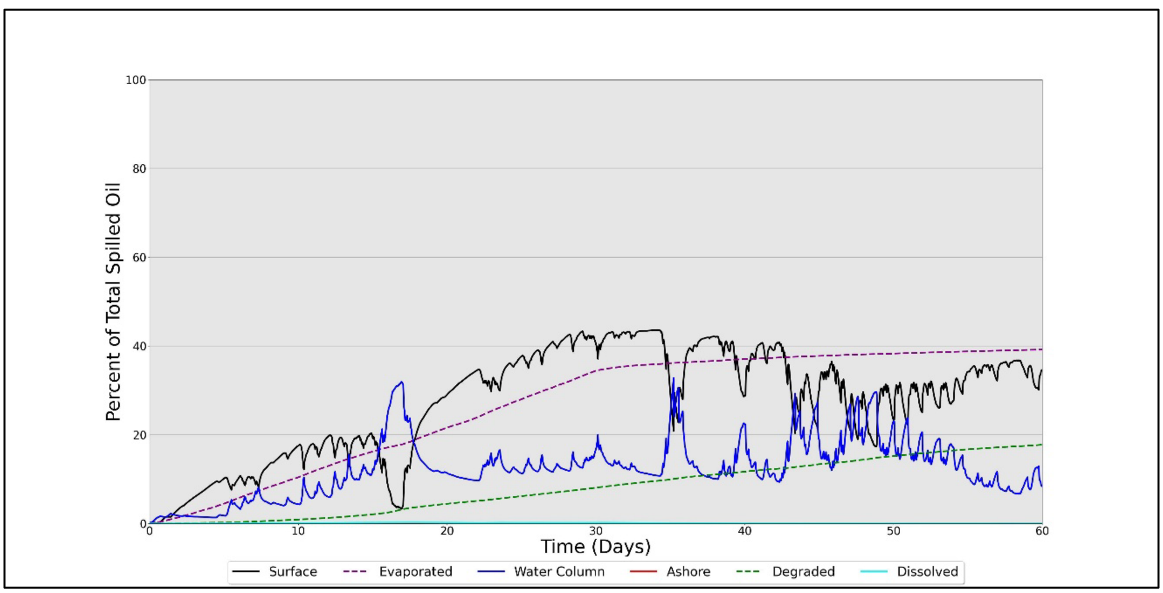


Figure 36. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Potential Second Well during the Summer (November – April) – Mass Balance Results.

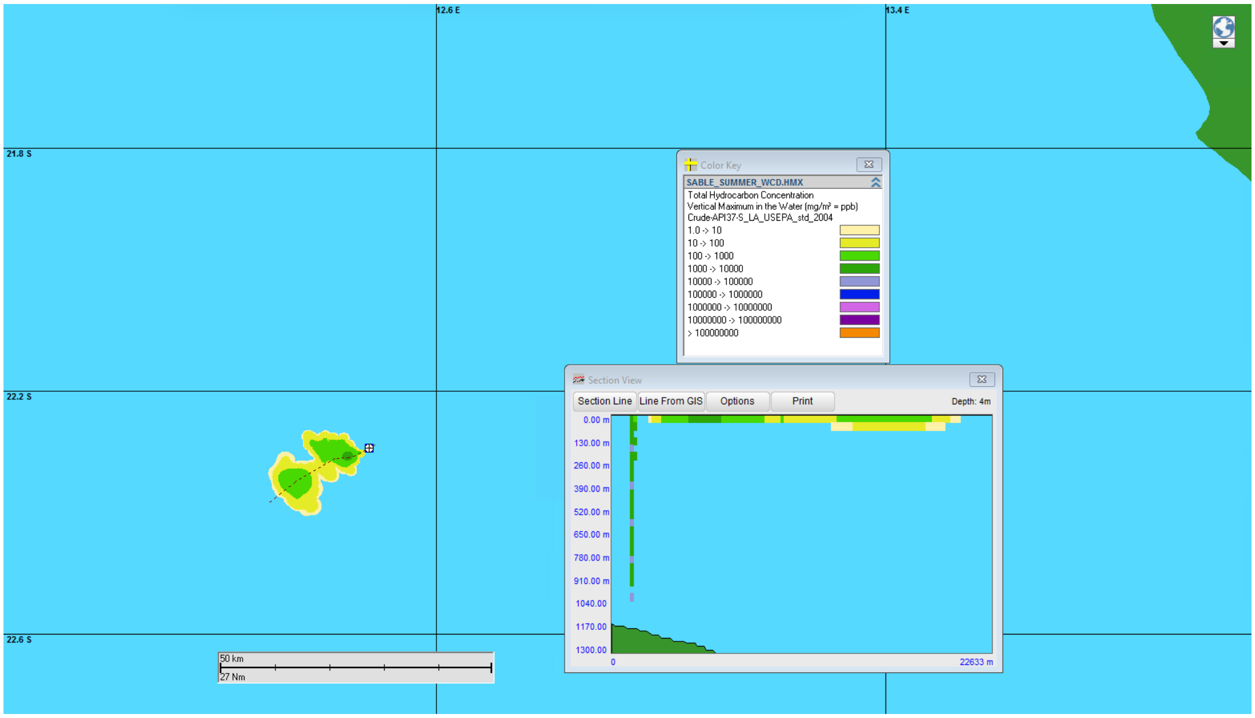


Figure 37. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Potential Second Well during the Summer (November – April) – Section view of water column data on day 2.

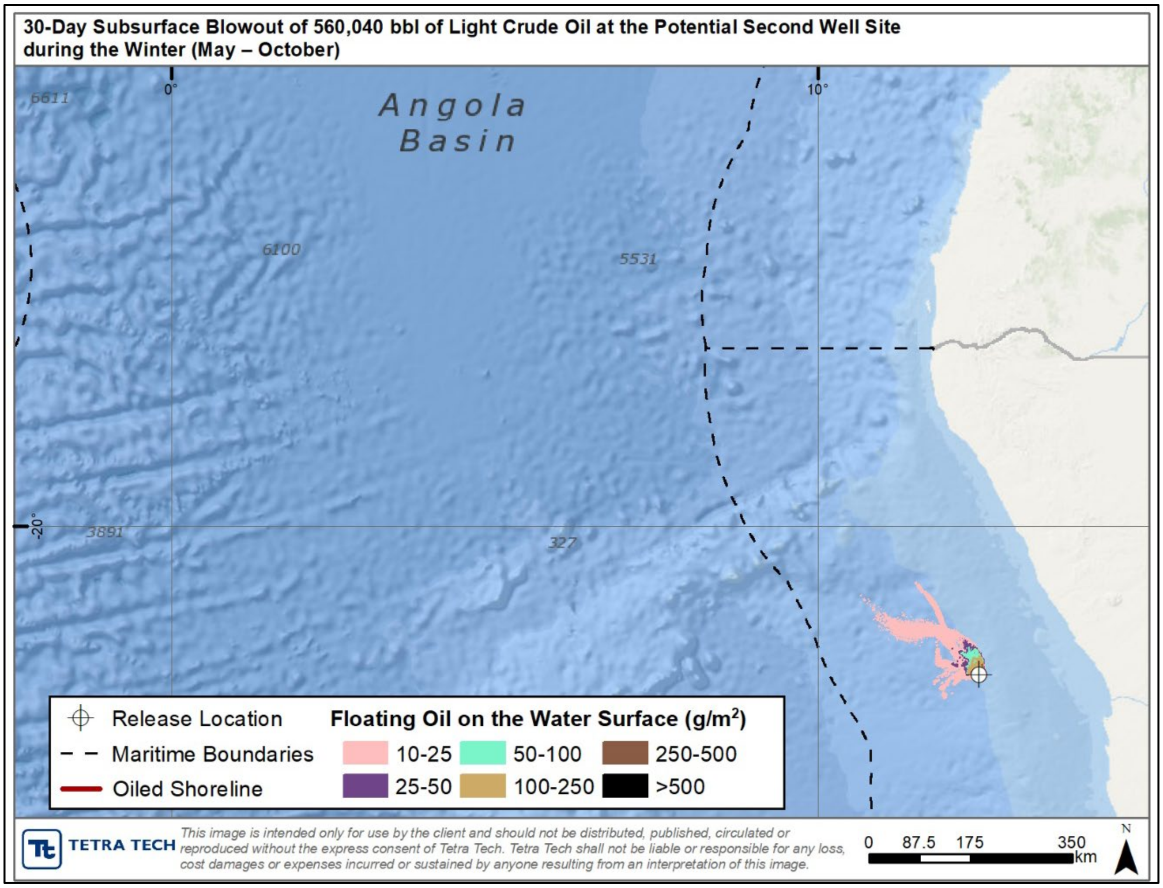


Figure 38. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Potential Second Well during the Winter (May – October) – Maximum Surface Oil Concentrations (>10 g/m^2) averaged over a grid cell and Associated Shoreline Oiling.

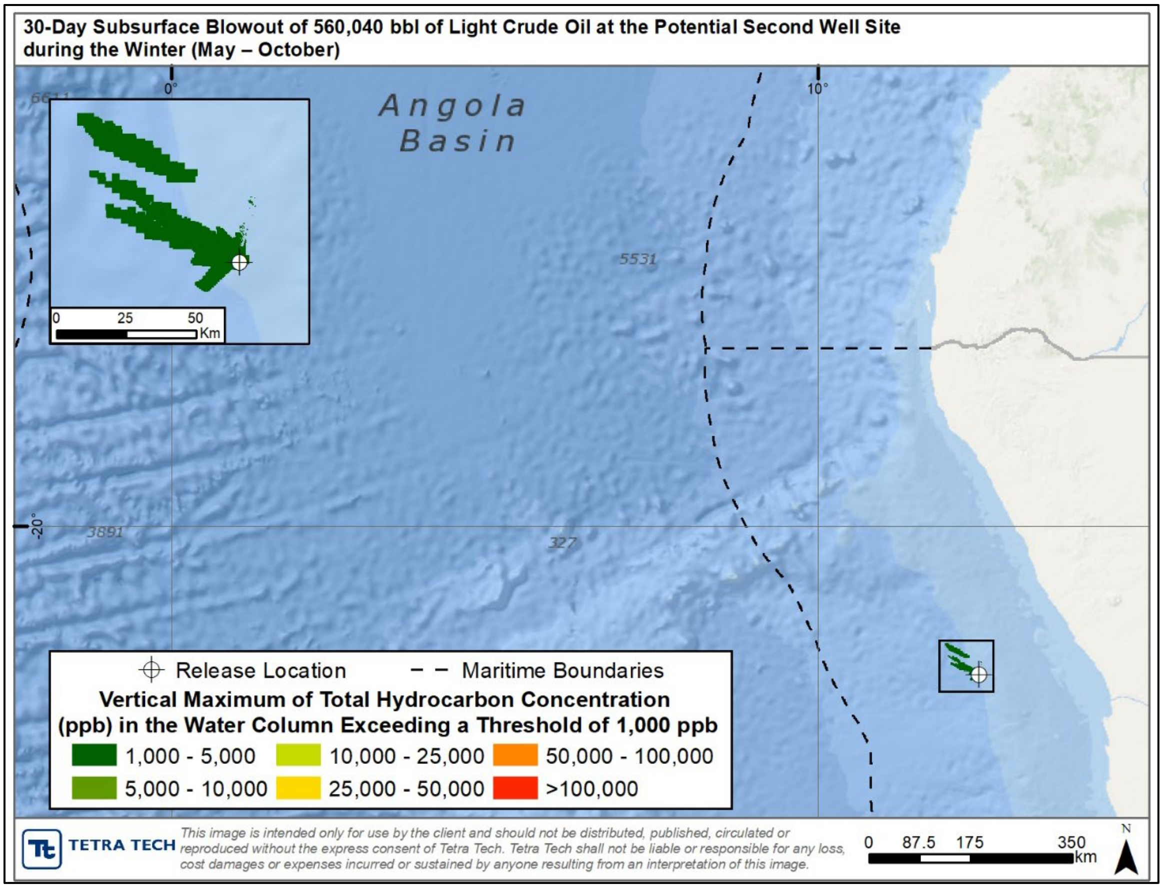


Figure 39. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Potential Second Well during the Winter (May – October) – Vertical Maximum Water Column Oil Concentrations (>1,000 ppb) averaged over a grid cell.

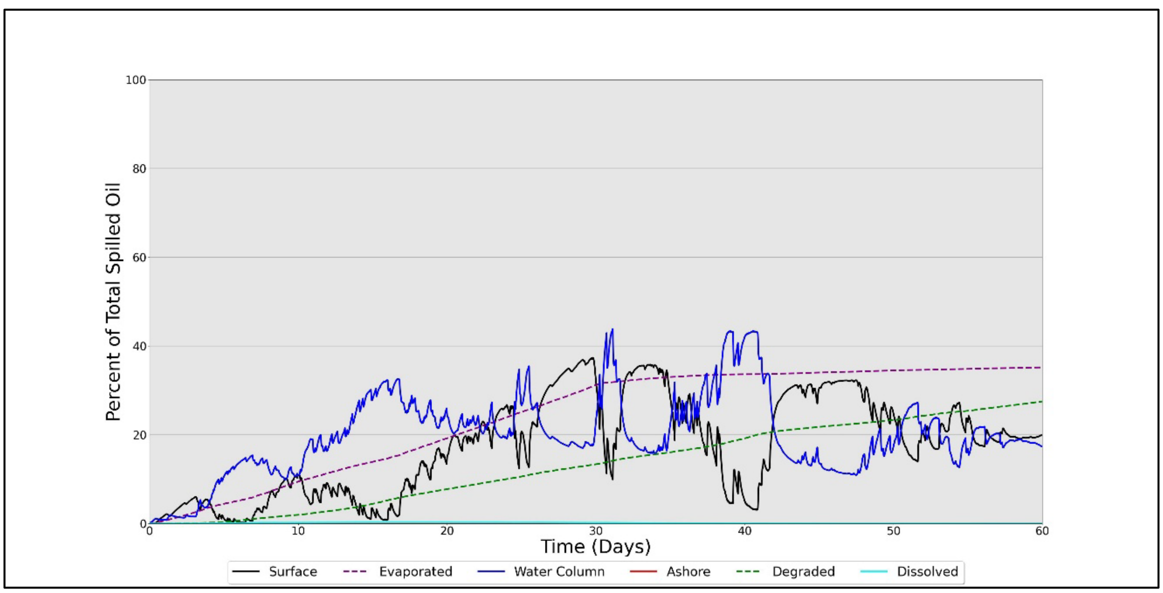


Figure 40. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Potential Second Well during the Winter (May – October) – Mass Balance Results.

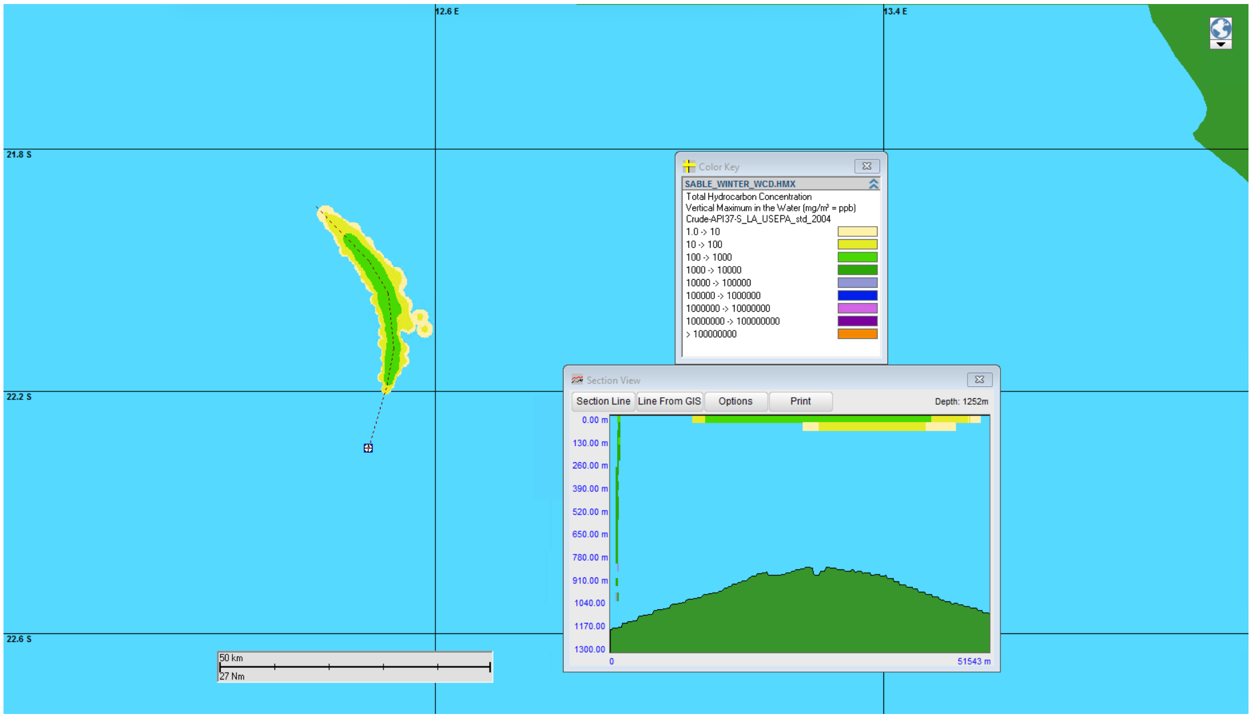


Figure 41. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Potential Second Well during the Winter (May – October) – Section view of water column data on day 2.

2.4.3 Shallow Well

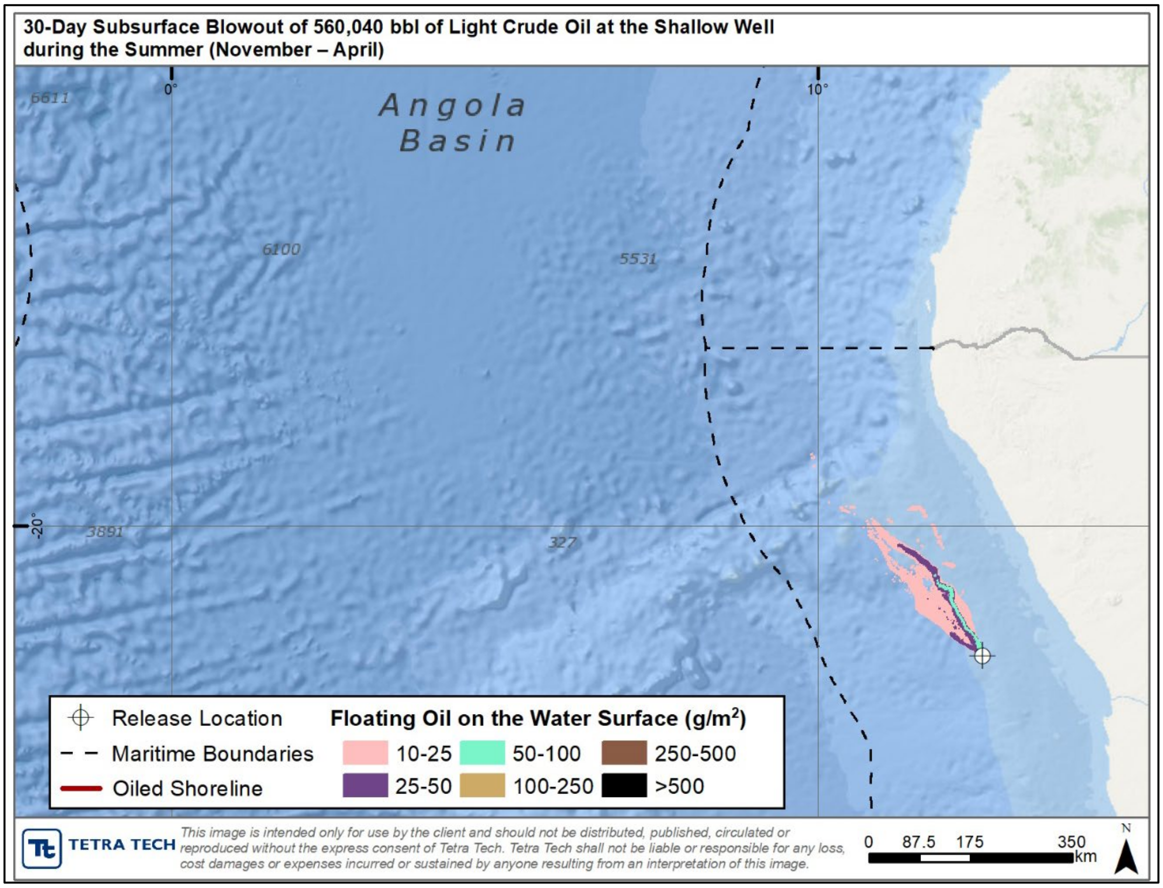


Figure 42. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Shallow Well during the Summer (November – April) – Maximum Surface Oil Concentrations (>10 g/m^2) averaged over a grid cell and Associated Shoreline Oiling.

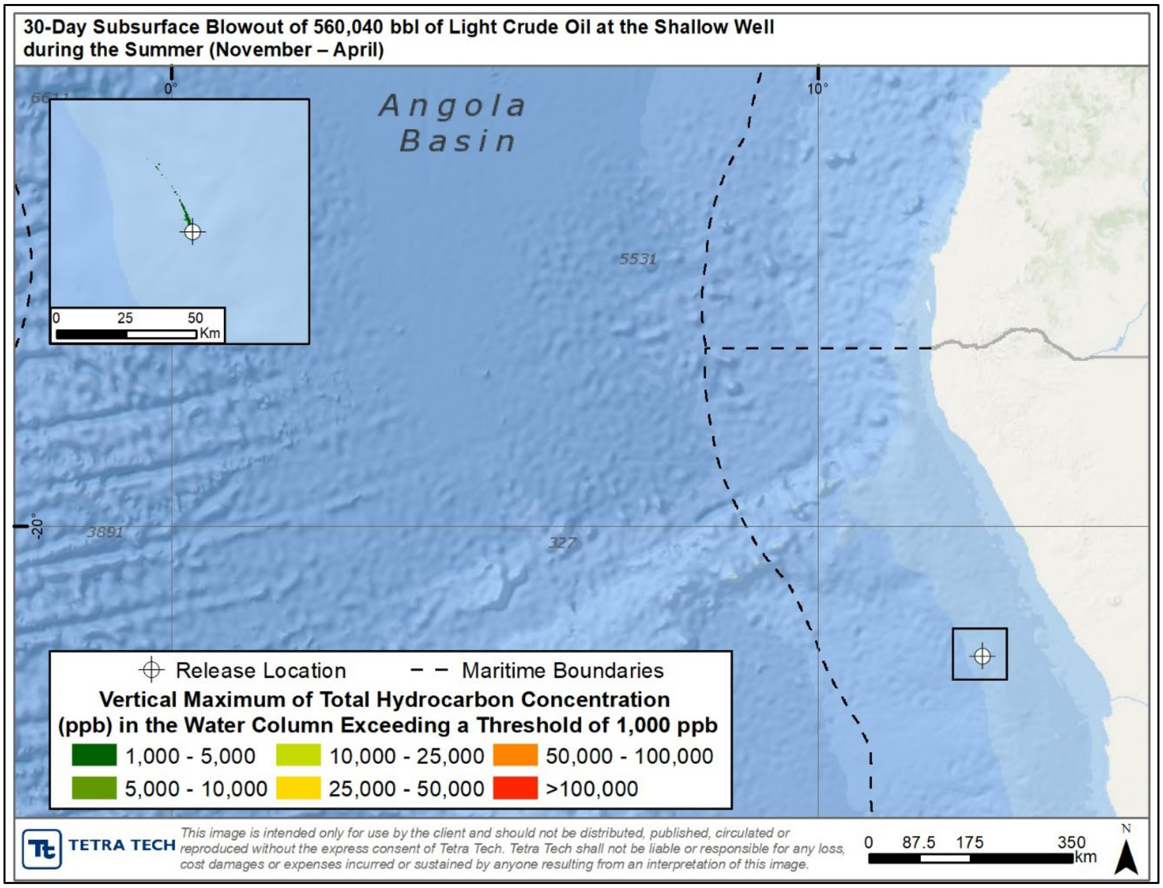


Figure 43. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Shallow Well during the Summer (November – April) – Vertical Maximum Water Column Oil Concentrations (>1,000 ppb) averaged over a grid cell.

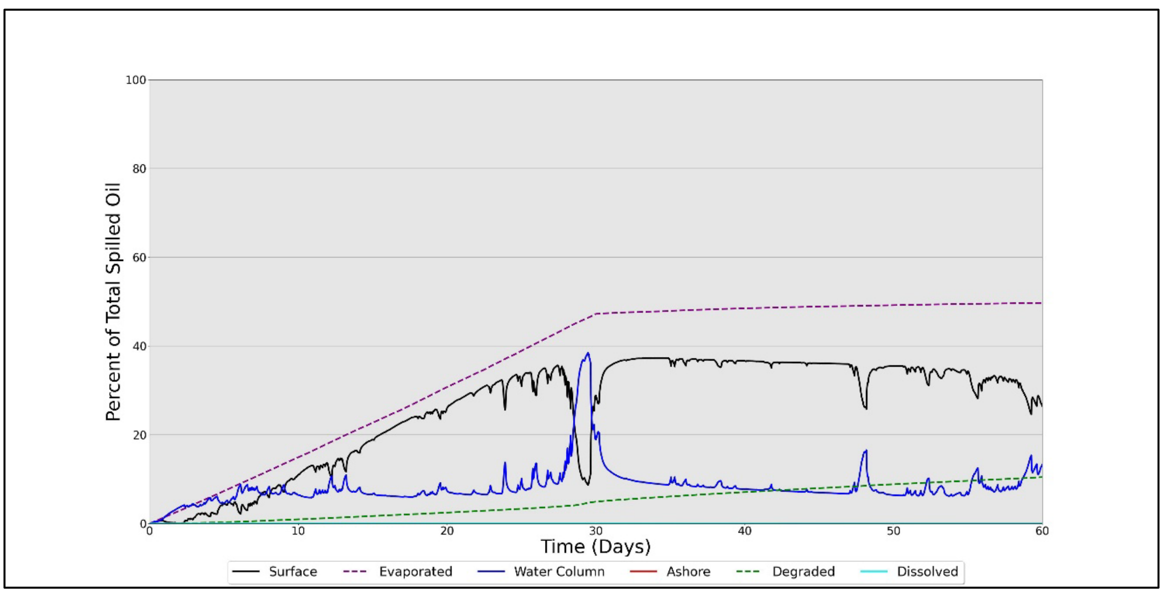


Figure 44. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Shallow Well during the Summer (November – April) – Mass Balance Results.

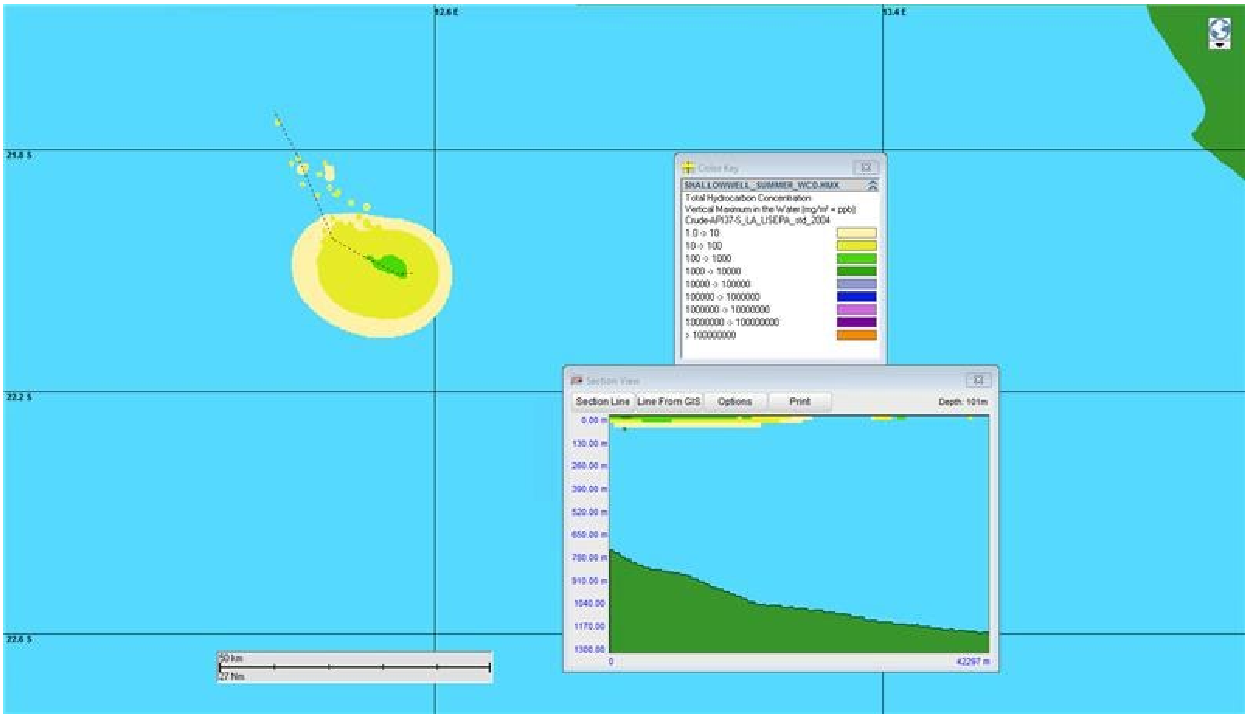


Figure 45. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Shallow Well during the Summer (November – April) – Section view of water column data on day 2.

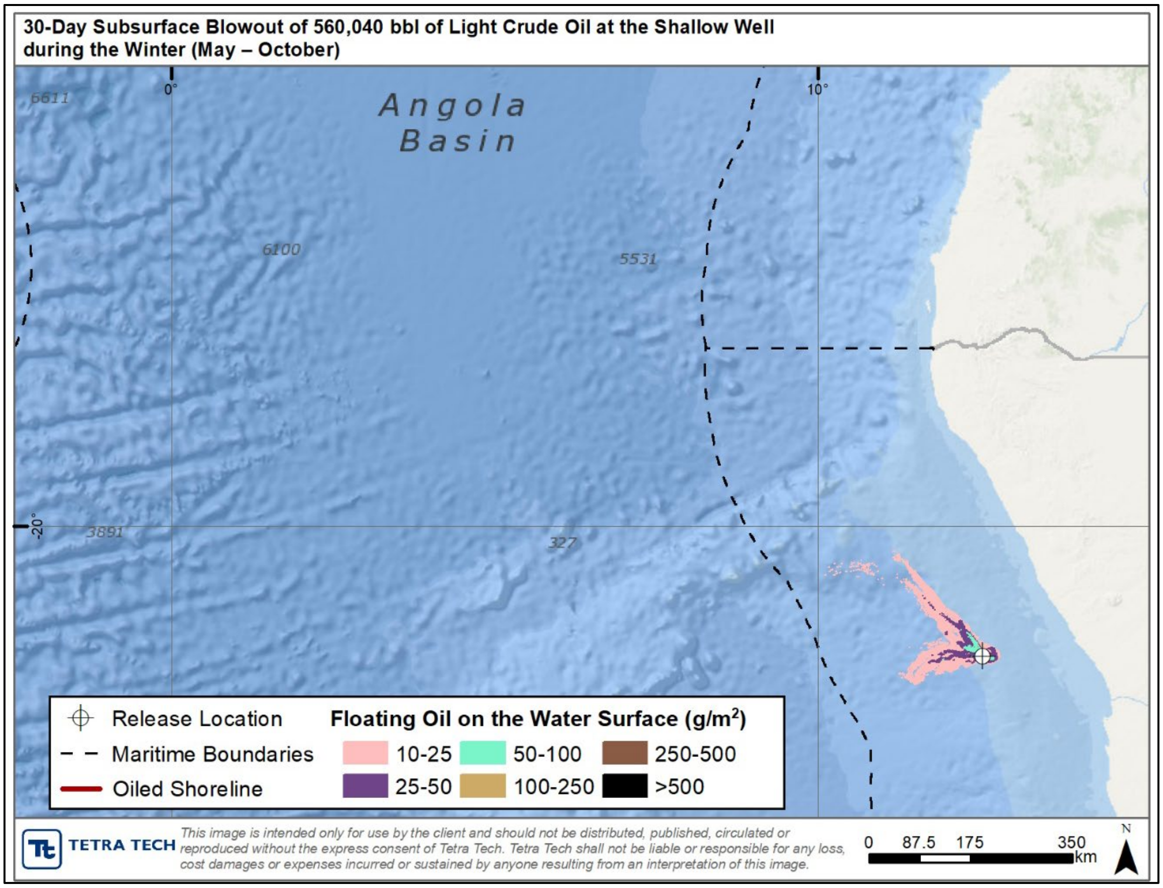


Figure 46. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Shallow Well during the Winter (May – October) – Maximum Surface Oil Concentrations (>10 g/m^2) averaged over a grid cell and Associated Shoreline Oiling.

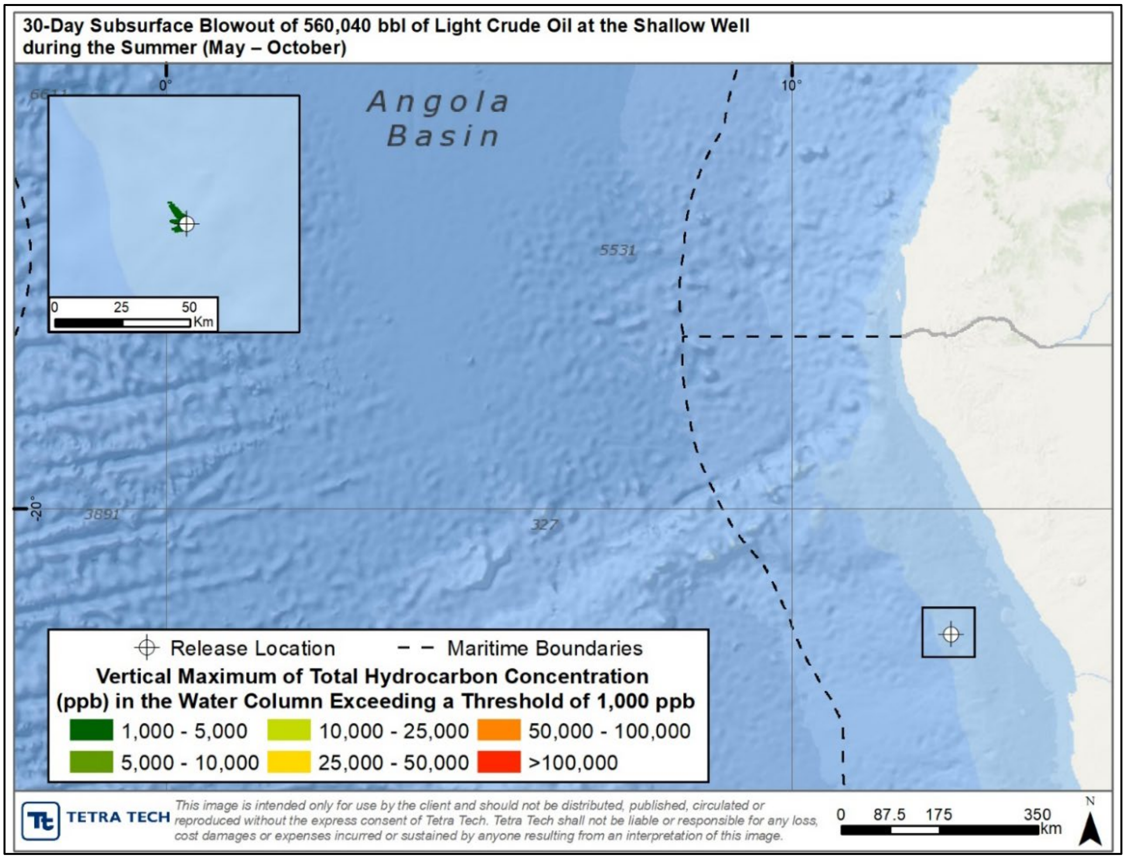


Figure 47. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Shallow Well during the Winter (May – October) – Vertical Maximum Water Column Oil Concentrations (>1,000 ppb) averaged over a grid cell.

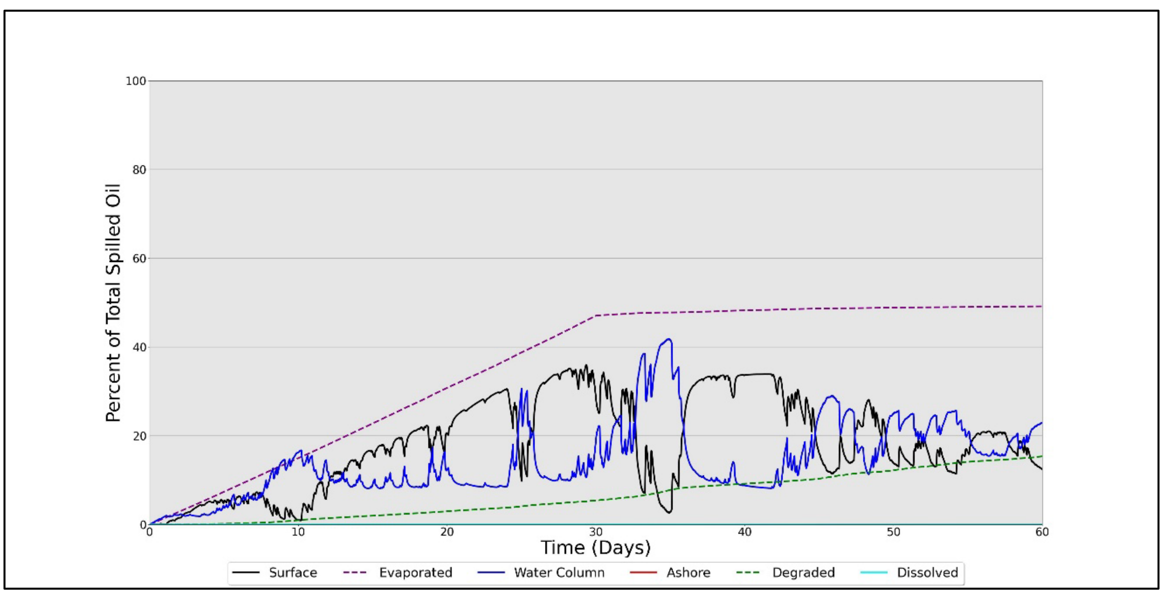


Figure 48. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Shallow Well during the Winter (May – October) – Mass Balance Results.

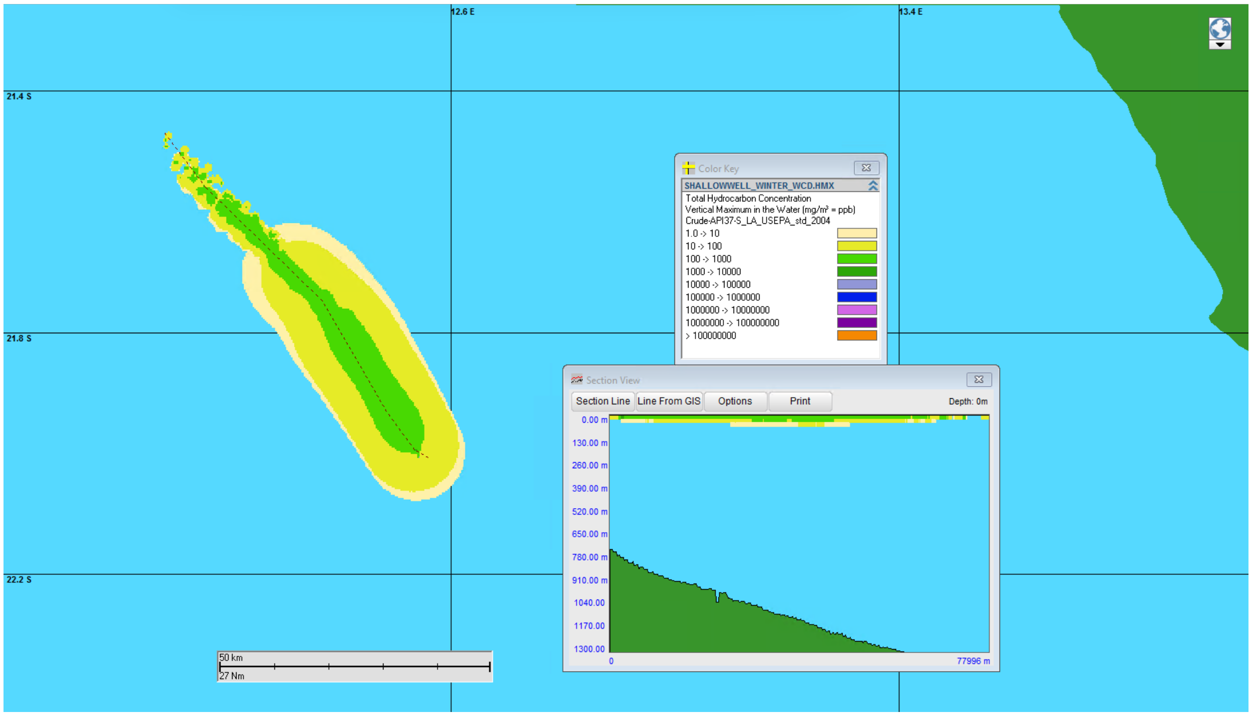


Figure 49. Worst-Case Deterministic Scenario – 560,040 bbl Light Crude Oil subsurface blowout at the Shallow Well during the Winter (May – October) – Section view of water column data on day 2.

3 CONCLUSIONS

In this study, ROS evaluated the trajectory and fate of hypothetical hydrocarbon spill events at three locations (Gemsbok, Potential Second Well, and Shallow Well) within the PEL 82 exploration license area, Block 2112B and Block 2212A, offshore Namibia. Each scenario modeled in this study was a 30-day release simulated for a total of 60 days. ROS' OILMAPDeep model evaluated the subsurface blowouts in the near field, and the ROS OILMAP/SIMAP Modeling System evaluated the releases in the far field. Each scenario was evaluated for two seasons: Summer (November – April) and Winter (May – October). The probability of impacts from these releases were described in the stochastic results (Section 2.3), and the impacts from representative worst-case deterministic scenarios were presented in Section 2.4.

An evaluation of the regional environmental conditions indicates that the prevailing winds are primarily from the south-southeast. Wind direction varies depending on proximity to the coastline: nearshore areas experience winds predominantly from the south to south-southeast, while offshore winds generally originate from the southeast. Wind speeds tend to increase during the winter season and decrease during the summer. Current direction varies from north to south via west. However, wind drift is the predominant forcing agent identified in the area.

For all scenarios evaluated, there was no predicted shoreline oiling due to the winds and currents transporting the oil offshore and the light nature of the Light Crude Oil, resulting in large amounts of evaporation and natural entrainment into the water column.

Although the scenario volumes were identical, the release depths of the subsurface blowouts ranged from 300 m (Shallow Well) to 1,200 m (Gemsbok). This variation led to different trap heights, which in turn affected the transport of oil both below the surface and at the surface. Due to these differences in the near field, the Shallow Well resulted in slightly larger stochastic surface footprints when compared to the other two release locations. Regardless of location, the stochastic surface oiling footprints exceeding 10 g/m^2 were predicted to be larger during the Summer Season.

For all six worst-case deterministic scenarios (regardless of the location or season), the released Light Crude Oil was primarily lost to evaporation (34% - 50%). Given the simulations involved a light oil with API 37.3 and a wind set where the 50th percentile wind speeds in the region were >4 m/s, it is reasonable that most of the volatile components within the Light Crude Oil evaporated to the atmosphere. As was the case with the stochastic scenarios, none of the representative worst-case scenarios resulted in shoreline oiling. The amount of oil remaining on the surface at the end of each deterministic scenario ranged from ~13 to 35% depending on the wind speeds during the simulation. In all cases, there was an oscillation of surface and water column oiling over the 60-day duration.

4 APPENDICES

4.1 Appendix A – Environmental Conditions and Data Analysis

To understand the behavior of marine spills, it is necessary to analyze and evaluate the predominant environmental conditions in the area of interest. Winds and currents are the key forcing agents that control the transport and weathering of oil following a release. To reproduce the natural variability of the environment, the oil spill model requires wind and current datasets that vary both spatially and temporally. Optimally, the minimum window of time for stochastic simulations is 5 years. Therefore, long-term records of wind and current data were obtained from the outputs of global numerical atmospheric and circulation models for this study.

The following sections describe the key environmental conditions that dominate in the region of interest and more specifically in the model domain. Figure 1 presents the location of environmental data collected for this study as described in the following sections.

4.1.1 General Dynamics and Climatology

The sites of interest are located offshore Namibia in the path of Benguela Current (BC), which is the eastern boundary current for the Subtropical Gyre of the South Atlantic Ocean. BC is driven by the southeast trade wind which is stable wind and does not show significant seasonal variation in speed and direction (Bakun and Nelson, 1991 and Shi et al., 2001).

The BC originates near the Cape of Good Hope, is fed by the South Atlantic Current and the Agulhas Current, moves parallel to the coast of southwest Africa and Namibia, and turns westward at about 18°S near Walvis Ridge (Berger et al. 1998). The northern boundary of BC is formed by the Angola-Benguela Front which separates BC from southward flowing Angola Current. The BC is associated with the Benguela Current Upwelling System (BCUS), which is one of the four major Eastern Boundary upwelling systems of the world’s oceans (Ekau et al., 2009). The BCUS stretches along the southwest African coast, roughly between 14°S and 37°S, encompassing the coastal upwelling regimes and the eastern part of the South Atlantic gyre (Figure 50). The offshore region of the BCUS is dominated by the BC while flow over continental shelf is influenced by prevailing winds (Shannon, 2001). Tidal currents in the near shore zone are weak (~0.1 m/s) (Elfrink et al., 2003).

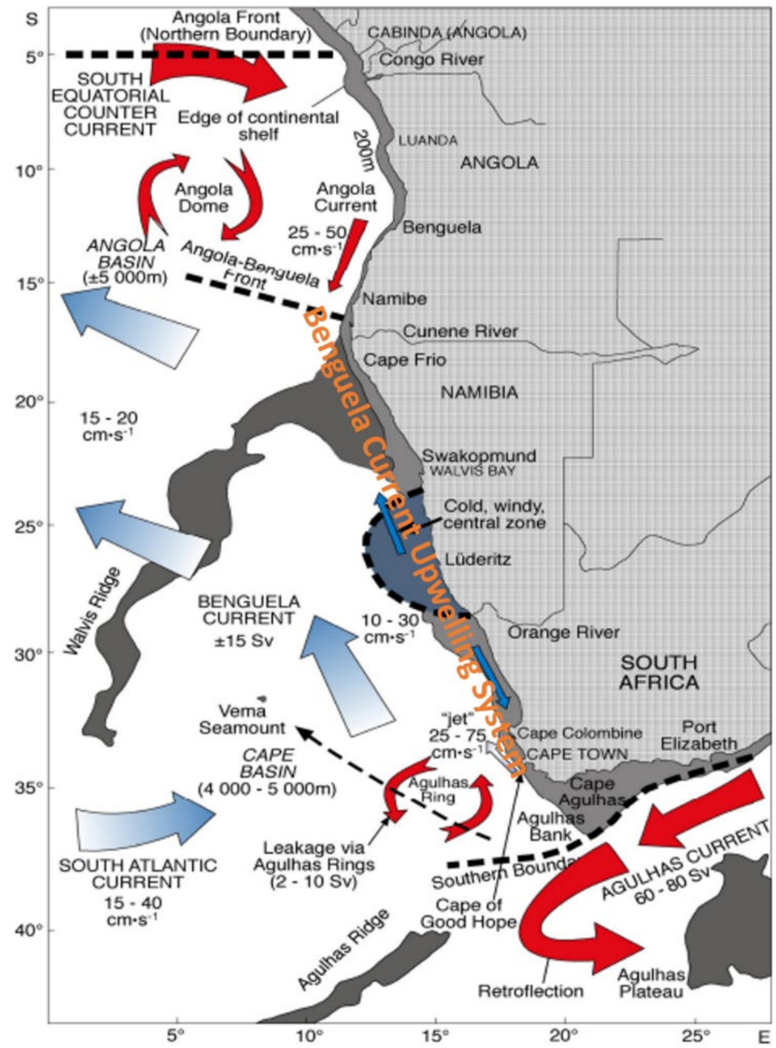


Figure 50. Offshore Namibia and oceanographic features in the region (adapted from Shannon (2006)).

The Benguela Marine Ecosystem, which is the region around BCUS, has been proposed to be listed as a World Heritage Site (UNESCO, 2019) due to its economic and ecological value. The BCUS has several upwelling cells along the coast, which bring nutrient-rich water up from around 200-300 m depth to the surface (UNESCO, 2019). Because of this enhanced primary productivity, the tBCUS region supports high biodiversity and biomass of marine organisms, including rich fish stocks, crustaceans, endemic marine mammals, and vast seabird colonies that generate guano, which is harvested and serves as an important economic resource for Namibia.

This study consists of three release locations in the waters offshore Namibia. As the metocean conditions are very similar at the release locations, only figures for Shallow Well are presented in this report. Data obtained from the World Ocean Atlas (WOA) Climatology dataset (Reagan et al., 2024; Locarnini et al., 2024) shows that the monthly SST at Shallow Well varies from approximately 15°C to 20°C (Figure 51). Warmest temperatures are observed from January to March while coolest temperatures were observed from July to September. The spill site shows relatively stable salinity (around 35.2 ppt.) throughout the year.

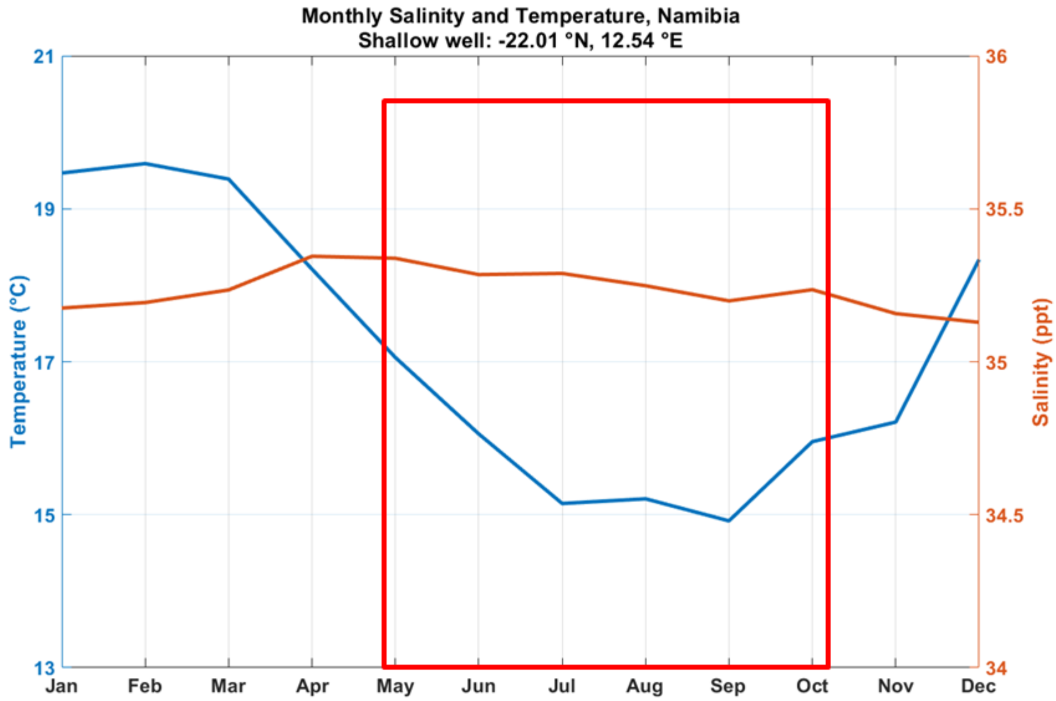


Figure 51. Monthly sea surface temperature (°C) in blue and salinity (ppt) in orange near Shallow Well, offshore Namibia, from WOA 2023 (Reagan et al., 2024; Locarnini et al., 2024). Red box shows the Winter Season.

Table 12. Seasonal breakdown at location based on CFSv2 wind and climatology of the region.

Season	Month Range	Rationale
Summer	November – April	Wind speed is relatively lower
Winter	May – October	Wind speed is relatively higher

4.1.2 Wind Dataset – CFSv2

For this study, wind data were obtained from the U.S. National Centers for Environmental Prediction (NCEP) Climate Forecast System version 2 (CFSv2) for a 5-year period (2020 – 2024; Table 13). The CFSv2 was designed and executed as a global, high-resolution, coupled atmosphere-ocean-land surface-sea ice system to accurately estimate the state of these coupled domains (Saha et al., 2014). This atmospheric model has a horizontal resolution of 38 km, with 64 vertical levels extending from the surface to the height at which air pressure reaches 0.26 hPa.

Table 13. The specifics of the wind dataset used for the modeling.

Name of Dataset	CFSv2
Coverage	-18°E to 20°E; 15°N to -35°N
Owner/Provider	NCEP (US)
Horizontal Grid Size	0.5° x 0.5°
Hindcast Period	2020 – 2024
Time Step	1-hour

The following figures provide a graphical description of the CFSv2 winds in this region to understand their variability, both spatially and temporally. The wind figures at the location were derived using distance-weighted interpolation from four surrounding CFSv2 nodes.

- Figure 52 – Spatial distribution of CFSv2 annual wind roses offshore Namibia.
- Figure 53 – Annual CFSv2 wind rose near Shallow Well.
- Figure 54 – Monthly average and 95th percentile CFSv2 wind speed statistics near Shallow Well.
- Figure 55 – Monthly CFSv2 wind roses near Shallow Well.

All figures display wind data in the meteorological convention. Roses indicate the direction which winds are blowing from in m/s.

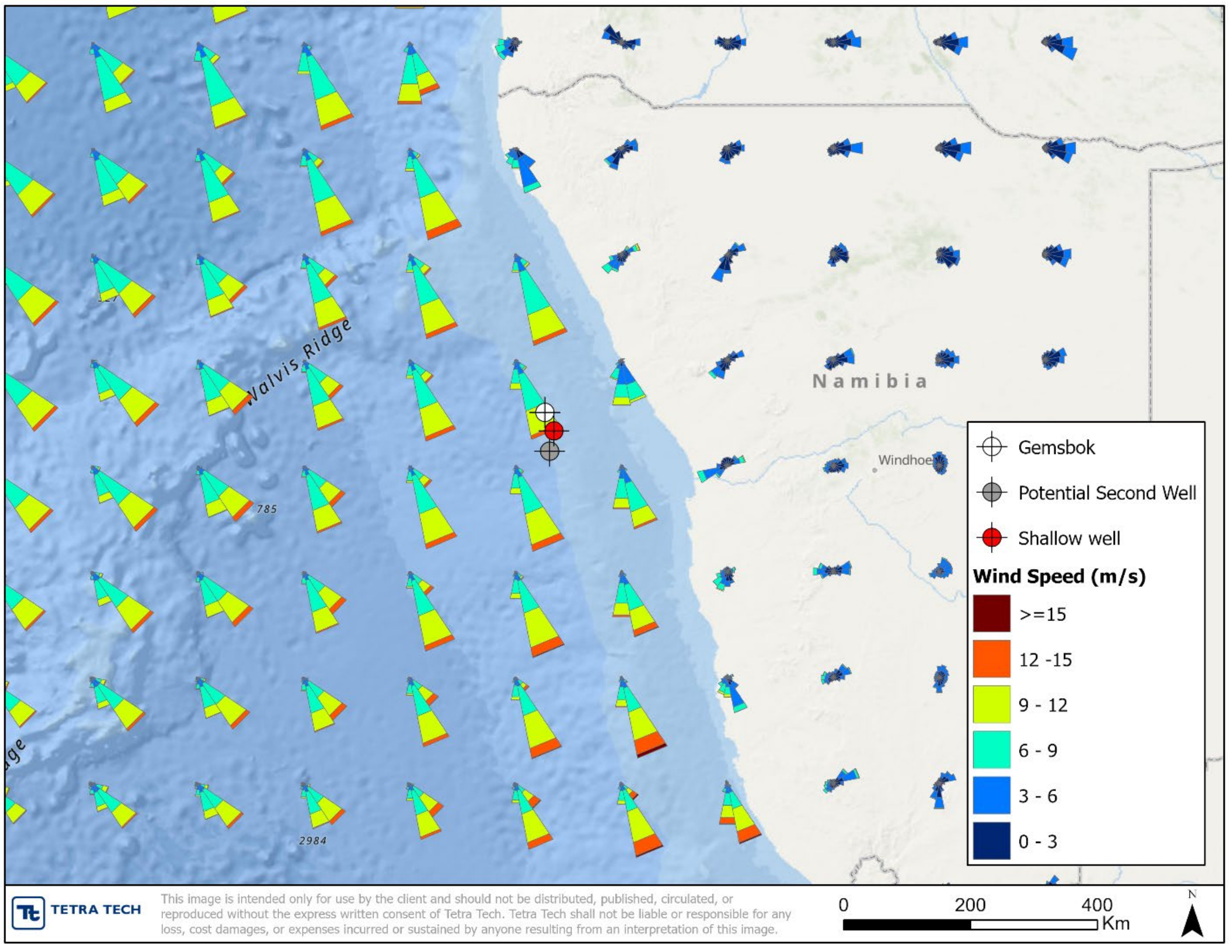


Figure 52. Spatial distribution of CFSv2 annual wind speed and direction offshore Namibia (in m/s).

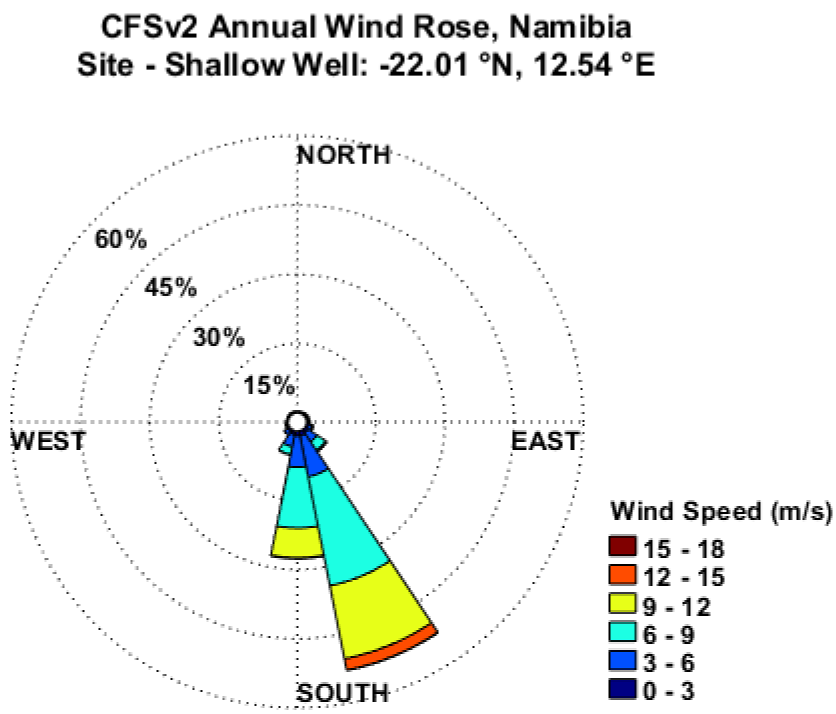


Figure 53. Annual CFSv2 rose near Shallow Well, offshore Namibia. Wind speeds in m/s, using meteorological convention (i.e., direction wind is coming from).

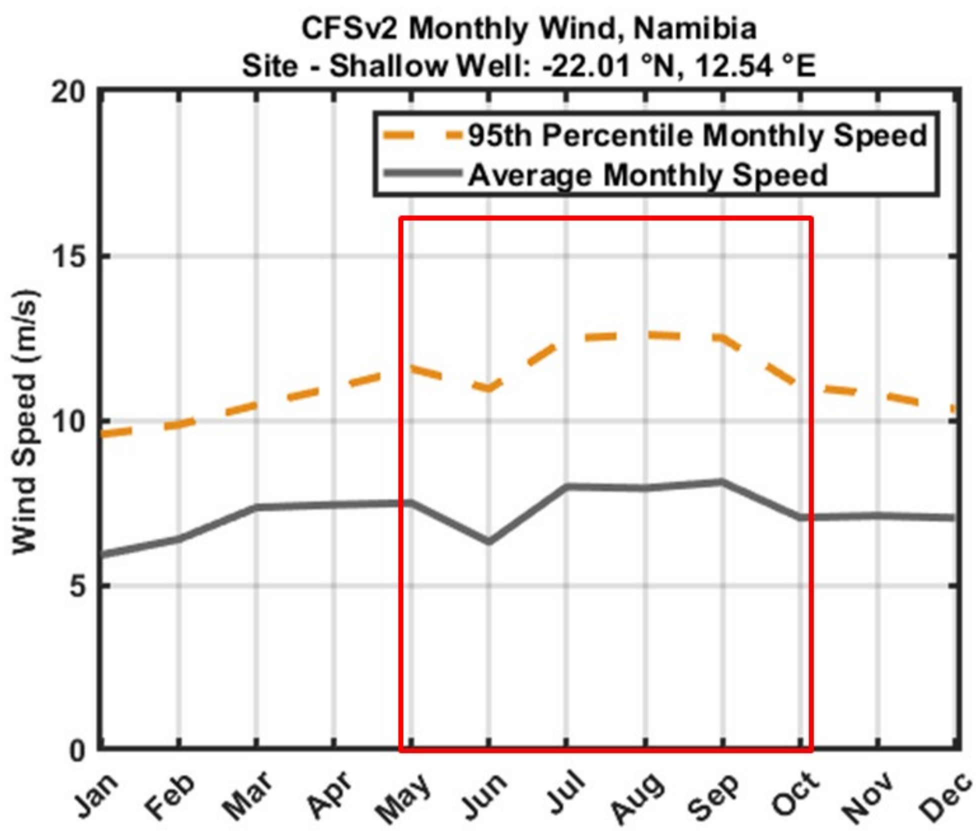


Figure 54. Monthly average (grey solid) and 95th percentile (orange dashed) CFSv2 wind speed statistics near Shallow Well. Wind speed reported in m/s. The red box shows the Winter Season.

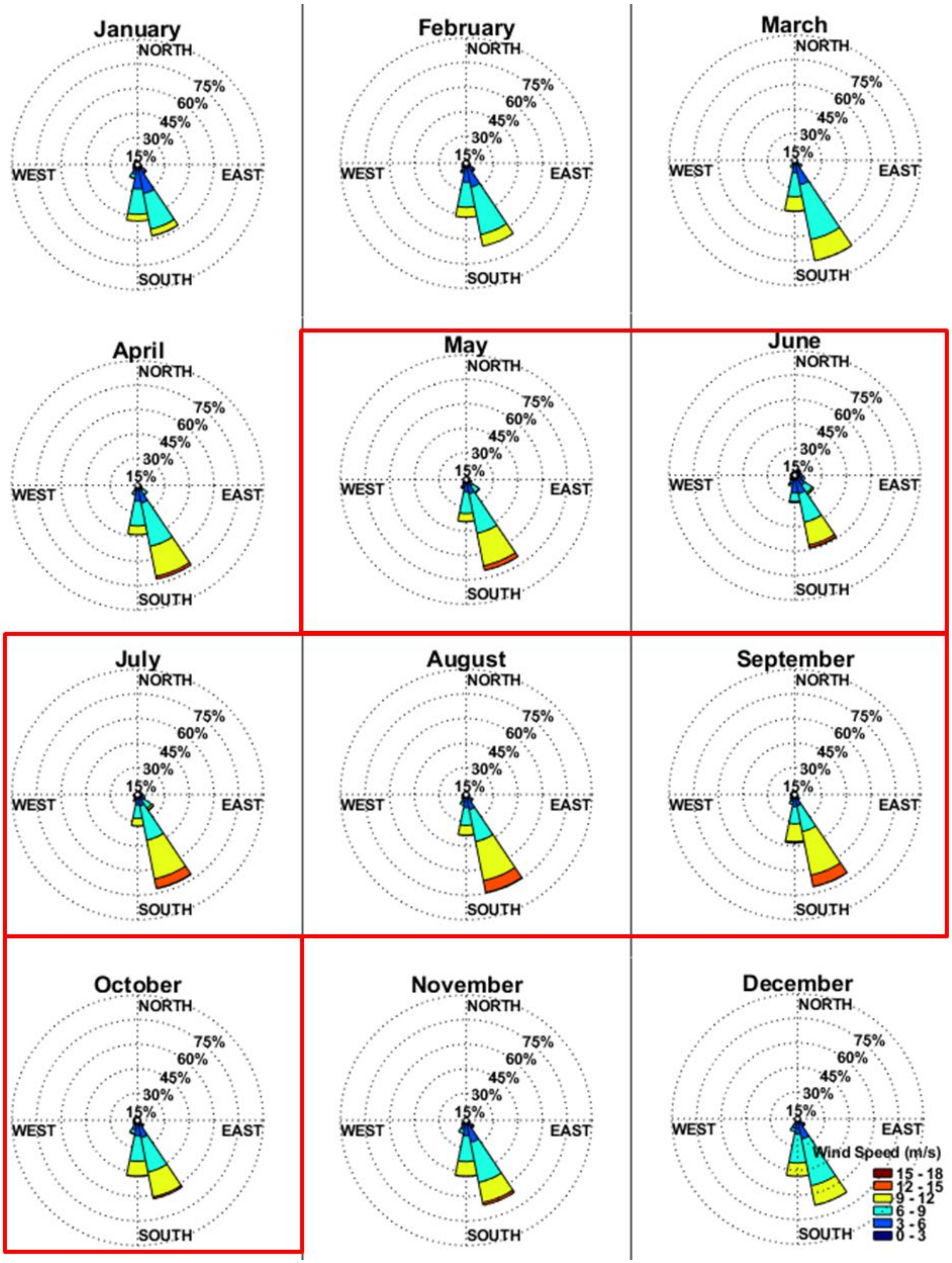


Figure 55. Monthly CFSv2 wind roses near Shallow Well. Wind speeds in m/s, using meteorological convention (i.e., direction wind is coming from). The red box shows the Winter Season.

Based on this global wind dataset and figures presented here, the following conclusions can be drawn:

- Wind direction varies as a function of the location and distance to the coast. Close to the shore, winds blow from the south/south-southeast, while the offshore winds come from the southeast sector. On land, wind varies in direction, and its magnitude decreases significantly.
- Near the spill site, wind is predominantly blowing from south-southeast.
- Monthly average wind speed ranges from 6 to 8 m/s. The 95th percentile wind speed ranges from approximately 10 to 13 m/s, with the strongest wind found in the Winter Season.

4.1.3 Current Dataset – HYCOM

Current data was obtained from the HYCOM (HYbrid Coordinate Ocean Model) global simulation from the US Naval Research Laboratory. This dataset captures the oceanic large-scale circulation in the study area. The Navy Coupled Ocean Data Assimilation (NCODA) uses the model forecast as a first guess in a three-dimensional (3D) variational scheme and assimilates available satellite altimeter observations from the Naval Oceanographic Office (NAVOCEANO) Altimeter Data Fusion Center, in-situ Sea Surface Temperature (SST), and available in-situ vertical temperature and salinity profiles from XBTs (Expendable Bathythermographs), Argo floats, and moored buoys. Details of the data assimilation procedure are described in Cummings and Smedstad (2013) and Cummings (2005). Ocean dynamics, including geostrophic and wind-driven currents, are reproduced by the model.

Table 14. The specifics of the current datasets used for the modeling.

Name of Dataset	HYCOM (GLBy0.08/expt_93.0)
Coverage	-18°E to 20°E; 15°N to -35°N
Owner/Provider	Naval Research Laboratory (USA)
Horizontal Grid Size	0.08° longitude x 0.04° latitude
Hindcast Period	2020 – 2024
Time Step	24-hour

The following figures describe the variability of current speed and direction near the potential spill site based on the regional datasets:

- Figure 56 – Spatial distribution of the HYCOM averaged (2020-2024) current intensity and direction map.
- Figure 57 – Annual HYCOM surface current rose near Shallow Well.
- Figure 58 – Monthly average and 95th percentile HYCOM current speed statistics near Shallow Well.
- Figure 59 – HYCOM monthly surface current roses near Shallow Well.

All figures display current data in the oceanographic convention. Roses indicate the direction which currents are flowing toward.

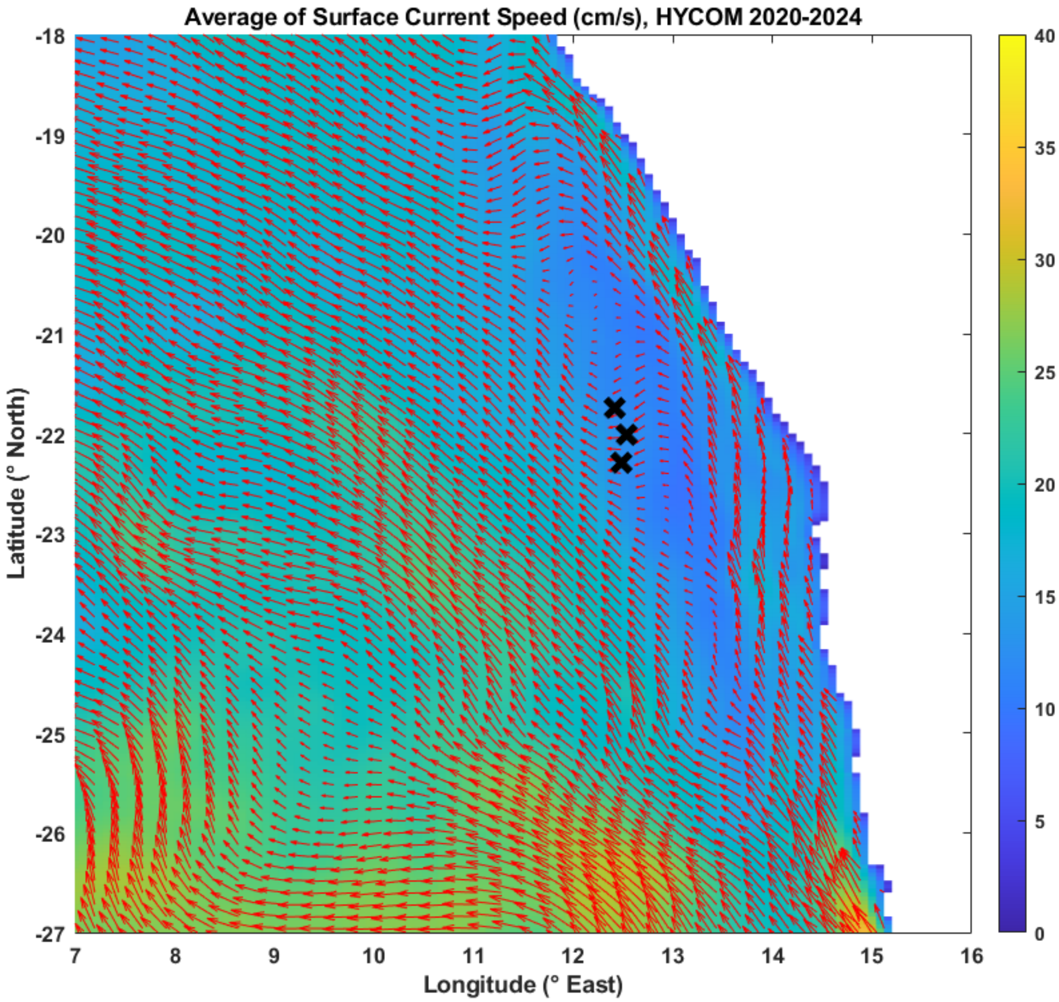


Figure 56. HYCOM surface current speed (cm/s) averaged over the period of 2020 to 2024. Black crosses represent the release locations.

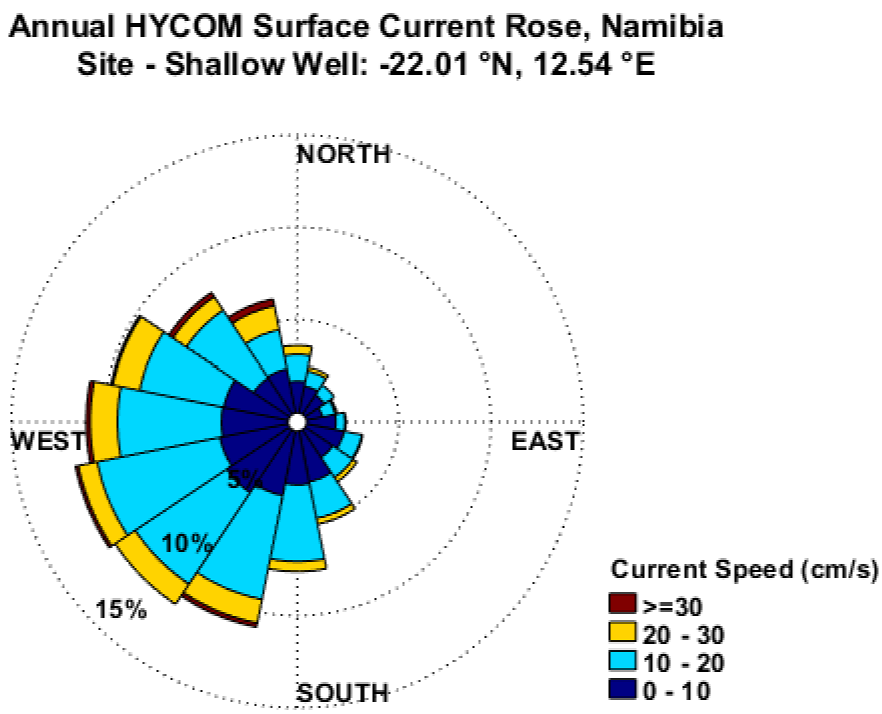


Figure 57. Annual HYCOM rose near Shallow Well for 2020-2024. Currents following oceanographic convention (currents flowing towards in cm/s).

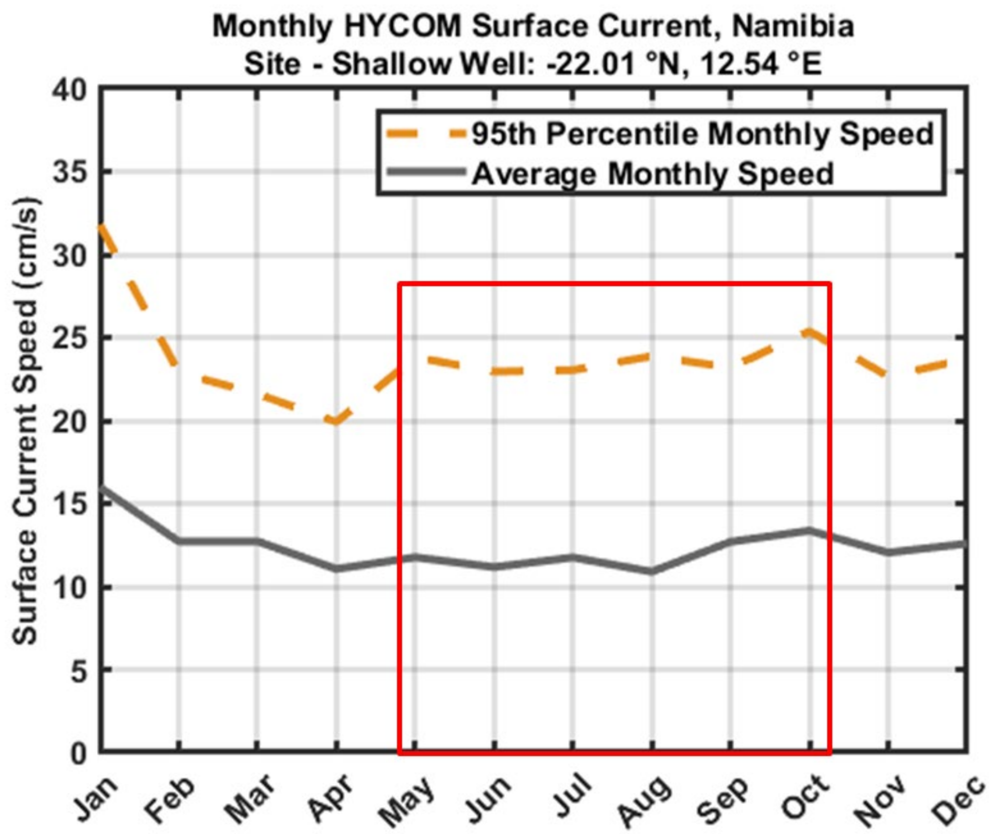


Figure 58. Monthly average (grey solid) and 95th percentile (orange dashed) HYCOM current speed (cm/s) statistics near Shallow Well. Red box shows the Winter Season.

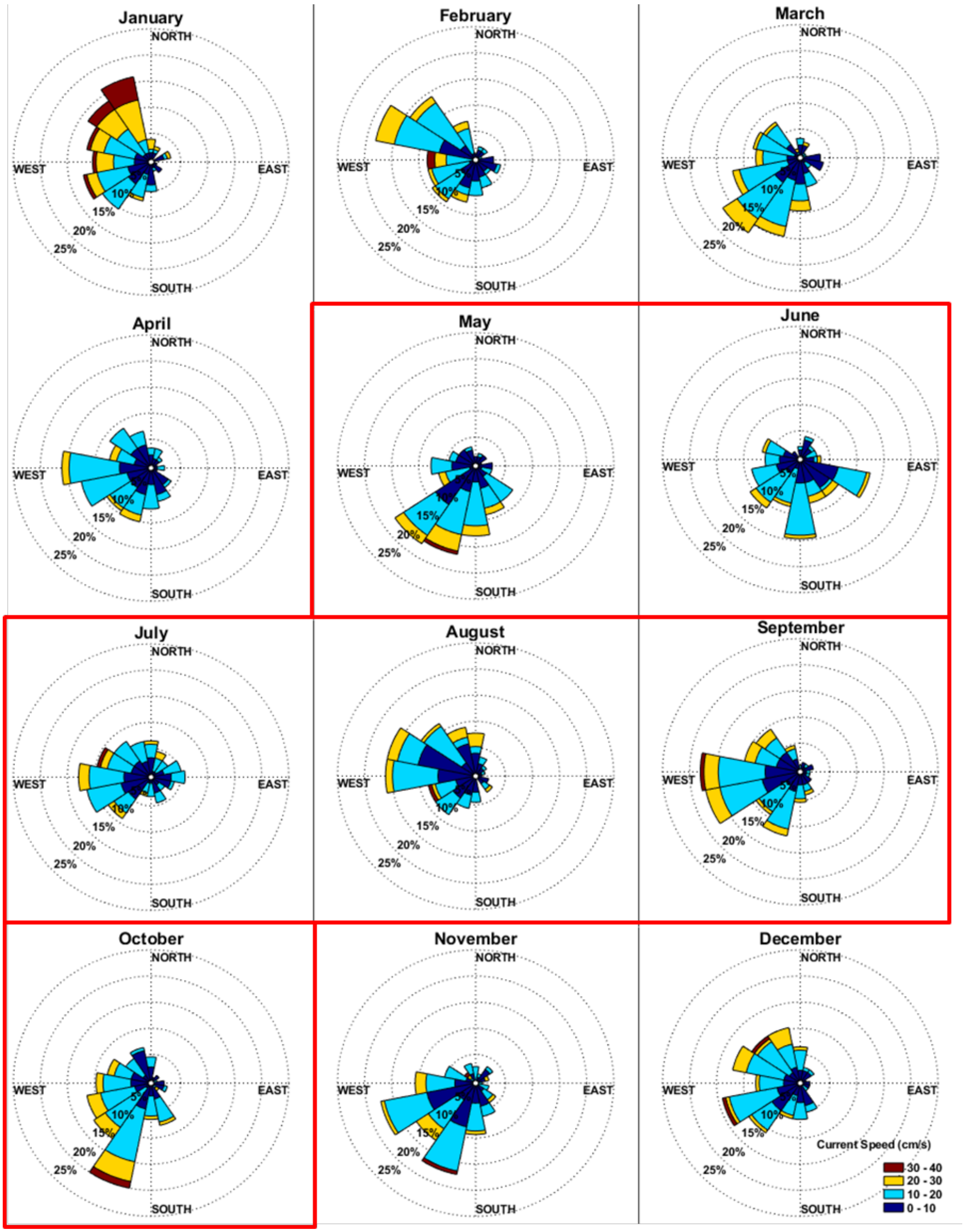


Figure 59. Monthly HYCOM surface current roses near Shallow Well. Currents following oceanographic convention (currents flowing towards in cm/s). Red box shows the Winter Season.

Based on the analysis of HYCOM model output, the following conclusions can be drawn:

- The annually-averaged HYCOM surface current offshore Namibian coast shows the presence of the northwestward-flowing BC.
- The annual HYCOM surface current rose at Shallow Well shows current direction usually varies between north and south via west.
- The current speed close to Shallow Well is slow and about 11 cm/s to 16 cm/s on average. The 95th percentile currents range from roughly 20 to 32 cm/s.
- The current direction does not show significant seasonal variation at Shallow Well.

4.1.4 Surface Transport

To evaluate the relative influence of wind-driven versus current-driven surface transport, wind drift speeds and current speeds were compared at a location near Shallow Well, as illustrated in Figure 60. In this analysis, wind drift was estimated to be 3.5% of the wind speed. Based on this analysis, wind drift is stronger than the associated current in both seasons. Therefore, wind will likely be the predominant forcing agent for floating slicks at Shallow Well.

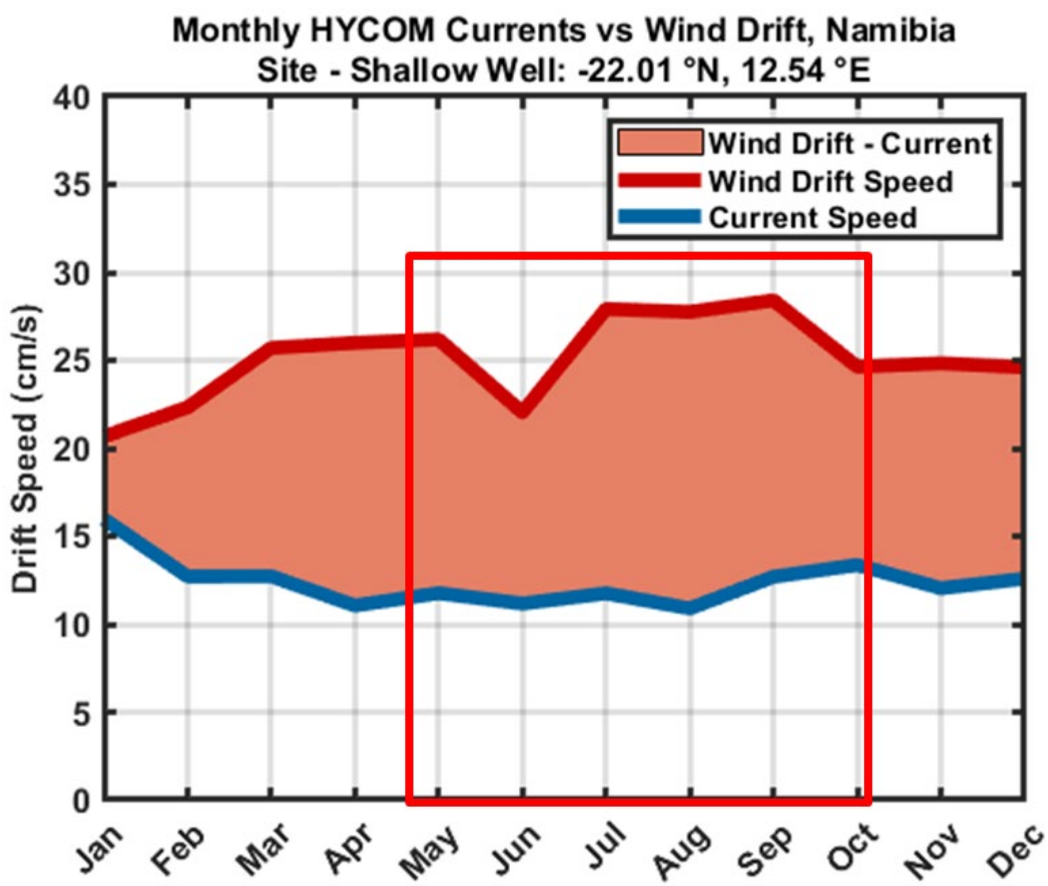


Figure 60. Surface drift forcing comparison statistics near Shallow Well: monthly-averaged CFSv2 wind drift compared with HYCOM current speed. Wind drift is calculated as 3.5% of the wind speed. Periods with predominant wind transport are shaded pink. Red box shows the Winter Season.

4.2 Appendix B – OILMAP/SIMAP Oil Spill Modeling System – Description

4.2.1 OILMAP/SIMAP Introduction

OILMAP is ROS' comprehensive modeling system; it is made of several interactive modules to reproduce the transport and fate of oil releases in different environments, land, water and atmosphere. The impact assessment module – SIMAP – was derived from the physical fates and biological effects submodels in the Natural Resource Damage Assessment Models for Coastal and Marine and Great Lakes Environments (NRDAM/CME and NRDAM/GLE), which were developed for the U.S. Department of the Interior (USDOI) as the basis of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) Natural Resource Damage Assessment (NRDA) regulations for Type A assessments (French et al., 1996; Reed et al., 1996). The physical fates model has been validated with more than 20 case histories, including the Exxon Valdez and other large spills (French McCay, 2003, 2004; French McCay and Rowe, 2004), as test spills designed to verify the model's transport algorithms (French et al., 1997). The wildlife mortality model has been validated with more than 20 case histories, including the Exxon Valdez and other large spills, verifying that these values are reasonable (French and Rines, 1997; French McCay 2003, 2004; French McCay and Rowe, 2004). The technical documentation for SIMAP is in French McCay (2003, 2004, 2009).

Applications for OILMAP/SIMAP include impact assessment; hindcast/forecast of spill response; Natural Resource Damage Assessment (NRDA); contingency planning; ecological risk assessment; cost-benefit analysis, and drills and education. The model may be run for a hindcast/forecast of a specific release or be used in stochastic mode to evaluate the probable distribution of contamination.

OILMAP/SIMAP contains several major components:

- The physical fates model estimates surface distribution and subsurface concentrations of the spilled oil and its components over time.
- The biological effects model estimates impacts resulting from a spill scenario on fish, invertebrates, wildlife, and for each of a series of habitats (environments) affected by the spill.
- The probability of impact from an oil discharge is quantified using the three-dimensional stochastic model.
- Currents that transport contaminants(s) and organisms are entered using the graphical user interface or generated using a (separate) hydrodynamic model. Alternatively, existing current data sets may be imported.
- Environmental, chemical, and biological databases supply required information to the model for computation of fates and effects.
- The user supplies information about the spill (time, place, oil type, and amount spilled) and some limited environmental conditions at the time (such as temperature and wind data).

As with ROS' other modeling systems, OILMAP/SIMAP is easily applied to a wide variety of conditions. It is set up and runs within ROS' standard Geographic Information System (GIS) or ESRI's ArcView GIS and can be applied to any aquatic environment (fresh or salt) in the world. It uses any of a variety of hydrodynamic data file formats (1-, 2- and 3-dimensional; time varying or constant) and allows 2-D vertically-averaged current files to be created within the program system when modeled currents are not available. Outputs include easily interpreted visual displays of dissolved and particulate concentrations and trajectories over time, as appropriate to the properties of the chemical being simulated. An optional biological exposure model is available to evaluate areas and volumes exposed above concentrations of concern and to predict the impacts on exposed fish and wildlife.

OILMAP/SIMAP specifically simulates the following processes:

- initial plume dynamics;
- slick spreading, transport, and entrainment of floating oil;
- evaporation and volatilization (to atmosphere);
- Transport and dispersion of entrained oil and dissolved aromatics in the water column;
- dissolution and adsorption of entrained oil and dissolved aromatics to suspended sediments;
- sedimentation and re-suspension;
- natural degradation
- shoreline entrainment, and
- boom and dispersant effectiveness.

The physical and biological models require environmental, oil and biological data as inputs. One of ROS' strengths is the ability to synthesize data from disparate sources. The data come from many sources including government and private data services, field studies and research. Modeling techniques are used to fill in "holes" in the observational data, thus allowing complete specification of needed data. The environmental database is geographical, including data of the following types: coastline, bathymetry, shoreline type, ecological habitat type, and temporally varying ice coverage and temperature. This information is stored in the simplified geographic information system. The chemical database includes physical-chemical parameters for a wide variety of oils and petroleum products. Data have been compiled by ROS from existing, but diffuse, sources.

An oil spill is simulated using site-specific wind, current, and other environmental data gathered from existing information, on-line services, and/or field studies. Shoreline and habitat types, as well as bathymetry, are mapped and gridded for use as model input. The physical, chemical, and toxicological properties of the spilled oil are provided by the oil database or updated to the specific conditions of the release. The model estimates the fate of the oil over time. The model outputs are time-varying concentrations and mass per unit area on surfaces (i.e., water surface, shoreline, sediments), which quantifies exposure to aquatic biota and habitats. Atmospheric loading in space and time is also computed and provides input to air dispersion models.

4.2.2 Model Uncertainty / Limitations

The model has been developed over many years to include as much information as possible to simulate the fates and effects of oil spills. However, as in all science, there are significant gaps in knowledge and the ability to simulate the detailed behavior of organisms and ecosystems. Typically, assumptions based on available scientific information and professional judgment are made in the development of the model, which represent our best assessment of the processes and potential mechanisms for effects (consequences) that would result from oil spills.

The major sources of uncertainty in the oil fates and biological effects model are:

- Oil contains thousands of chemicals of varying physical and chemical properties that determine their fate in the environment. In addition, those chemicals (their properties) change over time. The model must treat the oil as a mixture of a limited number of hydrocarbon components, grouping chemicals by physical-chemical properties.

- The fates model contains a series of algorithms that are simplifications of complex physical-chemical processes. These processes are understood to varying degrees but can dramatically vary depending on the environmental conditions (e.g. cold vs warm waters).
- Organisms are assumed uniformly distributed in affected habitats they occupy for the duration of the spill simulation. The accuracy of this assumption varies between organisms, but the objective is to assess potential effects for an average-expected condition, which is what this assumption most closely resembles.
- Biological effects are quantified based on acute exposure and toxicity of contaminant concentrations as a function of degree and duration of exposure. The SIMAP model used is not designed to address long-term, chronic exposure to pollutants.
- The model treats each spill as an isolated pollution event and does not account for any potential cumulative effects.
- Various physical / environmental parameters including river flow, depth / sea bottom roughness, total suspended solids concentration, etc. were not sampled extensively at each location of the extended domain (hundreds of square kilometers). What limited data that did exist was applied to each location, leading to a certain degree of homogenization of the environmental (marine/coastal) conditions.

In addition, in any given oil spill, the fates and effects will be highly related to the specific environmental conditions, the precise locations of organisms, and a myriad of details related to the event. Thus, the results are a function of the scenarios simulated and the accuracy of the input data used. The goal of this study was not to capture every detail that could potentially occur, but to describe the range of possible consequences so that an informed analysis could be made as to the likely effects of spills under various scenarios. The model inputs are designed to provide representative conditions to such an analysis. Thus, the modeling is used to provide quantitative guidance in the analysis of the spill scenarios being considered.

4.2.3 Model Validation

ROS' Oil Spill Modeling Package (OILMAPDeep and SIMAP) were used to evaluate and simulate the Deepwater Horizon (DWH) oil spill in support of the Natural Resource Damage Assessment (NRDA) by the US and state government trustees. Spaulding et al. (2015, 2017) and French-McCay et al. (2015, 2016) describe the modeling used by the DWH trustees in making their assessment (DWH NRDA Trustees, 2016) and validation of the model results below 20 m using field data collected during and after the spill. French-McCay et al. (2015, 2016, 2018a) showed that model-predicted concentrations of semi-soluble hydrocarbon (S/SS HCs) within 10-15 km of the wellhead agreed in magnitude with measured concentrations. French-McCay et al. (2018a, b) describe additional analyses and modeling of the DWH spill undertaken to validate the ROS Spill Modeling package, finding that predictions of floating oil mass agreed with estimates based on remote sensing data. In addition to the DWH spill, the authors validated the model with data from >20 large surface oil spills, including the Exxon Valdez (French and Rines 1997; French-McCay 2003, 2004; French-McCay and Rowe 2004), as well as test spills designed to verify the model (French et al. 1997). These studies showed that the accuracy of oil trajectories depended on the accuracy of the current and wind data input to the model, and that, given reasonably accurate input data for transport (as evidenced by floating oil trajectory and shoreline oiling distributions as compared to observations), predicted concentrations of oil hydrocarbons in water and sediments agreed within an order of magnitude with measurements.

4.3 Appendix C – Near-Field Blowout and Far-Field Modeling Descriptions

4.3.1 Near-field Blowout Modeling

This section describes the methodology for modeling a blowout release from the sea floor, for scenarios where this type of hypothetical release is being evaluated. In a well blowout, discharged materials consisting of a mixture of gaseous and liquid hydrocarbons go through three general phases.

1. **Momentum jet**

The immediate pressure difference between inside the well and the ambient water drives the initial discharge. Due to the relatively high density of deep ocean water, this jet momentum dissipates relatively quickly and is confined to the vicinity of the seabed (on the order of meters).

2. **Buoyant density plume**

The density difference between the expanding gas bubbles in the plume and the receiving water results in a buoyant force which drives the plume upward. As the plume rises, it continues to entrain sea water, reducing the plume's velocity and buoyancy and increasing its radius. The plume ultimately terminates when there is negligible difference between the plume bulk density and the receiving water.

As the plume reaches the sea surface or its termination (or trap height), it can be deflected in a radial pattern within a horizontal/surface flow zone. This radial jet carries the oil particles rapidly away from the center of the plume, while the velocity and oil concentrations in this surface flow zone decrease.

The oil released in the plume breaks into droplets due to the oil-water interfacial tension and the release turbulence. These droplets (typically a few micrometers to millimeters in diameter) are initially transported upward by the rising plume; in the near-field their individual rise velocities contribute little to their upward motion

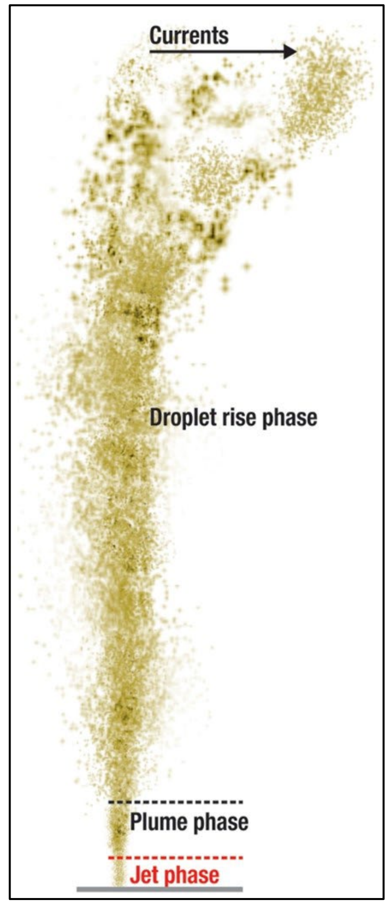


Figure 61. Visualization of a well blowout.

3. **Free rise and advection-diffusion**

Subsequent to plume termination and radial flow, oil particles ascend to the surface (if the plume terminates in the water column) solely by their own buoyancy. Rise velocities of oil droplets are typically much slower than the average velocity of a buoyant gas-liquid plume, resulting in particle transport that may take considerably longer to reach the surface and result in transport farther (horizontally) from the release site due to ambient currents. Plumes and oil droplets that reach the surface are further transported and in response to the ambient winds and currents.

To simulate this dynamic process, blowout modeling is performed in two steps: 1) a near-field analysis, describing the oil/gas plume generated by the blowout that typically evolves vertically due to vertical processes (relative buoyancy), and 2) a far-field analysis, describing the long-term transport and weathering of the released oil mixture that typically evolves as a horizontal process due to currents and winds.

The near-field model results provide the initial conditions for both the stochastic and deterministic modes of the far-field modeling. In most cases, the near-field results depend more on the blowout conditions (flow rate, gas to oil ratio, and pipe diameter), and less on the environmental conditions (e.g., seasonality). Conversely, the far-field modeling is highly dependent on the environmental conditions such as winds and currents as the main drifting/driving forces.

Near-field modeling is completed using ROS' OILMAPDeep model. The objective of this first step of the blowout modeling is to characterize the plume mixture (oil, gas and water) discharged from the wellhead blowout. In most cases, the near-field region occurs only within a few hundred meters of the wellhead.

The OILMAPDeep model was developed as an enhanced version of the ROS' OILMAP/SIMAP modeling system. The blowout model solves equations for the conservation of water mass, momentum, buoyancy, and gas mass using integral plume theory, following work outlined in McDougall (1978).

The results of near-field modeling provide a description of the behavior of the blowout plume, its evolution within the water column and the expected initial dilution (concentration decrease) with distance from the wellhead (seafloor). It provides information about the termination ("trap") height of the plume and the oil droplet size distribution(s) associated with the release. These results are used as initial conditions of the far-field fate and trajectory modeling.

The particle size distribution predicted by OILMAPDeep is based on a calculation of the volume mean diameter (VMD) and a lognormal distribution (Li et al, 2017). The VMD is most heavily influenced by the release exit velocity and oil-water interfacial tension. The release velocity is a proxy for the energy available to break the oil into droplets, and the oil-water interfacial tension is a metric related to the energy needed to break oil into droplets. Relatively speaking, a greater release velocity or lower oil-water interfacial tension (achieved through the use of dispersants) results in smaller droplets. The oil-water density differential also plays a role, to a smaller degree, with a larger differential associated with smaller droplet sizes.

Depending on the environmental conditions near the spill location, there may be significant degradation and decay of oil before surfacing occurs. The oil decay rate is typically much higher in warm water environments where biological productivity is high and microbial organisms play an active role in the breakdown of oil. Thus, if the oil remains in the water column longer, there may be significantly less oil by mass that eventually surfaces due to biological degradation/decay.

4.3.2 Far-field and Surface Spill Modeling

ROS' 3-D oil spill modeling system, OILMAP/SIMAP, is used for all far-field simulations. The model quantifies the transport and fate of several components of hydrocarbon mixtures through different compartments of the marine environment over time. The modeling system uses a three-dimensional Lagrangian model where each component of the spilled oil (floating, dispersed, shoreline, etc.) is represented by an ensemble of independent mathematical particles or "spillets". Each spillet comprises a subset of the total mass of hydrocarbons spilled and is transported by both currents and surface wind drift.

The far-field model initializes these particles either at the surface or at the trap depth calculated by the OILMAPDeep near-field model and they are then transported by both currents and surface wind drift. Additionally, horizontal and vertical dispersion coefficients in the oil spill model reproduce: a) the horizontal spreading of the oil slick due to its natural tendency to thin out (balance of inertial, gravity, and interfacial tensions), and b) to reproduce the vertical mixing within the upper mixing layer of the ocean. Overall, while those coefficients are important to reproduce the micro-scale processes (emulsion water-in-oil, sediment trapping, minimum thickness), other macro-scale factors play a much bigger role in the overall transport of the oil spill, such as advection due to winds and currents or interaction with the coastline. Additional information on the modeling system is contained in Section 4.2.

Oil spill modeling is performed in two steps: 1) a stochastic analysis that predicts the spatial and temporal probabilistic distribution for a spill event, and 2) a deterministic analysis that identifies the worst-case scenario.

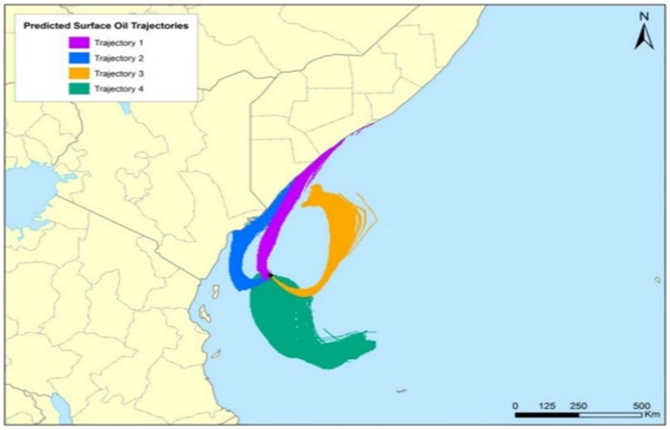
Stochastic Simulations

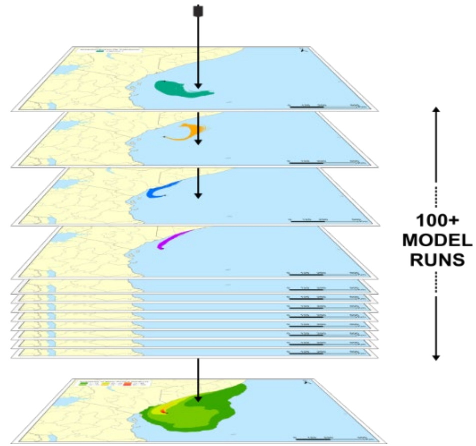
Stochastic simulations provide insight into the probable behavior of potential oil spills in response to temporally- and spatially-varying meteorological and oceanographic conditions in the study area. The stochastic model computes surface trajectories for an ensemble of hundreds of individual cases for each spill scenario, thus sampling the variability in regional and seasonal wind and current forcing by starting the simulation at different dates within the timeframe of interest. Thus, the stochastic results represent sensitivity to the environmental variability, as each trajectory experiences a different set of wind and current conditions that occur based on the model start date.

The stochastic analysis provides two types of information: 1) the footprint of sea surface areas that might be oiled and the associated probability of oiling, and 2) the shortest time required for oil to reach any point within the areas predicted to be oiled. The areas and probabilities of oiling are generated by a statistical analysis of all the individual stochastic runs (Section 2.3). It is important to note that a single run will encounter only a relatively small portion of this footprint. In addition, the simulations provide shoreline oiling data expressed in terms of minimum and average times for oil to reach shore, and the percentage of simulations in which oil is predicted to reach shore. Results from this modeling step are presented in the Stochastic Modeling Results Section.

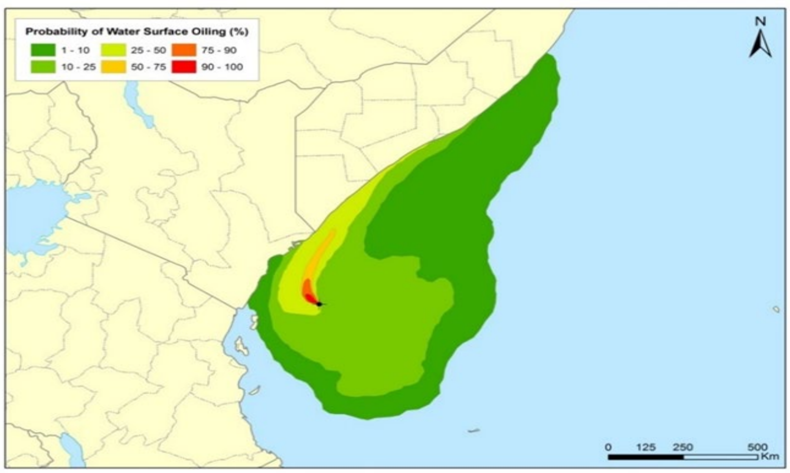
Deterministic Simulations

For each spill scenario, one deterministic trajectory/fate simulation is run to investigate a specific worst-case spill event that could potentially occur using the same combination of winds and current forcing used in the corresponding stochastic simulation from which it was identified. The worst-case scenario is selected based on the degree of shoreline oiling. Different parameters or indicators can be used to compare and assess the degree of shoreline oiling, for example “time to reach the coast”, “oil mass to reach the coast”, or “total length of oiled coastline”. For this study, a scenario’s “worst case” simulation is defined as the individual trajectory with the largest cumulative surface area oiled. This case represents a scenario where a large clean-up response would be necessary to protect shoreline habitats. Results from this modeling step are presented in the 'Worst-Case' Modeling Results Section.





Examples of four individual spill trajectories predicted by OILMAP for a particular spill scenario. The frequency of contact with given locations is used to calculate the probability of impacts during a spill. Essentially, all 100+ model runs are overlain (shown as the stacked runs on the right) and the number of times that a trajectory reaches a given location is used to calculate the probability for that location.



Probability of surface oil exceeding a given threshold for the example scenario. This figure overlays 100+ individual model runs to calculate the percentage of runs that caused oiling above the threshold in a given area. This figure does not depict the areal extent of a single model run/spill.

Figure 62. Diagram of ROS stochastic modeling approach; an ensemble of individual trajectories creates the stochastic probability footprint.

4.4 Appendix D – References

Bakun, A., & Nelson, C. S. (1991). The seasonal cycle of wind-stress curl in subtropical eastern boundary current regions. Journal of Physical Oceanography, 21(12), 1815–1834.

Bejarano, A. C., Gardiner, W. W., Barron, M. G., & Word, J. Q. (2017). Relative sensitivity of Arctic species to physically and chemically dispersed oil determined from three hydrocarbon measures of aquatic toxicity. Marine Pollution Bulletin, 122, 316–322.

Berger, W. H., Wefer, G., Richter, C., Lange, C. B., Giraudeau, J., Hermelin, O., & Shipboard Scientific Party. (1998). The Angola-Benguela upwelling system: Paleoceanographic synthesis of shipboard results from Leg 175. In Proceedings of the Ocean Drilling Program, Initial Reports (Vol. 175, pp. 505–531).

Clark, R. B. (1984). Impact of oil pollution on seabirds. Environmental Pollution (Series A), 33, 1–22.

Cummings, J. A. (2005). Operational multivariate ocean data assimilation. Quarterly Journal of the Royal Meteorological Society, 131(613), 3583–3604.

Cummings, J. A., & Smedstad, O. M. (2013). Variational data assimilation for the global ocean. In S. E. Kruse, X. Liang, & W. C. Yang (Eds.), Data assimilation for atmospheric, oceanic and hydrologic applications (Vol. II, pp. 303–343). Springer.

Ekau, W., Auel, H., Pörtner, H. O., & Gilbert, D. (2009). Impacts of hypoxia on the structure and processes in the pelagic community (zooplankton, macro-invertebrates and fish). Biogeosciences Discussions, 6, 5073–5144.

Elfrink, B., Prestedge, G., Rocha, C. B., & Juhl, J. (2003). Shoreline evolution due to highly oblique incident waves at Walvis Bay, Namibia. Journal of Coastal Engineering, 46, 12–13.

Engelhardt, F. R. (1983). Petroleum effects on marine mammals. Aquatic Toxicology, 4, 199–217.

French McCay, D. (2016). Potential Effects Thresholds for Oil Spill Risk Assessments. In Proceedings of the 39th AMOP Technical Seminar on Environmental Contamination and Response, Emergencies Science Division, Environment Canada, Ottawa, ON, Canada, pp. 285–303.

French McCay, D., Jayko, K., Li, Z., Horn, M., & Spaulding, M. (2018b). Volume II: Appendix II - Oil Transport and Fates Model Technical Manual. In C. W. Galagan, D. French-McCay, J. Rowe, & L. McStay (Eds.), Simulation Modeling of Ocean Circulation and Oil Spills in the Gulf of Mexico (pp. 60–277). Prepared by RPS ASA for the US Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2018-040.

French McCay, D., Reich, D., Michel, J., Etkin, D., Symons, L., Helton, D., & Wagner, J. (2012). Oil Spill Consequence Analyses of Potentially-Polluting Shipwrecks. In Proceedings of the 34th AMOP Technical Seminar on Environmental Contamination and Response, Emergencies Science Division, Environment Canada, Ottawa, ON, Canada.

French McCay, D., Reich, D., Rowe, J., Schroeder, M., & Graham, E. (2011). Oil Spill Modeling Input to the Offshore Environmental Cost Model (OECM) for US-BOEMRE's Spill Risk and Cost Evaluations. In Proceedings of the 34th AMOP Technical Seminar on Environmental Contamination and Response, Emergencies Science Division, Environment Canada, Ottawa, ON, Canada.

French, D. P., & Rines, H. (1997). Validation and use of spill impact modeling for impact assessment. In Proceedings of the 1997 International Oil Spill Conference (pp. 829–834). American Petroleum Institute Publication No. 4651.

French, D. P., Rines, H., & Masciangioli, P. (1997). Validation of an Orimulsion spill fates model using observations from field test spills. In Proceedings of the 20th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar (pp. 933–961). Environment Canada.

French, D., Reed, M., Jayko, K., Feng, S., Rines, H., Pavignano, S., Isaji, T., Puckett, S., Keller, A., French III, F. W., Gifford, D., McCue, J., Brown, G., MacDonald, E., Quirk, J., Natzke, S., Bishop, R., Welsh, M., Phillips, M., & Ingram, B. S. (1996). The CERCLA type A natural resource damage assessment model for coastal and marine environments (NRDAM/CME), Technical Documentation, Vol. I–V. U.S. Department of the Interior. Report No. PB96-501788.

French-McCay, D. P. (2003). Development and application of damage assessment modeling: Example assessment for the North Cape oil spill. Marine Pollution Bulletin, 47(9–12), 341–359. https://doi.org/10.1016/S0025-326X(03)00208-X.

French-McCay, D. P. (2009). State-of-the-art and research needs for oil spill impact assessment modeling. Proceedings of the 32nd AMOP Technical Seminar on Environmental Contamination and Response, Emergencies Science Division, Environment Canada, Ottawa, ON, Canada. pp. 601–653.

French-McCay, D. P., Robinson, H. J., Bock, M., Crowley, D., Schuler, P., & Rowe, J. J. (2022). Counter-Historical Study of Alternative Dispersant Use in the Deepwater Horizon Oil Spill Response. Marine Pollution Bulletin, 180, 113778. https://doi.org/10.1016/j.marpolbul.2022.113778.

French-McCay, D., Crowley, D., Rowe, J., Bock, M., Robinson, H., Wenning, R., Walker, A. H., Joeckel, J., & Parkerton, T. (2018). Comparative Risk Assessment of Spill Response Options for a Deepwater Oil Well Blowout: Part I. Oil Spill Modeling. Marine Pollution Bulletin, 133, 1001–1015. https://doi.org/10.1016/j.marpolbul.2018.05.042.

French-McCay, D., Horn, M., Li, Z., Jayko, K., Spaulding, M., Crowley, D., & Mendelsohn, D. (2018a). Modeling Distribution Fate and Concentrations of Deepwater Horizon Oil in Subsurface Waters of the Gulf of Mexico. In S. Stout & Z. Wang (Eds.), Oil Spill Environmental Forensics Case Studies (pp. 683–736). Elsevier. ISBN: 978-0-12-804434-6.

French-McCay, D. P. (2004). Oil spill impact modeling: Development and validation. Environmental Toxicology and Chemistry: An International Journal, 23(10), 2441–2456. https://doi.org/10.1897/03-382.

Geraci, J. R., & St. Aubin, D. J. (1988). Synthesis of Effects of Oil on Marine Mammals. Report to U.S. Department of the Interior, Minerals Management Service, Atlantic OCS Region, OCS Study, MMS 88-0049, Battelle Memorial Institute, Ventura, CA, 292 p.

Jenssen, B. M. (1994). Review article: Effects of oil pollution, chemically treated oil, and cleaning on the thermal balance of birds. Environmental Pollution, 86, 207–215.

Kraly, J., Pond, R. G., Walker, A. H., Caplis, J., Aurand, D. V., Coelho, G. M., Martin, B., & Sowby, M. (2001). Ecological Risk Assessment Principles Applied to Oil Spill Response Planning. In Proceedings of the 2001 International Oil Spill Conference (pp. 177–184). American Petroleum Institute, Washington, DC.

Li, Z., Spaulding, M., & French McCay, D. (2017). An algorithm for modeling entrainment and naturally and chemically dispersed oil droplet size distribution under surface breaking wave conditions. Marine Pollution Bulletin, 119. pp. 145–152. doi: 10.1016/j.marpolbul.2017.03.048.

Locarnini, R. A., Mishonov, A. V., Baranova, O. K., Reagan, J. R., Boyer, T. P., Seidov, D., Wang, Z., Garcia, H.E., Bouchard, C., Cross, S.L., & Paver, C.R., (2024). World Ocean Atlas 2023, Volume 1: Temperature.

McCay, D. F., & Payne, J. R. (2001). Model of oil fate and water concentrations with and without application of dispersants. In Arctic and Marine Oilspill Program Technical Seminar. (pp. 611-646. Environment Canada; 1999.

McCay, D. F., & Rowe, J. J. (2004). Evaluation of bird impacts in historical oil spill cases using the SIMAP oil spill model. In Proceedings of the 27th Arctic and Marine Oilspill Program Technical Seminar, Vol. 1. pp. 421-452. Environment Canada; 1999.

National Academies of Sciences, Engineering, and Medicine (NASEM). 2020. The Use of Dispersants in Marine Oil Spill Response. Washington, DC: The National Academies Press, 340p. https://doi.org/10.17226/25161.

National Research Council (NRC), Oil Spill Dispersants: Efficacy and Effects, National Academy Press, Washington, DC, 377p, 2005.

Reagan, J. R., Seidov, D., Wang, Z., Dukhovskoy, D., Boyer, T. P., Locarnini, R. A., Baranova, O.K., Mishonov, A.V., Garcia, H.E., Bouchard, C. and Cross, S.L. (2024). World Ocean Atlas 2023, Volume 2: Salinity.

Reed, M., French, D.P., Feng, S., French III, F.W., Howlett, E., Jayko, K., Knauss, W., McCue, J., Pavignano, S., Puckett, S., Rines, H., Bishop, R., Welsh, M., & Press, J. (1996). The CERCLA type a natural resource damage assessment model for the Great Lakes environments (NRDAM/GLE), Vol. I - III. Final report, submitted to Office of Environmental Policy and Compliance, U.S. Department of the Interior, Washington, DC, by Applied Science Associates, Inc., Narragansett, RI, April 1996, Contract No. 14-01-0001-88-C-27.

Saha, S., Moorthi, S., Wu, X., Wang, J., Nadiga, S., Tripp, P., Behringer, D., Hou, Y.T., Chuang, H.Y., Iredell, M. and Ek, M. (2014). The NCEP climate forecast system version 2. Journal of climate, 27(6), 2185-2208.

Shannon, L. V. (2001). Benguela Current. In Encyclopedia of Ocean Sciences (pp. 255–267). Academic Press. https://doi.org/10.1006/rwos.2001.0359.

Shannon, V. (2006). A plan comes together. In K. Sherman & G. Hempel (Eds.), Large marine ecosystems (Vol. 14, pp. 3–10). Elsevier.

Shi, N., Schneider, R., Beug, H. J., & Dupont, L. M. (2001). Southeast trade wind variations during the last 135 kyr: Evidence from pollen spectra in eastern South Atlantic sediments. Earth and Planetary Science Letters, 187(3–4), 311–321.

Spaulding, M. Z. Li, Mendelsohn. D., Crowley. D., French-McCay. D., & Bird, A. (2017). Application of an integrated blowout model system, OILMAP DEEP, to the Deepwater Horizon (DWH) spill. Marine Pollution Bulletin, 120, 37-50.

Spaulding, M.L., Mendelsohn, D., Crowley, D., Li, Z., & Bird, A. (2015). Draft Technical Reports for Deepwater Horizon Water Column Injury Assessment: WC_TR.13: Application of OILMAP DEEP to the Deepwater Horizon Blowout. DWH NRDA Water Column Technical Working Group Report. Prepared for National Oceanic and Atmospheric Administration by RPS ASA, South Kingstown, RI 02879. Administrative Record no. DWH-AR0285366.pdf https://www.doi.gov/deepwaterhorizon/adminrecord.

Trustees, D. N. (2016). Deepwater Horizon oil spill: final programmatic damage assessment and restoration plan and final programmatic environmental impact statement. Deepwater Horizon.

United Nations Educational, Scientific, and Cultural Organization (UNESCO). (2019). Benguela Current marine ecosystem sites. World Heritage Tentative Lists. http://whc.unesco.org/en/tentativelists/6094/.

ERM

UNDERWATER NOISE MODEL REPORT

Environmental and Social Impact Assessment (ESIA) for Offshore Drilling Activities in Namibia in PEL 82

Underwater Noise Report

PREPARED FOR

Chevron Namibia Exploration Limited II

IN COLLABORATION WITH

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Environmental and Social Impact Assessment (ESIA) for Offshore Drilling Activities in Namibia in PEL 82

Underwater Noise Report

0775081

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ACRONYMS AND ABBREVIATIONS

Acronym	Description
AUD INJ	Auditory Injury
CNEL	Chevron Namibia Exploration Limited II
DP	Dynamic positioning
ERM	Environmental Resources Management
ESIA	Environmental and Social Impact Assessment

Acronym	Description
GIS	Geographical Information System
Hz	Hertz
KHz	Kilohertz
km	Kilometre
Km/h	Kilometre per hour
m	Metre
m/s	Metre per second
MMNET	Marine Mammal Noise Exposure Tool
MMO	Marine Mammal Observer
MODU	Mobile Offshore Drilling Unit
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PAM	Passive Acoustic Monitoring
PEL	Petroleum Exploration License
PTS	Permanent Threshold Shift
RMS	Root-Mean Square
SEL	Sound exposure levels
SELcum	Cumulative Sound Exposure Level
TTS	Temporary Threshold Shift
VSP	Vertical Seismic Profile

EXECUTIVE SUMMARY

Chevron Namibia Exploration Limited II (CNEL) is planning offshore exploration within Petroleum Exploration License (PEL) 82, covering blocks 2112B and 2212A in the Walvis Basin, Namibia. The program initially involves one exploration well at the Gemsbok prospect (Block 2112B), with the possibility of drilling additional wells, depending on results. To support the ESIA, CNEL commissioned Environmental Resources Management (ERM) to conduct an underwater noise impact assessment for the proposed drilling and potential Vertical Seismic Profiling (VSP) activities.

The study aims to:

- Model underwater sound propagation from drilling and VSP activities.
- Assess potential impacts on marine mammals, fish, and sea turtles.
- Define potential impact zones for auditory injury, temporary threshold shifts (TTS), and behavioral disturbance.

Noise impact criteria have been developed through an examination of the most recent guidelines and literature. These criteria include physiological and behavioral effects on marine mammals, fish, and sea turtles.

Detailed modelling predictions have been undertaken for noise emissions due to suggested drilling and potential VSP activities, at for Gemsbok well and the second potential well.

For both drilling and VSP, and at both well locations, predicted impact zones for all marine mammal hearing groups remain within 100 m from the source, well inside the standard 500 m exclusion zone, which can be monitored by Marine Mammal Observers (MMOs) and Passive Acoustic Monitoring (PAM). Potential behavioral impact zones can extend up to 400 m for the LF frequency hearing group due to VSP activities. Other groups are limited to 100 m from the source. Potential disturbance, due to drilling may extend up to 9.6 km at Gemsbok and 11 km at the second potential well, primarily in deeper waters.

For fish, potential injury thresholds for both impulsive (VSP) and continuous (drilling) noise are exceeded only within 100 m of the source, at both locations, whilst potential behavioral disturbance zones extends up to 1 km from both wells due to drilling activities.

For sea turtles, potential impact and behavioral impact zones remain within 100 m for both drilling and VSP, at both locations.

Overall, the risk of potential impacts to marine fauna from both VSP and drilling is confined to within 100 m of the source. The most significant potential effect is behavioral disturbance, particularly for marine mammals during drilling (up to ~11 km) and for fish (up to 1 km).Sea turtles show the lowest level of vulnerability., with impacts predicted to remain very localized (<100 m).Implementation of a 500 m safety zone with MMO/PAM monitoring is sufficient to mitigate potential injury risks.

The study concludes that underwater noise impacts from the proposed activities are limited and manageable with appropriate mitigation measures.

1. INTRODUCTION

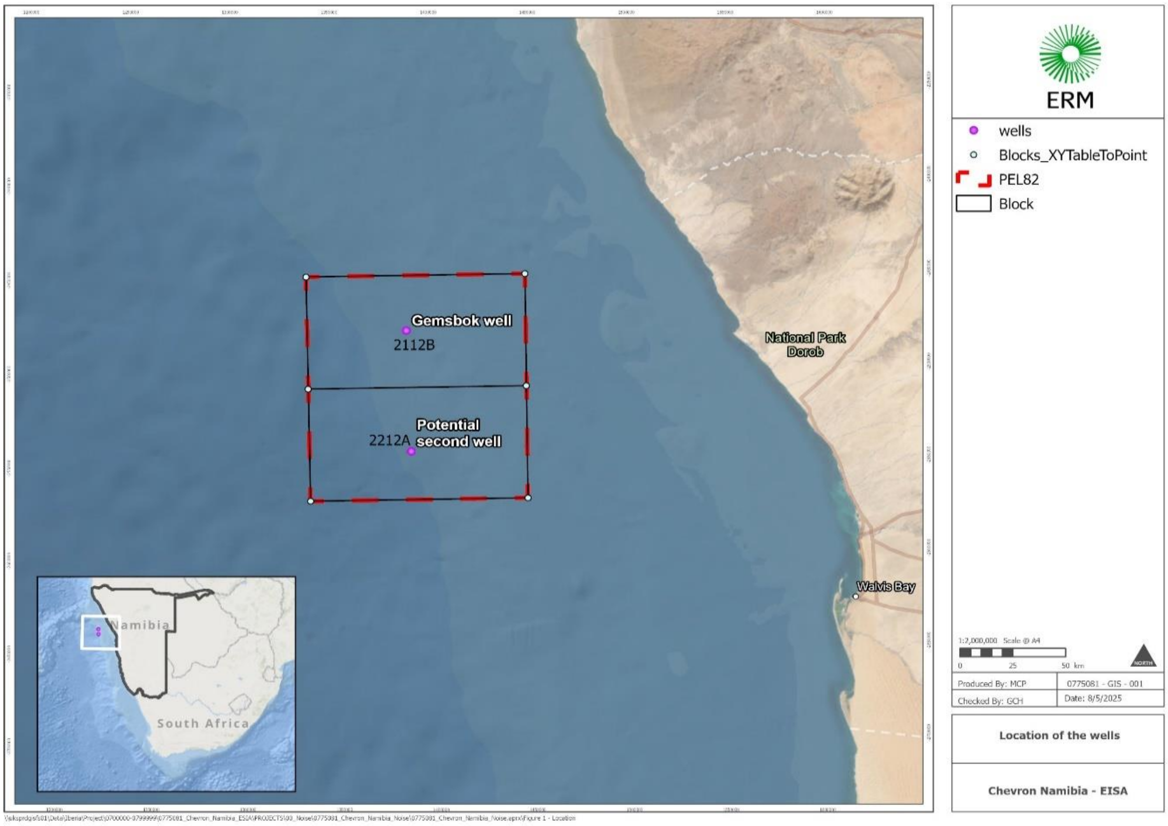
Chevron Namibia Exploration Limited II (CNEL) proposes to initiate an offshore exploration program within Petroleum Exploration License (PEL) 82 encompassing blocks 2112B and 2212A situated in the Walvis Basin, Namibia (i.e. proposed project). CNEL holds the Exploration License for both blocks which spans over an area of approximately 11,400 km². Blocks 2212A and 2112B are located approximately 101 km and 72 km respectively from the Namibia shoreline.

The plan is to initially conduct a one-well campaign at the Gemsbok prospect, located within Block 2112B (coordinates: LAT: 21° 44′ 48.15″ S, LONG: 12° 27′ 13.74″ E), in water depths ranging from 1,000 m to 1,500 m, projected late 2026 to early 2027. Based on the results of this well, it may be followed by an appraisal well. Additional drilling campaigns of up to 3 to 4 wells could potentially start from late 2027 to 2028 over a 3 to 5 year period for a total of up to 10 wells (exploration or appraisal). The drilling of one well is expected to require a maximum of 90 days to complete, including mobilisation, drilling operations, well testing, if conducted, and demobilisation.

To support the Environmental and Social Impact Assessment (ESIA), CNEL has appointed Environmental Resources Management (ERM) to carry out an underwater noise modelling study. The purpose of this study is to assess the potential impacts of underwater sound generated by operational activities, such as well drilling and Vertical Seismic Profiling (VSP) if it is conducted, on marine fauna and fish species.

The assessment focuses on two well locations, namely the Gemsbok Well in Block 2112B and a potential second well in Block 2212A, as illustrated in Figure 1-1 and and described in Table 1-1. This report presents the methodology and results of the underwater noise modelling for each block and forms the basis for evaluating the significance of underwater sound effects on marine fauna and fish within the ESIA Report.

FIGURE 1-1 LOCALITY MAP



Source: Chevron, 2025

TABLE 1-1 DETAILS OF THE GEMSBOK WELL IN BLOCK 2112B AND A POTENTIAL SECOND WELL IN BLOCK 2212A

Well / Block	Latitude	Longitude	Easting UTM 33S (m)	Northing UTM 33S (m)	Sea Depth (m)*
Gemsbok / Block 2112B	21° 44′ 48.15″ S	12° 27′ 13.74″ E	236,653	7,593,043	917
Potential second well / Block 2212A	22° 17' 38.04" S	12° 28' 51.21" E	240,449	7,532,469	1166

Source: CNEL, 2025

Note: * Based on the bathymetric survey data provided by CNEL

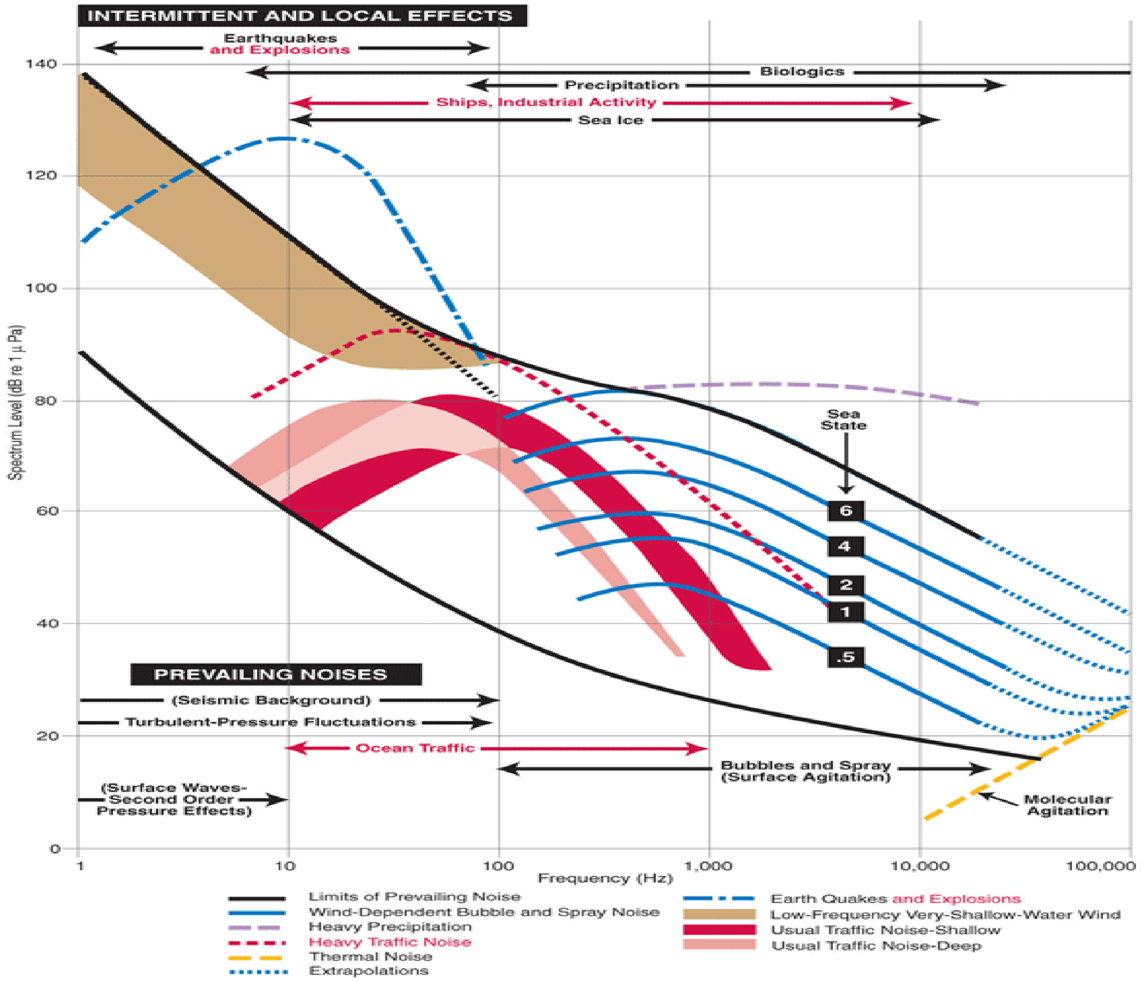
2. METHODOLOGY

2.1 INTRODUCTION

In order to predict the impact of underwater sound, transmission loss modelling has been carried out. This type of modelling takes into account the specific acoustic properties of the study area which determines how far sound will spread from a source of underwater noise. This section describes in more detail the methodology which has been used to carry out these predictions.

The background sounds in the ocean can be summarised in Figure 2-1 showing typical sound levels at different frequencies, as measured by Wenz (1962). This graph is therefore also referred to as the Wenz curves. The sound levels are given in underwater dB summed over 1 Hz wide frequency bands, which is often written as dB re 1 μPa^2/Hz. It is noted that the overall baseline noise levels from human activity such as shipping have tended to increase over time, however, the frequency ranges indicated below are still representative of the underwater sound environment.

FIGURE 2-1 WENZ CURVES: SPECTRA AND FREQUENCY DISTRIBUTION OF UNDERWATER SOUND SOURCES



Source: Miksis-Olds et al., 2013 (reproduction from Wenz (1962))

Sounds generated by human activities are an important part of the total ocean acoustic background. Underwater sound is used for many purposes, including communication, navigation, defence, research and commercial fishing. Regular features of anthropogenic noise include the low frequency noise generated by marine traffic both locally and from distant shipping. The sound emitted by the drilling activity during use of dynamic positioning (DP) thrusters is likely to fall into a similar frequency range as distant shipping noise, and it is possible that at long distances from the drilling activity, the noise from the DP thrusters may be masked by the ambient noise. If conducted, noise from VSP is impulsive and highly directional in the downward vertical direction to ensure adequate seabed penetration for optimal seismic data acquisition. As a result, levels of underwater sound transmitted in the horizontal plane is less than an omni-directional source of equivalent source level (dynamic positioning, drilling etc). However, no specific background noise in the project area has been identified, and a conservative approach has been taken in this assessment assuming that baseline noise levels are relatively low.

Marine fauna use sound to obtain detailed information about their surroundings. They rely on sound to communicate, navigate, and feed. Marine mammals, such as dolphins, use high frequency sound to locate and identify objects. By emitting clicks, or short pulses of sound, and listening to the echo, dolphins can detect individual prey and navigate around objects underwater. These sounds are at much higher frequencies than those that are likely to be produced by the drilling activity and therefore are not expected to be affected by the project noise sources.

The most widespread effects from the project are likely to be behavioural disturbance, and absolute noise criteria have been selected to identify the noise levels at which these effects will occur. Since the background noise levels have been assumed to be low, it is likely that the absolute noise criteria are likely to be met before the sound has reached the background noise levels. Therefore, this assessment does not rely on background noise levels, but instead it is based on absolute noise level criteria. Whilst noise may be audible over wider ranges, the effects on fauna are more subtle and are likely to be limited given the duration of the project.

2.2 PREDICTION MODEL

The model used for this prediction exercise is an ERM in-house software package MMNET (the Marine Mammal Noise Exposure Tool). It uses widely accepted mathematical algorithms which are discussed in more detail in Section 2.4. The model includes two main components, the noise propagation calculation and the exposure level calculation (which simulates the movement of animals within the sound field).

The noise propagation component calculates how the sound level varies in the marine environment, according to certain source and receiving environment characteristics.

The exposure level calculation is based on the accumulation of sound exposure over time for a marine organism moving relative to the sound source and experiencing variations in noise levels in the water column.

International noise impact criteria for marine species have been derived to assess the effects of these sound levels on marine organisms. These criteria are commonly accepted by the technical, scientific and regulatory communities and are based on numerous studies related to effects on marine mammals and fishes.

The distances from the drilling activities where the criteria adopted for this assessment will be met have been calculated. This allows for zones to be established over which potential noise impacts may occur. The two components of the model are sensitive to different input parameters. The propagation calculation is sensitive to some of the physical input parameters (such as seabed characteristics and bathymetry) which affect noise propagation. On the other hand, the exposure calculation is adjusted to the marine organism’s behaviour, which could be variable depending on the circumstances. The combination of these two factors results in potential variability of the resulting impact distances. This is common to all modelling exercises and means that the distances calculated must be treated as orders of magnitude, rather than precise distances.

2.3 NOISE SOURCE

The project under consideration is in the planning phase. The main noise sources from the proposed project will be:

- Drilling activities; and
- If conducted, Vertical Seismic Profile (VSP).

2.3.1 VERTICAL SEISMIC PROFILE (VSP)

A Dual Delta Sodera G-Gun (G-Gun, manufactured by Sercel) array of 1, 200 CUI supplied by Nitrogen gas quads was used to model the proposed VSP operations. The array consists of 6 active G-Gun units (3 x 250 CUI + 3 x 150 CUI) and has an average towing depth of 7 to 10 m and an operating pressure of 2 000 pounds PSI.

The source levels, spectrum (Figure 2-2), signature (Figure 2-3), and directivity (Figure 2-4) are outputted by a GUNDALF simulation (https://www.gundalf.com/). The one-third octave SEL source spectral levels to be used as the sound transmission modelling inputs are presented in Figure 2-5.

The source levels for the VSP G-Gun array show the Peak level to be 242 dB re 1 μPa at 1 m, the RMS 230 dB re 1 μPa at 1 m, and the SEL 221 dB re $\mu Pa^2 \cdot s$ at 1 m.

The signal from VSP operations is highly directional in the downward vertical direction to ensure adequate seabed penetration for optimal seismic data acquisition. As a result, levels of underwater sound transmitted in the horizontal plane is less than an omni-directional source of equivalent source level (such as underwater noise generated from thrusters used for dynamic positioning systems in offshore drilling operations).

FIGURE 2-2: SPECTRAL DENSITY

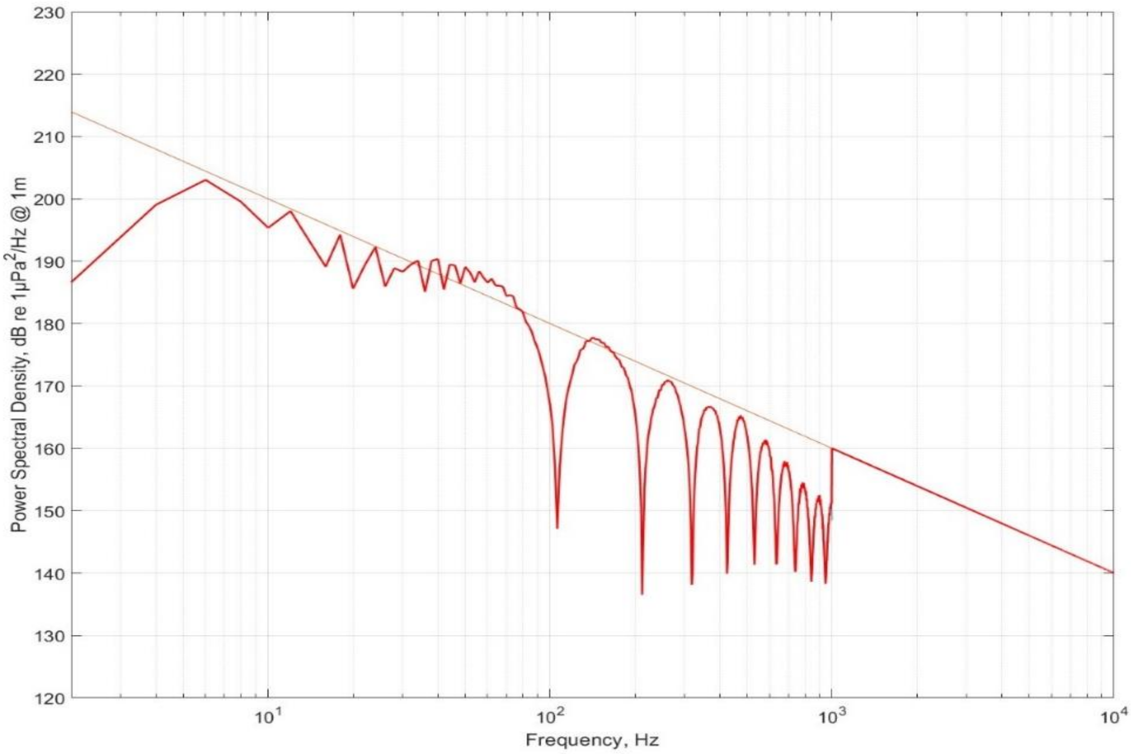


FIGURE 2-3: TIME SIGNATURE

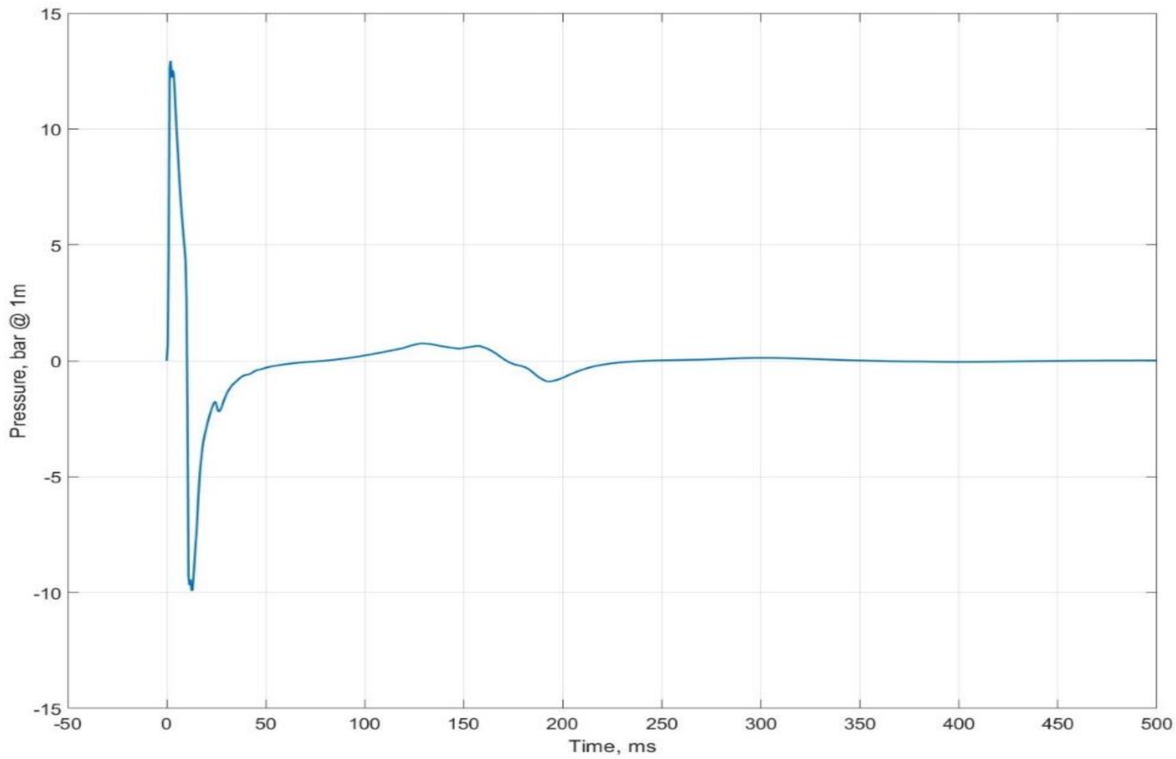
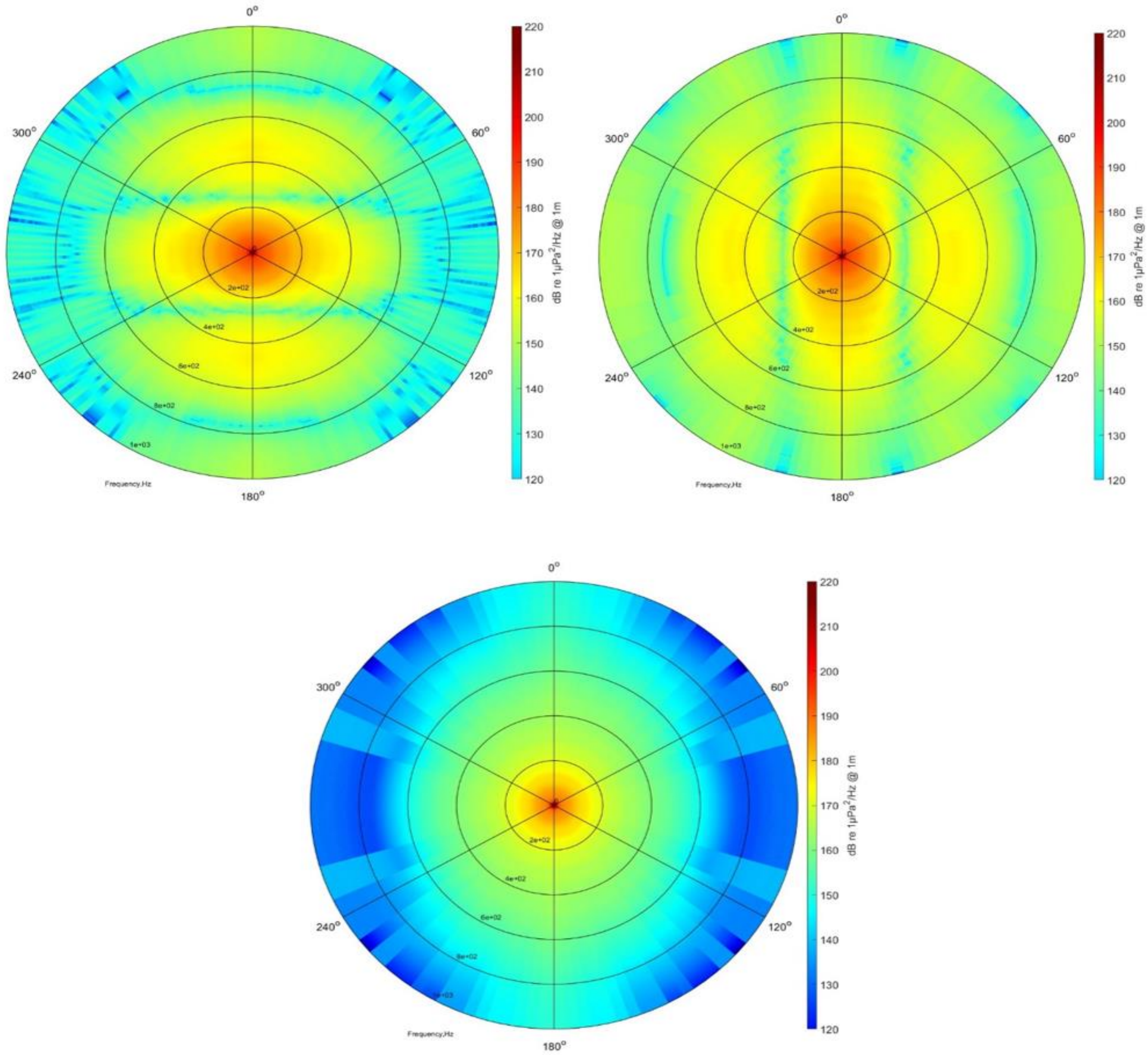
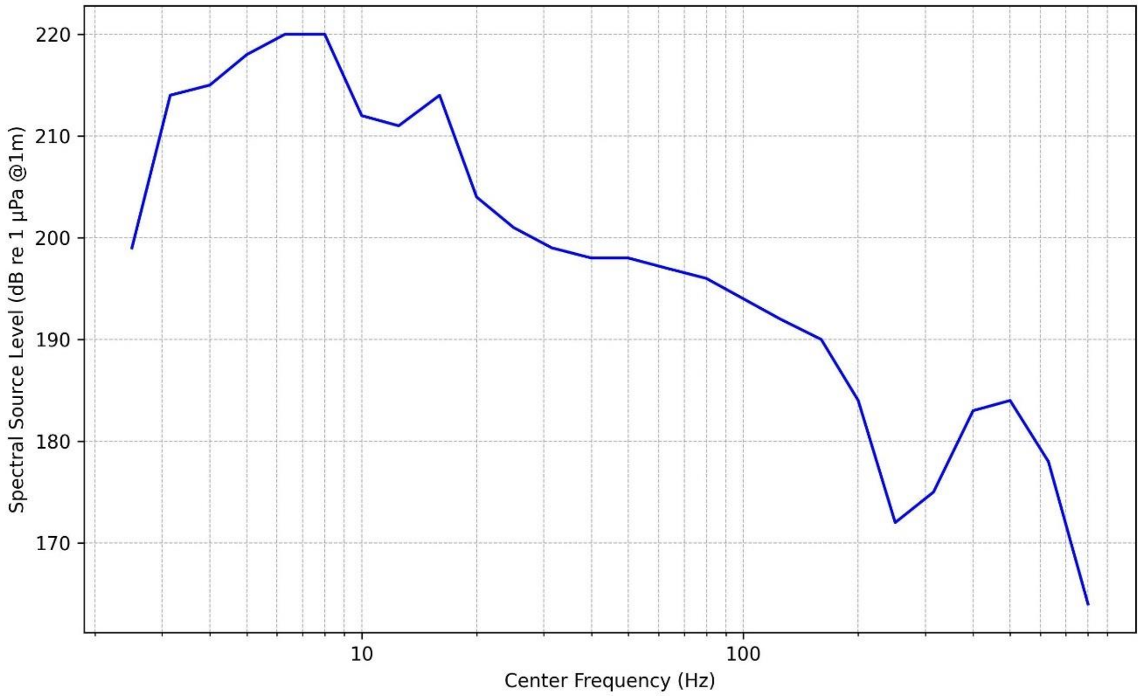


FIGURE 2-4: DIRECTIVITY



The horizontal plane with 0 degrees corresponds to the in-line direction (top-left). The vertical plane for the in-line direction and downward direction (top-right). The vertical plane for the cross-line direction and downward direction (bottom).

FIGURE 2-5: SPECTRUM



2.3.2 DRILLING ACTIVITIES

The Samsung Green Future (GF) 12000 drillship or MODU, was considered to model the proposed well drilling operations. The maximum drilling water depth of the ship is 3,810 m. It has six retractable 5,500 KW thrusters. It also has dynamic positioning capabilities.

The noise emissions from the drillship are predominantly generated by propeller and thruster cavitation especially when the dynamic-positioning system is operating, with a smaller fraction of sound produced by transmission through the hull, such as by engines, gearing, and other mechanical systems.

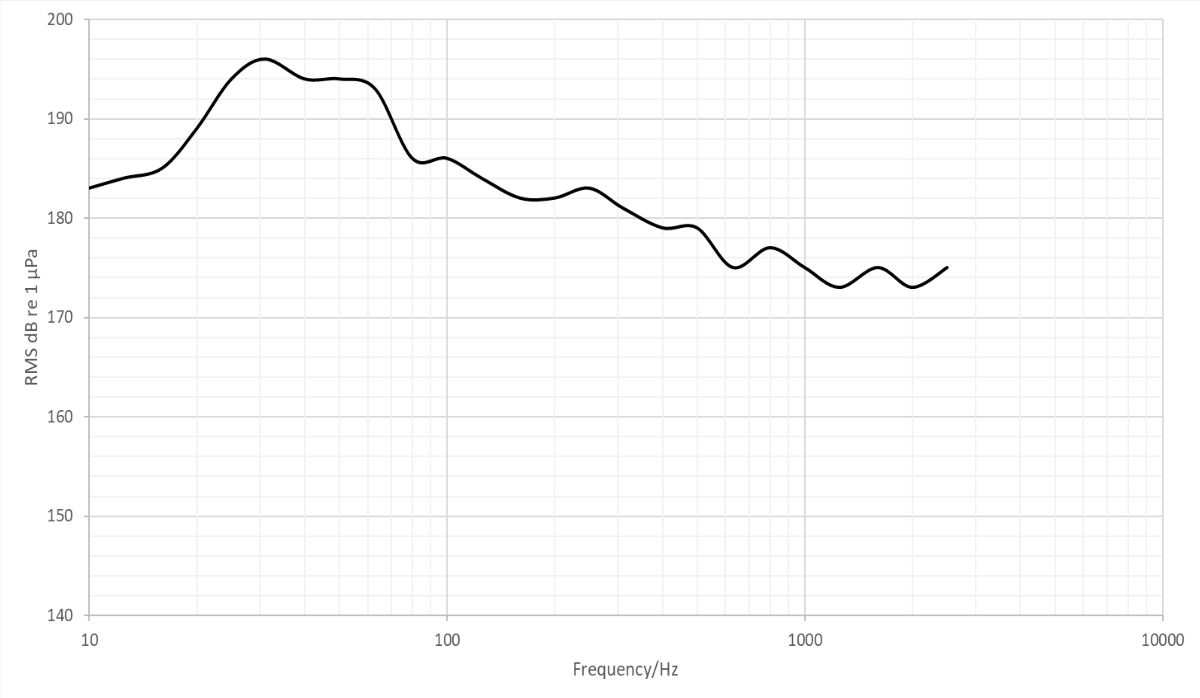
The drillship and support vessel noise levels are estimated based on a source level predicting empirical formula suggested by Brown (1977). The formula predicts the source level of a propeller based on the propeller diameter (m) and the propeller revolution rate (rpm). The following source levels have been considered:

- MODU – 196.2 dB re 1 µPa @ 1 m RMS
- Support vessel – 195.4 dB re 1 µPa @ 1 m RMS

The overall noise level from combined noise emissions from drillship and four support vessels is approximately 202 dB re 1 µPa @ 1 m RMS.

The one-third octave RMS source spectral levels for the drillship, supported vessels and combined total level is shown in Figure 2-6.

FIGURE 2-6 SOURCE LEVEL SPECTRUM OF MODU AND SUPPORT VESSELS EMISSIONS



The potential for auditory injury from non-impulsive sounds such as drilling is assessed using the SEL. This parameter is used to calculate a cumulative noise exposure over a period of time. For behavioural effects criteria, RMS levels are used. The SEL is equal to the RMS pressure (in dB re 1 µPa) plus 10 x $\log_{10}$ (exposure duration, in seconds). The mathematical relation of SEL and RMS pressure level is given by the equation below:

$$SEL = SPL(RMS) + 10\log10(T) \text{ re } 1\ \mu Pa^2 s$$

Where T is the duration of the signal in seconds.

For non-impulsive drilling noise, it is assumed that the SEL source level is equivalent to their corresponding RMS source level, considering the consistency and longer durations of the typical continuous drilling noise emissions.

2.4 UNDERWATER SOUND PROPAGATION

2.4.1 FACTORS AFFECTING THE MODELLING

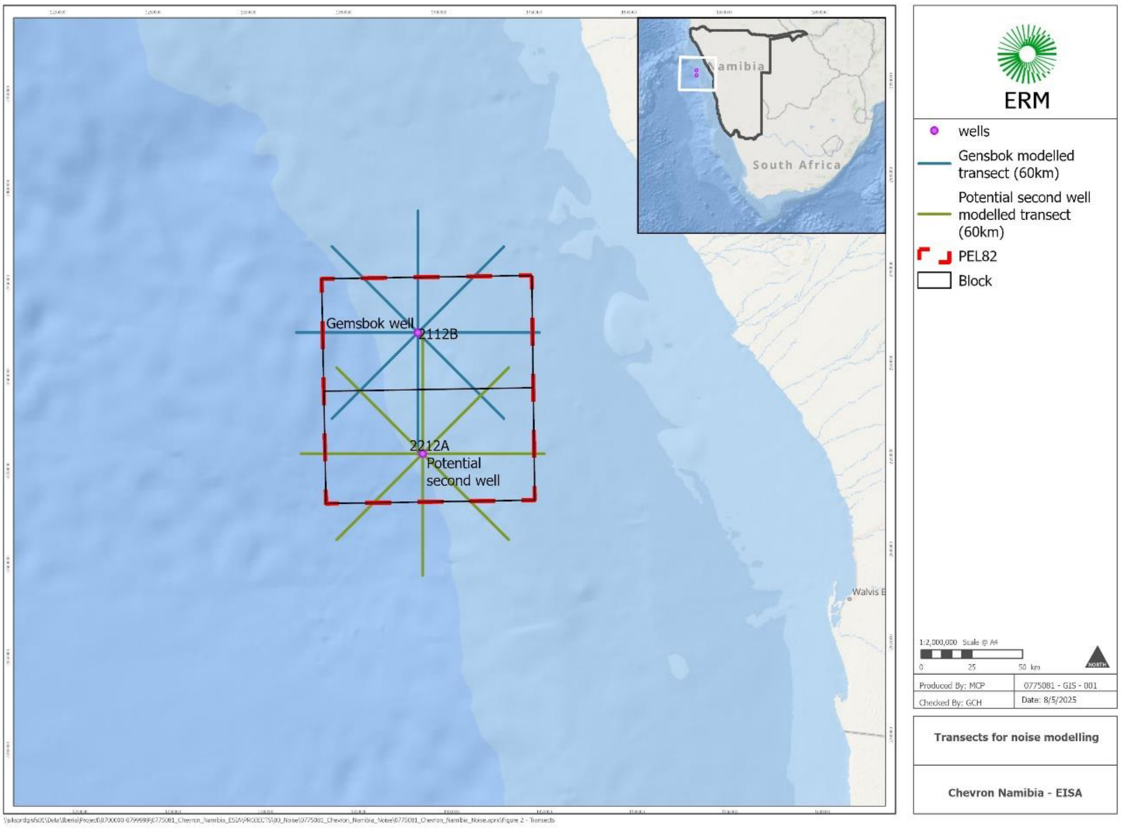
The underwater sound propagation model considers site-specific factors that affect propagation such as bathymetry, seabed type and acoustic properties of the water column. Since underwater sound can travel at long distances, the modelling is carried out to 50 km from the noise source. Prediction codes such as RAMGEO, RAMSGEO and Bellhop and Bounce (Maggi and Duncan, n.d.) can be used to reflect the intricacies of real-life environments, in range-dependent conditions such as sloping or irregular seabed areas, range-varying sound speed profiles and elastic/fluidised seabed, over a large frequency range.

In this case, sound modelling has been carried out using a well-established sound modelling algorithm (RAMGEO for 20 Hz up to 800 Hz and Bellhop for 1000 Hz up to 20000 Hz) to predict sound propagation as it spreads out from the sound source in the marine environment. As mentioned, the main inputs to the sound propagation model are the acoustic characteristics of the marine environment. The key variables which affect sound propagation (acoustic properties) in the marine environment are sound speed profile of the water column, bathymetry and seabed characteristics. The assumptions made for each of these parameters are discussed in the following sections.

2.4.2 MODELLED TRANSECTS

Model inputs for 8 transects were prepared in different directions (N, NE, E, SE, S, SW, W and NW). For each modelled transect, the acoustic transmission loss was calculated for the frequency range 20 to 20,000 Hz. The modelled transects for each drilling location are shown in Figure 2-7. For each transect, the highest noise levels at any depth have been calculated for distances up to 50 km in steps of 100 m.

FIGURE 2-7: MODELLED TRANSECTS



2.4.3 SEABED CHARACTERISTICS

Generally, seabed sediments are characterised by textural gradients parallel to the coast, becoming finer seaward (Bianchi, 1999). Inshore this pattern is altered by rivers and biological deposition. A feature of note is a 500 km long mud belt between Cape Frio and Conception Bay. The high productivity of the upwelled Benguela water causes the sediments to be biogenic. The continental shelf off the Namibian coast extends to a maximum of around 150 kilometres from the coast. The continental margin is divisible in two based on shelf morphology and the composition of the surficial sediments. North of 18°40'S is the Kunene shelf which is narrow, whilst to the south is the Walvis Shelf which is wider.

Sand, with patches of gravely sand and sandy gravel, occupies the midshore and nearshore areas of both the Kunene and Walvis Shelves. Overlying these coarse sediments is a small deposit of muddy sand and sandy mud adjacent the Kunene River mouth and an extensive belt of similar, though muddier material, on the Walvis Inner Shelf. According to Geological Survey of Namibia (Geological Survey of Namibia, 2003) further offshore, muddy sand covers most of the outer shelf. Sandy mud coincides roughly with the outer-shelf break. and is the dominant texture on the upper slope. Only on the Walvis Ridge Terrance does the sediment become coarser (sandy mud) with increasing depth.

Unconsolidated sediments on the continental margin of Namibia are classified into various textural lithofacies using a gravel-sand-mud ternary diagram (Bremner, 1983). Of the ten possible textural or size grades, only six are present, and two of these, namely sandy gravel and gravelly sand, are combined because of the limited occurrence of the former. Large patches of gravelly sediment, composed mainly of relict mollusc shells, are present on the middle shelf of the Walvis Margin at depths of 200 m.

In addition, small deposits of terrigenous gravelly sediment occur sporadically all along the coast on the inner shelf.

Sand and muddy sand are the dominant textural components for the entire continental shelf. Further offshore, sandy mud occurs approximately coincident with the outer shelf-break, and mud prevails on the continental slope. Only on the Walvis Ridge terrace off Rocky Point does the sediment texture coarsen to sandy mud with increasing depth.

The sediment profile and its properties are presented in Table 2-1.

TABLE 2-1: GEOACOUSTIC PROPERTIES BASED ON PROXY VALUES

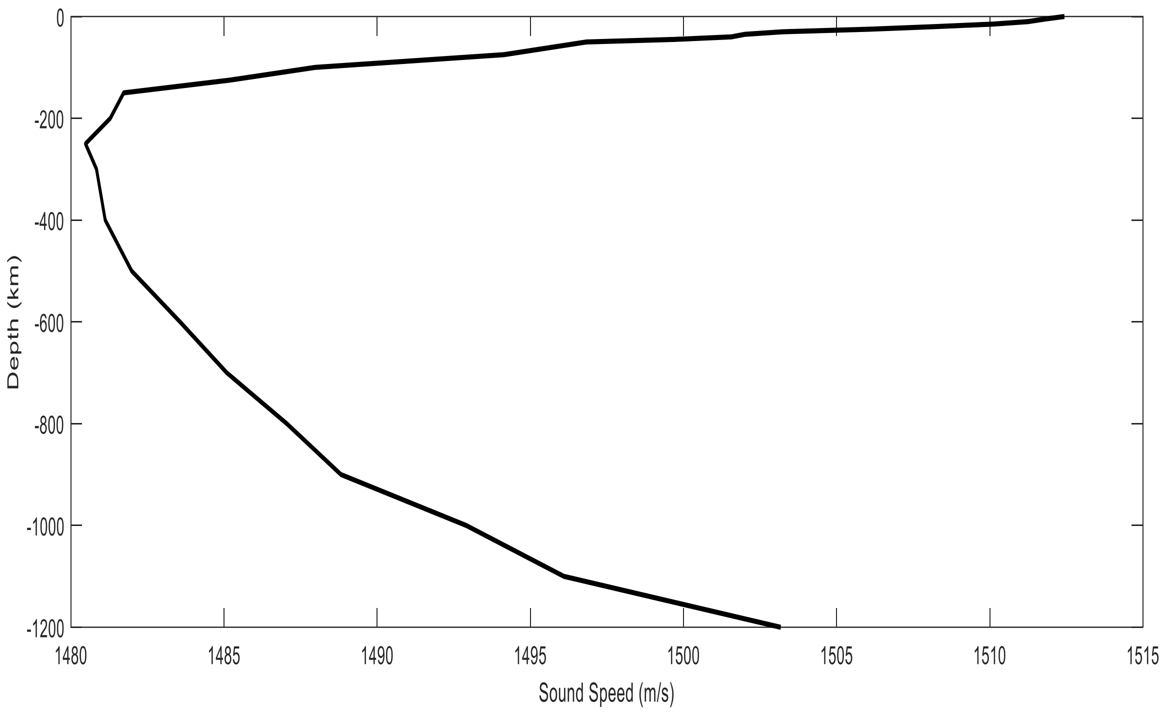
Sediment Type	Depth (m)	Density (g/cm^3)	Compressional wave velocity m/s	Compressional attenuation (dB/wavelength)	Shear - wave velocity m/s	Shear-wave attenuation (dB/wavelength)
Pelagic Clay/Mud (Hamilton,1980, Godin, 2021, Kimura,2013.)	0–50	1.3–1.6	1350–1500	2.0–4.0	100-300	4-8
Siliceous Ooze	50–200	1.4–1.7	1400–1550	1.5–3.5	150-400	3-6
Turbidite Sands	200–500+	1.8–2.1	1600–1800	0.5–1.5	400-600	1-2.5
Volcaniclastic Sediments	Variable	2.0–2.3	1700–2000	0.3–1.0	500-800	0.5-1.5

2.4.4 SOUND SPEED PROFILE

The speed of sound in the ocean increases with increasing values of temperature, salinity and pressure (which increases with depth). The sound speed depends more strongly on temperature than on the other variables (Duncan and McCauley, 2008). In deeper water, the pressure can dominate, and the sound speed can increase with increasing depth.

Sound speed profile data for the water column were derived from NOAA database (NOAA World Ocean Atlas, 2023). The actual period of the activities has not been defined yet. Therefore, the annual average sound speed profile has been used for the calculations.

FIGURE 2-8: SOUND SPEED PROFILE



2.4.5 BATHYMETRY DATA

The bathymetric data were provided by CNEL but also obtained from GEBCO (www.gebco.net), which provides publicly available bathymetric data sets in Geographical Information System (GIS) format. The depth data have been extracted at 0.5 km intervals between the noise source location and a point 50 km from the source.

2.4.6 CUMULATIVE SOUND EXPOSURE (SELcum) CALCULATION METHOD

2.4.6.1 VSP

The method used calculate the Cumulative Sound Exposure Level (SELcum) is to model a stationary animal. For each modelling location the following two scenarios have been considered:

- 50 Pulses in 2 hours
- 250 Pulses in 12 hours

The marine fauna will receive pulses of sound energy, which are quantified in the model using the SEL parameter for each VSP pulse. The noise model then calculates the SELcum over a 24-

hour period by accumulating the sound energy from all the pulses to which the animal will be subjected.

3. NOISE ASSESSMENT CRITERIA

3.1 MARINE MAMMALS

3.1.1 POTENTIAL IMPACT (AUD INJ AND TTS)

The criteria defined by Southall et al. 2019 and NOAA (National Marine Fisheries Service, 2024) are well accepted as reflecting the current state of knowledge regarding the potential for auditory effects on marine fauna. This publication evaluates Southall et al. (2007). In light of more recent scientific findings, revised noise exposure criteria are proposed to predict the likely onset of auditory effects on marine mammals. The criteria for potential auditory injury (i.e. AUD INJ) have been estimated from data on Temporary Threshold Shift (TTS), which is effectively auditory fatigue and does not constitute permanent effects on hearing. The National Oceanic and Atmospheric Administration in 2024 used slightly different thresholds and frequency weightings as are included in guidance produced by the National Oceanic and Atmospheric Administration (NOAA) in 2018 and Southall et al. (2019). Other the Sirenians (Figure 3-2), the revised frequency-weighting curves for the cetacean groups and marine carnivores in water are shown in Figure 3-1 and Figure 3-2.

FIGURE 3-1: FREQUENCY WEIGHTING CURVES NOAA 2024 (LOW FREQUENCY, HIGH FREQUENCY AND VERY HIGH FREQUENCY CETACEANS)

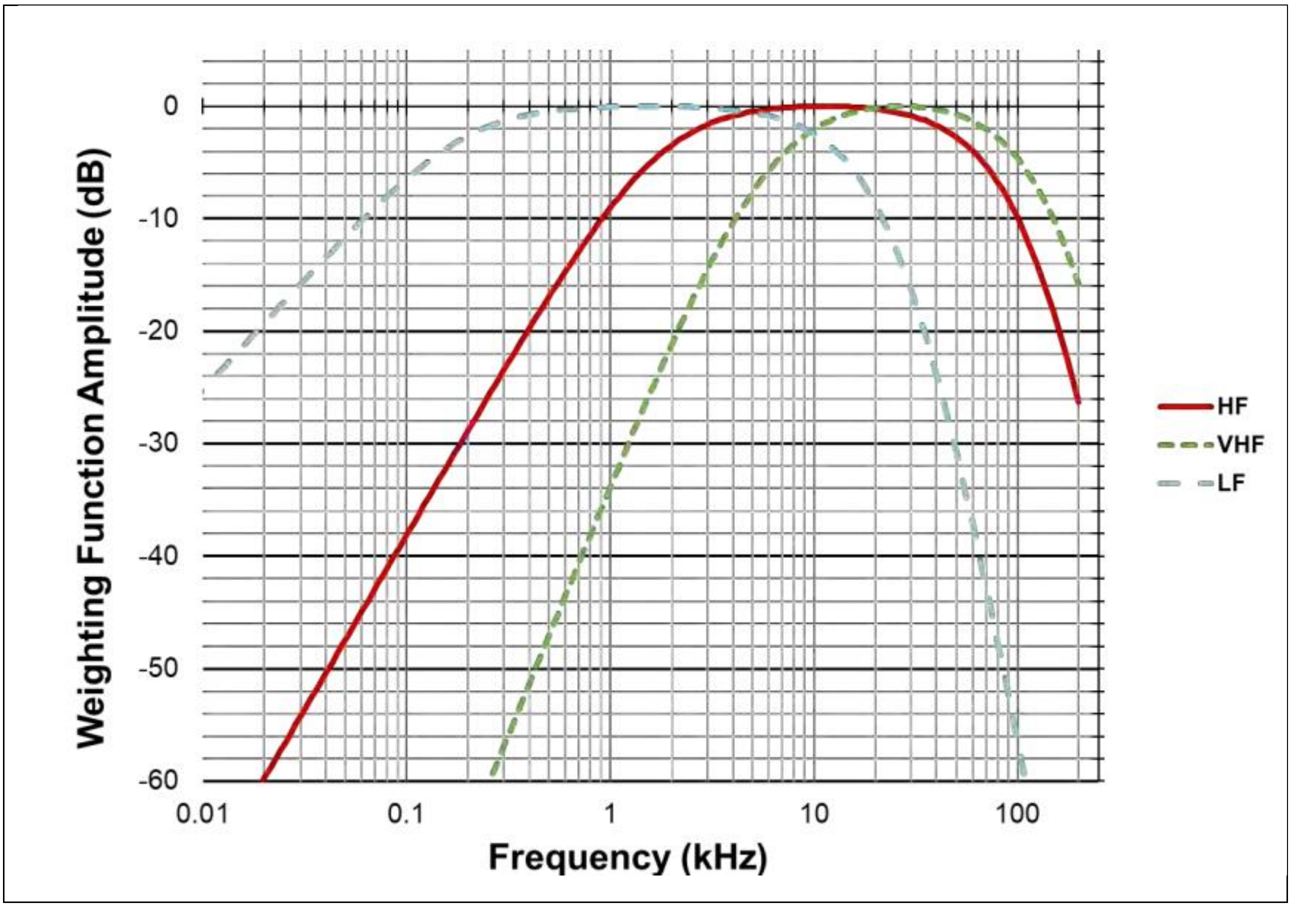


FIGURE 3-2: FREQUENCY WEIGHTING SOUTHALL ET AL 2019 (SIRENIANS)

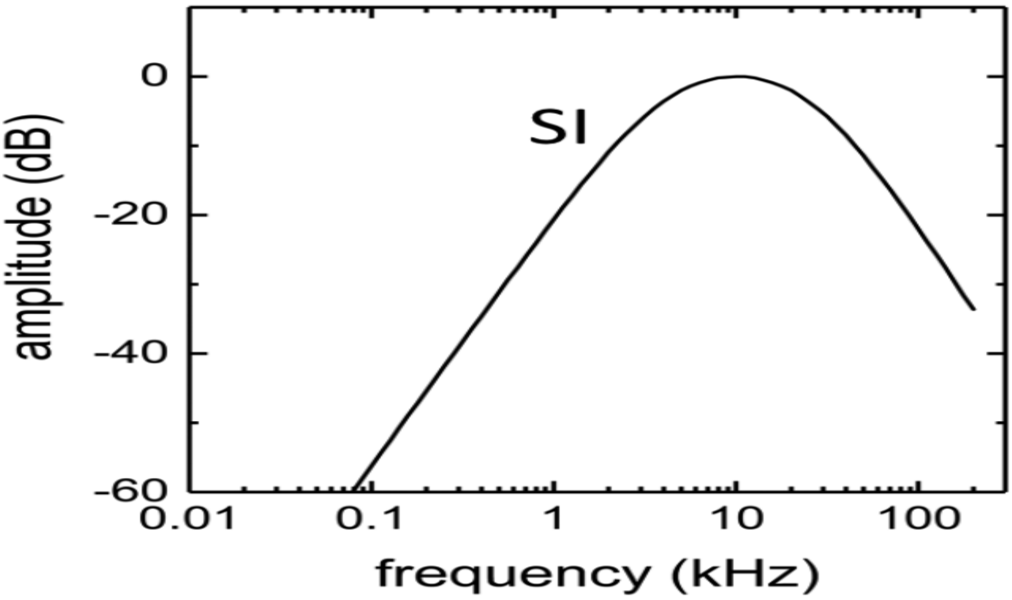
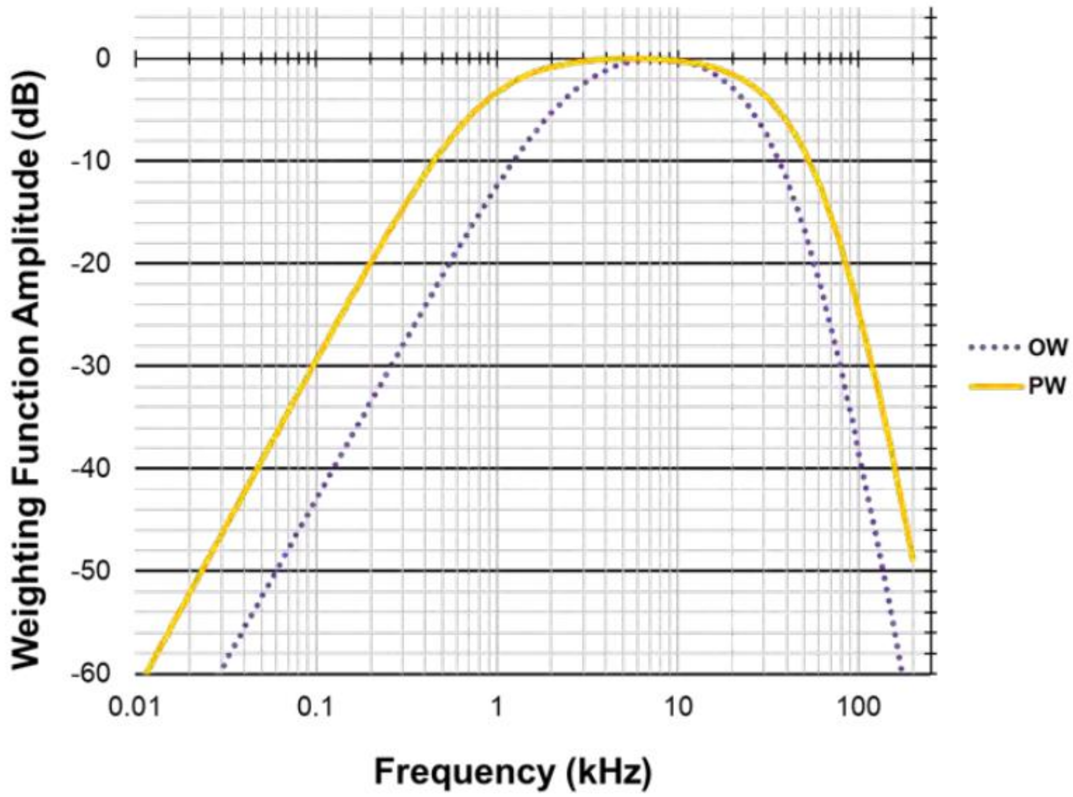


FIGURE 3-3: FREQUENCY WEIGHTING CURVES NOAA 2024 (PW AND OW)



A summary of the criteria for AUD INJ and TTS is presented in Table 3-1 for VSP and Table 3-2 for drilling.

TABLE 3-1: THRESHOLD VALUES - VSP

Hearing Group	**VSP**			
	AUD INJ		**TTS**	
	Peak Threshold (dB re 1 µPa)	**Cumulative SEL Threshold (dB re 1 µPa^{2}s)**	**Peak Threshold (dB re 1 µPa)**	**Cumulative SEL Threshold (dB re 1 µPa^{2}s)**
LF cetaceans	222	183	216	168
HF cetaceans	230	193	224	170
VHF cetaceans	202	159	196	140
Sirenians (SI)	226	190	220	175
Phocid pinnipeds (PCW)	223	183	217	170
Other Marine Carnivores (OCW)	230	185	224	188

Source: NOAA 2024 and Southhall et al, 2019

ERROR! REFERENCE SOURCE NOT FOUND.

TABLE 3-2: THRESHOLD VALUES - DRILLING

Hearing Group	**Drilling**	
	AUD INJ	**TTS**
	Cumulative SEL Threshold (dB re 1 μPa²s)	**Cumulative SEL Threshold (dB re 1 μPa²s)**
LF cetaceans	197	177
HF cetaceans	201	181
VHF cetaceans	181	161
Sirenians (SI)	206	186
Phocid pinnipeds (PW)	195	175
Other Marine Carnivores (OW)	199	179

Source: NOAA 2024 and Southhall et al, 2019

3.1.2 BEHAVIOURAL CRITERIA

Regarding continuous noise sources such as drilling, there is a variety of sources of information regarding the likely behavioural effects of marine mammals due to sound exposure. Data from studies found in Southall et al. (2007) include examples of behavioural responses of low-frequency cetaceans. Humpback whales and grey whales subject to vessel noise and playback of drilling noise all show behavioural responses to received sound levels of 110 to 120 dB re 1 μPa (RMS). Based on the studies that show observable reactions, a criterion of 120 dB re 1 μPa (RMS) has been adopted for all low-frequency species for behavioural response.

Limited data are available on behavioural responses by mid-frequency marine mammals[1]. However, a study of belugas that were exposed to playback of drilling sound found individuals displayed strong reactions to noise levels of 110 to 130 dB re 1 μPa (RMS) (Southall et al. 2007). They are considered to be representative of mid-frequency hearing cetaceans.

For high-frequency marine mammals[2], the combined wild and captive animal data clearly support the observation that harbor porpoises are quite sensitive to a wide range of human sounds at very low exposure noise levels (~90 to 120 dB re 1 μPa), at least for initial exposures. All recorded exposures exceeding 140 dB re 1 μPa induced profound and sustained avoidance behaviour in wild harbor porpoises (Southall et al., 2007). Harbor porpoises also tend to avoid moving boats. However, Southall et al also note that habituation to sound exposure was noted in some but not all studies. In certain field conditions, strong initial reactions of high-frequency cetaceans at relatively low noise levels appeared to wane rather rapidly with repeated exposure (Cox et al., 2001). In contrast, several laboratory observations showed little or no indication of reduced behavioural sensitivity as a function of exposure experience (Kastelein et al., 1997, 2005). As a result of the drilling vessel being stationary, it is more likely that habituation would be a factor in lessening high frequency marine mammal reactions, and sustained avoidance reactions would appear to be more likely at levels around 140 dB re 1 μPa.

[1] It is noted that "mid frequency" was replaced with the term "high frequency" in Southall 2018, but the original term is used in Southall 2007 is used in this section
[2] It is noted that "high frequency" was replaced with the term "very high frequency" in Southall 2018, but the original term is used in Southall 2007 is used in this section.

This study applies the marine mammal behavioural threshold for all marine mammals based on the current interim U.S National Marine Fisheries Service (NMFS) criterion, NMFS (2014), for marine mammals of 120 dB re 1µPa (RMS) for disturbance of marine mammals by non-impulsive sound sources. The NMFS noise criterion is broadly in agreement with a conservative interpretation of the noise levels at which behavioural effects were observed in the literature that was analysed by Southall et al. (2007).

The widely used threshold level for the onset of possible behavioural response in all marine mammals is the SPL of 160 dB re 1 µPa from a single seismic pulse. For multiple detonations (within a 24-hour period), the National Marine Fisheries Service (NMFS 2023b) relies on a behavioural threshold of -5 dB from TTS criteria, as presented in Table 3-1.

3.2 FISH & SEA TURTLES

3.2.1 FISH

For impulsive noise sources, similar numerical criteria apply to the potential for permanent injury to fish and sea turtles. Popper et al 2014 sets out noise criteria at which mortality and potential mortal injury, and recoverable injury (i.e. temporary loss of hearing) are predicted to occur. These are set for fish at different stages of life (i.e. as adults, larvae and eggs). The potential injury criteria adopted for impulsive noise sources in this assessment are shown in Table 3-3.

TABLE 3-3: ADOPTED CRITERIA FOR POTENTIAL INJURY FOR FISH DUE TO IMPULSIVE SOUND

Type of Animal	Mortality and Potential Mortal Injury	Recoverable Injury
Fish: no swim bladder (particle motion detection)	>219 dB SELcum or >213 dB Peak	>216 dB SELcum or >213 dB Peak
Fish: swim bladder not involved in hearing (particle motion)	210 SELcum or >207 dB Peak	203 dB SELcum or >207 dB Peak
Fish: swim bladder involved in hearing (primary pressure detection) juveniles and eggs	207 SELcum or >207 dB Peak	203 dB SELcum or >207 dB Peak
Fish: Eggs and Larvae	210 SELcum or >207 dB Peak	(N/A – moderate potential near to source)

Source: Popper et al 2014.

Table 3-4 presents the relevant effects thresholds set out by Popper et al. 2014, for drilling and continuous noise. The guidelines define quantitative thresholds for three effects:

- Mortality and potential mortal injury;
- Recoverable injury;
- TTS.

TABLE 3-4: CRITERIA FOR ONSET OF POTENTIAL INJURY TO FISH DUE TO CONTINUOUS SOUND

Type of Animal	Mortality and potential mortal Injury	Recoverable Injury	TTS
Fish: no swim bladder (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low
Fish: swim bladder is not involved in hearing (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low
Fish: swim bladder involved in hearing (primarily pressure detection)	(N) Low (I) Low (F) Low	170 dB RMS for 48h	158 dB RMS for 12h
Eggs and larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low

Notes: RMS sound pressure levels dB re 1 μPa. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined as near (N), intermediate (I), and far (F).

Source: Popper et al 2014

To determine the behaviour response threshold for all fish species, except fish eggs and fish larvae, to impulsive and non-impulsive noise, NMFS 2023a uses the common of 150 dB re 1 μPa RMS. The derivation and origin of the informal 150 dB threshold is not as well-defined as other thresholds. However, various recent publications do not refute that behavioural disturbance can occur around this level (Hawkins, A.D. and Popper, A.N., 2017).

3.2.2 SEA TURTLES

Finneran et al 2017 revised thresholds, published Popper 2014, based on a review of references from at least five different species of sea turtles (TU) to construct their composite audiograms and provide thresholds for the onset of PTS and TTS (refer to Table 3-5). Finneran et al agreed that sea turtles have low sensitivity with their audiograms more similar to those of fish without specialized hearing adaptations for high frequency.

Data on the behavioural reactions of sea turtles to sound sources is limited. Currently, there is not enough data to derive separate thresholds for different source types. However, behavioural disturbance from impulsive and non-impulsive noise generally occurs around 175 dB re 1 μPa RMS (McCauley et al. 2000) which has also been adopted by NMFS. The revised thresholds for sea turtles to impulsive and non-impulsive noise are presented in Table 3-5 and Table 3-6, respectively.

TABLE 3-5:NOISE CRITERIA FOR SEA TURTLES - IMPULSIVE NOISE

Type of animal	Potential Injury (PTS) onset		TTS onset		Behaviour response
	Single pulse exposure	Cumulative exposure	Single pulse exposure	Cumulative exposure	Single pulse exposure
	Peak Threshold (dB re 1 µPa)	Cumulative SEL Threshold (dB re 1 µPa2s)	Peak Threshold (dB re 1 µPa)	Cumulative SEL Threshold (dB re 1 µPa2s)	RMS (dB re 1 µPa)
Sea Turtles	232	204	226	189	175

Source: Finneran et al. 2017

TABLE 3-6:NOISE CRITERIA FOR TURTLES - NON IMPULSIVE NOISE

Type of animal	Potential Injury (PTS) onset	TTS onset	Behaviour response
	Cumulative exposure	Cumulative exposure	Single pulse exposure
	Cumulative SEL Threshold (dB re 1 µPa^{2}s)	Cumulative SEL Threshold (dB re 1 µPa^{2}s)	RMS (dB re 1 µPa)
Sea Turtles	220	200	175

Finneran et al. 2017, McCauley et al. 2000

4. RESULTS

For both drilling locations (Gemsbok and second potential well), the impact zones (distances at which the criteria will be met) are presented below, based on the most conservative -case scenario in terms of environmental conditions. The predicted impact zones have been estimated based on the source values presented in Section 2.3.

4.1 IMPACT ZONES – MARINE MAMMALS

4.1.1 POTENTIAL INJURY

4.1.1.1 VSP (AUD INJ AND TTS)

In terms of AUD INJ and TTS criteria, the predicted impact zone are for all hearing groups is predicted to be within 100 m from the VSP location, complying with the 500 m safety zone that can be implemented by MMO/PAM. Table 4-1 and Table 4-2 show the predicted distances from each VSP location at which the SELcum and PEAK thresholds for AUD INJ and TTS onset are exceeded for marine mammals moving away from the piling.

TABLE 4-1: CALCULATED DISTANCES FOR THE AUD INJ AND TTS CRITERIA FOR MARINE MAMMALS DUE TO VSP - GEMSBOK

Hearing Group	Distance to SEL CUM Threshold Exceedance (km) 50 Pulses		Distance to SEL CUM Threshold Exceedance (km)250 Pulses		Distance to Peak Threshold Exceedance	
	AUD INJ	TTS	AUD INJ	TTS	AUD INJ	TTS
LF cetaceans	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1
HF cetaceans	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
VHF cetaceans	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Sirenians	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phocid pinnipeds (PCW)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Otariid pinnipeds (OCW)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

TABLE 4-2: CALCULATED DISTANCES FOR THE TTS CRITERIA FOR MARINE MAMMALS AS A RESULT OF VSP (250 PULSES) IF USED – POTENTIAL SECOND WELL

Hearing Group	**Distance to SEL CUM Threshold Exceedance (km) 50 Pulses**		**Distance to SEL CUM Threshold Exceedance (km)250 Pulses**		**Distance to Peak Threshold Exceedance (km)**	
	AUD INJ	**TTS**	**AUD INJ**	**TTS**	**AUD INJ**	**TTS**
LF cetaceans	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1
HF cetaceans	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
VHF cetaceans	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Sirenians	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phocid pinnipeds (PCW)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Otariid pinnipeds (OCW)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

4.1.1.2 DRILLING

For all hearing groups, predicted AUD INJ and TTS impact zones for all hearing groups are within less than 100 m from the source. These impact zones are within the safety zone of 500 m, which a Marine Mammal Observer (MMO)/ Passive Acoustic Monitoring (PAM) can be implemented. Table 4-3and TABLE 4-4 shows the impact zones from each drilling location.

TABLE 4-3: CALCULATED DISTANCES FOR THE AUD INJ AND TTS CRITERIA FOR MARINE MAMMALS – GEMSBOK

Hearing Group	Cumulative SEL Threshold (dB re 1 μPa²s)		Distance to Threshold Exceedance (km)[1]	
	AUD INJ	TTS	AUD INJ	TTS
LF cetaceans	197	177	< 0.1	< 0.1
HF cetaceans	201	181	< 0.1	< 0.1
VHF cetaceans	181	161	< 0.1	< 0.1
Sirenians	206	186	< 0.1	< 0.1
Phocid pinnipeds (PW)	195	175	< 0.1	< 0.1
Otariid pinnipeds (OW)	199	179	< 0.1	< 0.1

[1] Predicted distances have been rounded up to the nearest 0.1 km.

TABLE 4-4: CALCULATED DISTANCES FOR THE AUD INJ AND TTS CRITERIA FOR MARINE MAMMALS – POTENTIAL SECOND WELL

Hearing Group	Cumulative SEL Threshold (dB re 1 μPa²s)		Distance to Threshold Exceedance (km)[1]	
	AUD INJ	TTS	AUD INJ	TTS
LF cetaceans	197	177	< 0.1	< 0.1
HF cetaceans	201	181	< 0.1	< 0.1
VHF cetaceans	181	161	< 0.1	< 0.1
Sirenians	206	186	< 0.1	< 0.1
Phocid pinnipeds (PW)	195	175	< 0.1	< 0.1
Otariid pinnipeds (OW)	199	179	< 0.1	< 0.1

[1] Predicted distances have been rounded up to the nearest 0.1 km.

4.1.2 BEHAVIOURAL DISTURBANCE

4.1.2.1 VSP

According to NMSF 2023 criteria for multiple pulses are derived by the TTS criteria of each hearing decreased by 5 dB. For both locations (Gemsbok and potential second well), the behaviour impact zones are predicted to be up to 400 m for LF cetaceans for the 250 pulses scenario, or up to 200 m for the 50 pulses scenario. For the rest of the hearing groups for both scenarios, the behaviour impact zones are within 100 m from the source.

For the criterion of 160 dB re 1 μPa RMS that is applicable to all marine mammals, the predicted distances are up to 300 m from Gemsbok well, and up to 400 m for the potential second well.

4.1.2.2 DRILLING

The modelling predicts that during drilling activities, the behavioural disturbance can reach distances up to 9.6 km for Gemsbok and up to 11 km for the potential second well. This will apply mostly towards areas with great depths. These distances decrease towards areas with shallower waters.

4.2 IMPACT ZONES – FISH & SEA TURTLES

4.2.1 POTENTIAL IMPACT

4.2.1.1 VSP

For VSP the calculated zones for potential impact for both locations and scenarios are within 100 m from the noise source and are presented in Table 4-5 for Gemsbok well and Table 4-6 for the second potential well.

TABLE 4-5: CALCULATED IMPACT ZONES FOR POTENTIAL INJURY CRITERIA FOR FISH – GEMSBOK

Type of Animal	Parameter	Mortality and Potential Mortal Injury Threshold	Recoverable Injury Threshold	Distance (km) for Mortality (50 Pulses)	Distance (km) for Mortality (250 Pulses)	Distance (km) for Impairment (50 Pulses)	Distance (km) for Impairment (250 Pulses)
Fish: no swim bladder (particle motion detection)	SELcum	>219 dB	>216 dB	<0.1	<0.1	<0.1	<0.1
	Peak	>213 dB	>213 dB	<0.1	<0.1	<0.1	<0.1
Fish: swim bladder not involved in hearing (particle motion)	SELcum	210 dB	203 dB	<0.1	<0.1	<0.1	<0.1
	Peak	>207 dB	>207 dB	<0.1	<0.1	<0.1	<0.1
Fish: swim bladder involved in hearing (primary pressure detection), juveniles and eggs	SELcum	207 dB	203 dB	<0.1	<0.1	<0.1	<0.1
	Peak	>207 dB	>207 dB	<0.1	<0.1	<0.1	<0.1
Fish: Eggs and Larvae	SEL	210 dB	N/A – moderate potential near to source	<0.1	<0.1	N/A	N/A

Type of Animal	Parameter	Mortality and Potential Mortal Injury Threshold	Recoverable Injury Threshold	Distance (km) for Mortality (50 Pulses)	Distance (km) for Mortality (250 Pulses)	Distance (km) for Impairment (50 Pulses)	Distance (km) for Impairment (250 Pulses)
	Peak	>207 dB	N/A – moderate potential near to source	<0.1	<0.1	N/A	N/A

TABLE 4-6: CALCULATED IMPACT ZONES FOR POTENTIAL INJURY CRITERIA FOR FISH – SECOND POTENTIAL WELL

Type of Animal	Parameter	Mortality and Potential Mortal Injury	Recoverable Injury	Calculated Distance (km) for Adopted for Mortality and Potential Mortal Injury (50 Pulses)	Calculated Distance (km) for Adopted for Mortality and Potential Mortal Injury (250 Pulses)	Calculated Distance for Adopted (km) for Impairment (Recoverable Injury including Auditory Damage) (50 Pulses)	Calculated Distance for Adopted (km) for Impairment (Recoverable Injury including Auditory Damage) (250 Pulses)
Fish: no swim bladder (particle motion detection)	SEL_{cum}	>219 dB	>216 dB	<0.1	<0.1	<0.1	<0.1
	Peak	>213 dB	>213 dB	<0.1	<0.1	<0.1	<0.1
Fish: swim bladder not involved in hearing (particle motion)	SEL_{cum}	210 dB	203 dB	<0.1	<0.1	<0.1	<0.1
	Peak	>207 dB	>207 dB	<0.1	<0.1	<0.1	<0.1
Fish: swim bladder involved	SEL_{cum}	207 dB	203 dB	<0.1	<0.1	<0.1	<0.1

Type of Animal	Parameter	Mortality and Potential Mortal Injury	Recoverable Injury	Calculated Distance (km) for Adopted for Mortality and Potential Mortal Injury (50 Pulses)	Calculated Distance (km) for Adopted for Mortality and Potential Mortal Injury (250 Pulses)	Calculated Distance for Adopted (km) for Impairment (Recoverable Injury including Auditory Damage) (50 Pulses)	Calculated Distance for Adopted (km) for Impairment (Recoverable Injury including Auditory Damage) (250 Pulses)
in hearing (primary pressure detection), juveniles and eggs	Peak	>207 dB	>207 dB	<0.1	<0.1	<0.1	<0.1
Fish: Eggs and Larvae	SEL	210 dB	(N/A – moderate potential near to source)	<0.1	<0.1	N/A	N/A
	Peak	>207 dB	(N/A – moderate potential near to source)	<0.1	<0.1	N/A	N/A

For sea turtles the potential impact zones (AUD INJ and TTS) are predicted to be within 100 m from both VSP locations and both pulse scenarios if VSP is conducted.

TABLE 4-7:IMPACT ZONES FOR SEA TURTLES - GEMSBOK

Hearing Group	Cumulative SEL Threshold (dB re 1 µPa²s)		Distance to AUD INJ Threshold Exceedance (km)[1]		Distance to TTS Threshold Exceedance (km)[1]	
	AUD INJ	TTS	50 Pulses	250 Pulses	50 Pulses	250 Pulses
Sea Turtles	204	189	< 0.1	< 0.1	< 0.1	< 0.1

TABLE 4-8:IMPACT ZONES FOR SEA TURTLES – SECOND POTENTIAL WELL

Hearing Group	Cumulative SEL Threshold (dB re 1 µPa²s)		Distance to AUD INJ Threshold Exceedance (km)[1]		Distance to TTS Threshold Exceedance (km)[1]	
	AUD INJ	TTS	50 Pulses	250 Pulses	50 Pulses	250 Pulses
Sea Turtles	204	189	< 0.1	< 0.1	< 0.1	< 0.1

4.2.1.2 DRILLING

For the Gemsbok well, predicted RMS levels show the criterion for recoverable potential injury (170 dB re 1 µPa rms for 48 hours) will be met at distances within 0.1 km from the source, for both drilling locations. The TTS criterion (158 dB re 1 µPa rms for 12 hours), will be met at distances less than 0.4 km from both the drilling locations, as presented in Table 4-9 and Table 4-10.

TABLE 4-9: IMPACT ZONES FOR FOR FISH - GEMSBOK

Type of Animal	Mortality and potential mortal Injury	Distance to Threshold Exceedance	
		Recoverable Injury	TTS
Fish: no swim bladder (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low
Fish: swim bladder is not involved in hearing (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low
Fish: swim bladder involved in hearing (primarily pressure detection)	(N) Low (I) Low (F) Low	<0.1 km	<0.4km
Eggs and larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low

Type of Animal	Mortality and potential mortal Injury	Distance to Threshold Exceedance	
		Recoverable Injury	TTS
Notes: RMS sound pressure levels dB re 1 µPa. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined as near (N), intermediate (I), and far (F).			

TABLE 4-10: IMPACT ZONES FOR FOR FISH – POTENTIAL SECOND WELL

Type of Animal	Mortality and potential mortal Injury	Recoverable Injury	TTS
Fish: no swim bladder (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low
Fish: swim bladder is not involved in hearing (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low
Fish: swim bladder involved in hearing (primarily pressure detection)	(N) Low (I) Low (F) Low	<0.1 km	<0.4km
Eggs and larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low
Notes: RMS sound pressure levels dB re 1 µPa. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined as near (N), intermediate (I), and far (F).			

4.2.2 BEHAVIOURAL DISTURBANCE

4.2.2.1 VSP

The potential behavioural impact zones for fish (150 dB re 1 µPa RMS) are predicted at distances up to 0.4 km from Gemsbok well and from the potential second well. The potential behavioural impact zones for sea turtles, resulting from VSP activities if used, are within 100 m for both well locations, as presented in Table 4-11 and Table 4-12.

TABLE 4-11: BEHAVIOURAL IMPACT ZONES FOR SEA TURTLES AND FISH - GEMSBOK

Hearing Group	RMS (dB re 1 µPa)	Distance to Threshold Exceedance (km)
Sea Turtles	175	< 0.1
Fish	150	0.4

TABLE 4-12: BEHAVIOURAL IMPACT ZONES FOR SEA TURTLES AND FISH – SECOND POTENTIAL WELL

Hearing Group	RMS (dB re 1 μPa)	Distance to Threshold Exceedance (km)
Sea Turtles	175	< 0.1
Fish	150	0.4

4.2.2.2 DRILLING

The potential behavioural impact zones for fish (150 dB re 1 μPa RMS) are predicted at distances up to 1 km from Gemsbok well and for the second potential well. The potential behavioural impact zones for sea turtles, due to drilling activities, are within 100 m for both well locations, as presented in Table 4-13 and Table 4-14.

TABLE 4-13: BEHAVIOURAL IMPACT ZONES FOR SEA TURTLES AND FISH - GEMSBOK

Hearing Group	RMS (dB re 1 μPa)	Distance to Threshold Exceedance (km)
Sea Turtles	175	< 0.1
Fish	150	1

TABLE 4-14: BEHAVIOURAL IMPACT ZONES FOR SEA TURTLES AND FISH – SECOND POTENTIAL WELL

Hearing Group	RMS (dB re 1 μPa)	Distance to Threshold Exceedance (km)
Sea Turtles	175	< 0.1
Fish	150	1

5. CONCLUSIONS

This study aims to model an estimate of the transmission loss of underwater sound emissions related to VSP, if used, and drilling activities at the Gemsbok well and Second potential well in PEL 82, considering the specific acoustic properties of the study areas, which determines how far the sound will spread from a source of underwater noise.

The receptors are split in two main fauna groups:

- Marine mammals: Criteria are based on the work of NOAA 2024 and Southall et al. 2019, who adopt a dual criterion that considers the cumulative SEL value (SELcum). SELcum is calculated based on the cumulative noise exposure over a 24-hour period. The SELcum considers the relative movement of the source and receiver and its effect on the estimated value. The criteria are considered in order to establish the effect on marine mammals, in addition to set threshold related to behavioural reactions.
- Sea turtles and fish: Criteria are based on the work of Popper et al. (2014) and Finneran et al (2017). The criteria are set to identify mortality, potential mortal injury, and recoverable injury (e.g., potential temporary loss of hearing).

Predicted potential injury impacted zones for all cetaceans hearing groups and sea turtles, for both VSP and drilling, at both locations are predicted to be within 100 m from the source. For fishes (swim bladder involved in hearing (primarily pressure detection)), predicted TTS impact zones can reach up to 400 m from the source due to drilling activities at both wells.

Behavioural impact zones for the LF hearing group can reach up to 400 m from the VSP activities due to a worst case scenario (250 pulses), whilst for the rest of the hearing groups behavioural impact zones are within 100 m from the source. For drilling, behavioural impact zones can reach distances up to 9.6 km for Gemsbok and up to 11 km for the potential second well for all marine mammals. For sea turtles, the behavioural impact zones are predicted to be within 100 m from the source for both VSP if used and drilling, at both wells, but potential behavioural responses, especially in fish, can extend up to 1 km.

6. REFERENCES

Bianchi, G. 1999. Field guide to the living marine resources of Namibia. Food & Agriculture Organization. https://books.google.com.na/books?isbn=9251043450.

Bremner, J. M. 1983. Biogenic sediments on the South West African (Namibian) continental margin. In: Thiede, J. and Suess, E. (eds). Coastal Upwelling: Its Sediment Record, Part B: New York, Plenum Publishing. 73-104.

Cox, T. M., Ragen, T. J., Read, A. J., Vos, E., Baird, R. W., Balcomb, K., ... and Benner, L. 2001. Understanding the impacts of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management. 7(3):177-187.

Danish Energy Agency, 2023. Guideline for underwater noise: Installation of impact or vibratory driven piles.

Duncan, A., and McCauley, R. 2008. Environmental impact assessment of underwater sound: Progress and pitfalls. Annual Conference of the Australian Acoustical Society. 1-8.

Finneran, J.J., E.E. Henderson, D.S. Houser, K. Jenkins, S. Kotecki, and J. Mulsow. 2017. Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III). Technical report by Space and Naval Warfare Systems Center Pacific (SSC Pacific). 183 p.

Geological Survey of Namibia, 2003. Fishing Areas and distribution of marine mammals and seabirds. Map compiled by the Geological Survey of Namibia with Data Sources from the National Marine Information and Research Centre (NATMIRC), Swakopmund, Windhoek.

Godin, O. A. (2021). Shear waves and sound attenuation in underwater waveguides. The Journal of the Acoustical Society of America, 149(5), 3586–3598. https://doi.org/10.1121/10.0004999.

Hamilton, E. L. (1980). Geoacoustic modelling of the sea floor. The Journal of the Acoustical Society of America, 68(5), 1313–1340. https://doi.org/10.1121/1.385100.

Hawkins, A.D. and Popper, A.N., 2017. A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. ICES Journal of Marine Science, 74(3), pp.635-651.

Kastelein, R. A., Van de Voorde, S., and Jennings, N. 2018. Swimming Speed of a Harbor Porpoise (*Phocoena phocoena*) During Playbacks of Offshore Pile Driving Sounds. Aquatic Mammals. 44(1).

Kimura, M. (2013). Shear wave speed dispersion and attenuation in granular marine sediments. The Journal of the Acoustical Society of America, 134(1), 144–155. https://doi.org/10.1121/1.4809679.

Maggi, A., and Duncan, A. n.d. AcTUP: Acoustic Toolbox User Interface and Post-Processor. Centre for Marine Science and Technology, Curtin University.

McCauley R. D., Fewtrell J., Duncan A. J., Jenner, C., Jenner M. N., Penros J. D., Prince R. I. T., Adhitya A., Murdoch J. and McCabe K. 2000. Marine Seismic Surveys: Analysis and Propagation of Air Gun Signals, and Effects of Exposure on Humpback Whales, Sea Turtles, Fishes and Squid. Prepared for the APPEA. CMST, Curtin University

National Marine Fisheries Service (NMFS). 2023a. Summary of Endangered Species Act Acoustic Thresholds (Marine Mammals, Fishes, and Sea turtles) January 2023. Marine Mammal Acoustic Technical Guidance | NOAA Fisheries (Accessed 28 August 2023)

National Marine Fisheries Service, 2024. Update to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 3.0): Underwater and In Air Criteria for Onset of Auditory Injury and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-71. 182.

NOAA World Ocean Atlas, 2023. Worldwide Sound Speed, Temperature, Salinity, and Buoyancy.

Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D. A., Bartol, S., Carlson, T. J., ... and Tavolga, W. N. 2014. ASA S3/SC1.4 TR-2014 Sound exposure guidelines for fishes and sea turtles: A technical report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. ASA Press. Springer.

Southall, B. L., Finneran, J. J., Reichmuth, C., Nachtigall, P. E., Ketten, D. R., Bowles, A. E., ... and Tyack, P. L. 2019. Marine mammal noise exposure criteria: Updated scientific recommendations for residual hearing effects. Aquatic Mammals 45(2):125-232.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals 2007. 33:411-521.

Wenz, G. M. 1962. Acoustic ambient noise in the ocean: spectra and sources. The journal of the acoustical society of America. 34(12):1936-1956.

FISHERIES STUDY

Commercial Fisheries Specialist Assessment

ESIA for Exploration Drilling in PEL 82, Walvis Basin, Namibia

PREPARED FOR

Chevron Namibia Exploration Ltd

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Commercial Fisheries Specialist Assessment

ESIA for Exploration Drilling in PEL 82, Walvis Basin, Namibia

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ACRONYMS AND ABBREVIATIONS

Acronyms	Description
BAT	Best Available Techniques
BOP	Blow Out Preventer
MFMR	Ministry of Fisheries and Marine Resources
NABF	Non-Aqueous Base Fluid
NADF	Non-Aqueous Drilling Fluid
LAT	Latitude
LOC	Loss of Containment
LONG	Longitude
OSRP	Oil and Chemical Spill Response Plan
PAH	Polycyclic Aromatic Hydrocarbonb
PEL	Petroleum Exploration License
PTS	Permanent Threshold Shift
QMA	Quota Managment Area
RMS	Route Mean Square
ROV	Remotely Operated Vehicle
SEL	Sound Elevation Level
SOPEP	Shipboard Oil Pollution Emergency Plan
SCCP	Source Control Contingency Plan
STLM	Sound Transmission Loss Modelling
TAC	Total Allowable Catch
TAE	Total Allowable Effort
THC	Total Hydrocarbon Concentration
TSS	Total Suspended Solids
TTS	Temporary Threshold Shift
VSP	Vertical Seismic Profiling
WBM	Water Based Mud

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Expertise and Declaration of Independence

This report was prepared by Sarah Wilkinson of CapMarine (Pty) Ltd. Sarah Wilkinson has a BSc (Hons) degree from the University of Cape Town and is a professional natural scientist registered with the SA Council for Natural Scientific Professions (SACNASP). Sarah Wilkinson has 15 years of experience undertaking specialist fisheries assessments and specializes in spatial and temporal analysis (GIS) of fisheries in the southern African region.

This specialist report was compiled for ERM as part of the Environmental and Social Impact Assessment (ESIA) for Exploration Well Drilling in PEL 82, situated in the Walvis Basin offshore central Namibia. I hereby declare that I am are financially and otherwise independent of CNEL and of ERM.

Sarah Wilkinson

1. INTRODUCTION

Chevron Namibia Exploration Limited II (CNEL) is considering initiating an offshore hydrocarbon exploration program within Petroleum Exploration License (PEL) 82, encompassing Blocks 2112B and 2212A in the Walvis Basin, Namibia (i.e. potential project). PEL 82 is located approximately 257 km north-west of Walvis Bay, with water depths ranging from 200 m to 2,500 m. CNEL holds the Exploration License for both blocks which spans over an area of approximately 11,400 km².

CNEL is considering to initially conducting a one-well campaign at the Gemsbok prospect, located within Block 2112B (coordinates: LAT: 21° 44’ 48.15” S, LONG: 12° 27’ 13.74” E), in water depths ranging from 900 m to 1,500 m. Subject to the results of this initial campaign, follow-up drilling may include up to nine additional wells (total of 5 exploration and 5 appraisal wells) across blocks 2112B and 2212A over a 3 to 5 year period. Each well is expected to require a maximum of 90 days to complete, including mobilisation, drilling operations and demobilisation and appraisal wells, testing. The program anticipates drilling a maximum of 3 to 4 wells per year.

Drilling of the first exploration well may take place in the 2026 / 2027 timeframe. Based on results of the exploration well, an appraisal well may follow. Any additional wells would be contingent upon the results of these initial wells and would occur from 2027 onwards, rather than immediately following the first campaign.

- Mobilisation phase: up to 15 days
- Drilling phase:
  - Exploration well (including abandonment): up to 60 days
- Appraisal well (including abandonment and testing): up to 60 days
- Demobilisation phase: up to 15 days

1.1 TERMS OF REFERENCE

The information from this study is intended to inform the ESIA process through providing fisheries baseline data for PEL 82 and surrounds, an expert opinion on the relevant fisheries sectors and potential impact thereto, including potential mitigation measures to be implemented to manage/mitigate potential impacts of the potential exploration activities.

The following general Terms of Reference (ToR) apply to the specialist studies:

- Describe the receiving environment and baseline conditions that exist in the study area and identify any sensitive areas that will need special consideration.
- Review the Scoping Comments and Responses Report to ensure that all relevant issues and concerns relevant to fields of expertise are addressed.
- Where applicable, identify and assess potential impacts of the potential project activities and infrastructure following the impact assessment methodology, including describing any associated cumulative impacts (qualitative assessment, to the extent that this is feasible).
- Describe the legal, permit, policy and planning requirements.
- Identify areas where issues could combine or interact with issues likely to be covered by other specialists, resulting in aggravated or enhanced impacts.

- Indicate the reliability of information utilised in the assessment of impacts as well as any constraints to which the assessment is subject (e.g. any areas of insufficient information or uncertainty).
- Where necessary consider the precautionary principle in the assessment of impacts.
- Identify management and mitigation actions using the Mitigation Hierarchy by recommending actions in order of sequential priority. Avoid first, then reduce/minimise, then rectify and then offset.
- Identify alternatives that could avoid or minimise impacts.
- Determine significance thresholds for limits of acceptable change, where applicable.

The specific ToR for the commercial fisheries assessment are as follows:

- Provide a description of the fisheries sectors operating in Namibian waters, focusing on the blocks.
- Undertake a spatial and temporal assessment of recent and historical fishing effort and catch in the license area.
- Use available data to describe natural variability in historical trends and check monthly catches for seasonality.
- Assess the risk of impact of the exploration activities on specific commercial fish species and the consequential implications for fish catch by the different fishing sectors.
- Assess the potential impacts of normal operations and upset conditions (small accidental spills and large well loss of containment event) on the fishing activities in terms of estimated catch and effort loss.
- Identify practicable mitigation measures to avoid and / or reduce any negative impacts on the fishing industry.

1.2 APPROACH TO THE STUDY

1.2.1 DATA SOURCES

Access to Namibian commercial fisheries catch and effort data was granted by the Namibian Ministry of Fisheries and Marine Resources (MFMR) who provided the data range as listed in Table 1-1. The International Commission for the Conservation of Atlantic Tuna (ICCAT) Statistical Bulletin for 2023 provided annual catch data reported by the Namibian fleet. Information on fishing rights holdings and industrial bodies was sourced from the 2019 edition of the Fishing Industry Handbook. Information on species distribution was taken from the Benguela Current Large Marine Ecosystem (BCLME) Annual State of the Stocks Report 2011. Status of stocks was sourced from the Namibian Marine Resources Advisory Council (MRAC), 2023.

TABLE 1-1 DATE RANGE OF BASELINE FISHERIES DATASETS

Sector	Date Range	Comment
Small pelagic purse-seine	2010 – 2017	Fishery closed since 2018*
Midwater trawl	2010 – 2022	Active
Demersal trawl (hake)	2017 – 2022	Active
Demersal trawl (monk)	2010 – 2023	Active

Sector	Date Range	Comment
Demersal longline (hake)	2010 – 2023	Active
Large pelagic long-line	2010 – 2022	Active
Tuna pole	2010 – 2022	Active
Line-fish	2010 – 2023	Active
Deep-sea crab	2013 – 2022	Active
Deep-water trawl	1994 – 2007	Fishery closed since 2007
Rock lobster	2005 – 2016	Active
Fisheries research	2007 – 2012	Trawl stations are fixed and unlikely to change

Source: MFMR

* Reopened in 2025 with an allocation of 10 000 tons

1.2.2 ASSUMPTIONS AND LIMITATIONS

The study is based on some assumptions and is subject to certain limitations, which should be kept in mind when considering information presented in this report. The outcome of this assessment is, however, not expected to be affected by these assumptions and limitations.

The official governmental record of Namibian commercial fisheries data was used to show fishing catch and effort relative to the petroleum exploration license area. These data are derived from logbooks that are completed by skippers whilst at sea and then transcribed into electronic format by the MFMR. It is assumed that there would be a proportion of erroneous data due to inaccurate reporting and recording, but that this is likely to be minimal in comparison to the total volume of the dataset. Where obvious errors in the reporting of fishing positions were identified, these were excluded from the analysis.

The catch and effort data were provided, on request, by MFMR for use in this assessment. The assessment is therefore limited to the data made available and includes the most recent by MFMR at the time of the request. The dataset for each fishery covers at least a ten-year period as listed in Table 1-1.

1.2.3 ASSESSMENT PROCEDURE

This study has adopted a ‘desktop’ approach based on primary fisheries catch and effort data sourced from MFMR. The description of the baseline environment in the study area is therefore based on a review and collation of existing information. The information for the identification of potential impacts on marine fauna (specifically fish and ichthyoplankton) was drawn from the marine ecology impact assessment for this project (Pisces Environmental Services (Pty) Ltd).

The spatial distribution of catch was mapped at a resolution of 5 x 5 minutes[1] for all fishing sectors other than large pelagic longline fishery, which was mapped at 60 x 60 minutes (these grid sizes were selected based on the fishing method and resulting area covered by fishing gear). The catches recorded in the affected area were extracted for the periods listed in Table 1-1. The average annual catch and effort expended within the PEL 82 are presented as a

[1] Each degree is divided into 60 equal parts called minutes.

percentage of the total annual catch and effort for each sector. The overlap of PEL 82 with the fishing grounds of each sector was expressed as a percentage. The catch and effort for the entire exploration license area is presented, as well as the zones of potential impact of planned and unplanned activities to fishing operations (i.e. area of exclusion due to navigational safety zone, potential noise impact radius, drill cuttings discharge and oil spill scenarios).

The spatial distribution of fisheries catch and effort was mapped in relation to the area of each of the identified potential impacts. The convention used to evaluate the significance of the potential impact is provided in Appendix A. The potential impact magnitude was determined based on a combination of the nature, scale, geographical extend, duration, frequency and reversibility of the potential impact. The impact magnitude was assigned to the pre-mitigation impact (i.e. before additional mitigation measures are applied, but accounting for embedded controls specified in the project description) and residual impacts after additional mitigation is applied. Thereafter the potential impact significance rating was determined as a function of the magnitude of the impact and the sensitivity/vulnerability/importance of the receptor. Significance was assigned to the predicted impact pre-mitigation and post-mitigation (residual) after considering all possible feasible mitigation measures in accordance with the mitigation hierarchy. Terminology, criteria, and ratings are outlined further in Appendix A.

1.2.4 APPLICATION OF MITIGATION HIERARCHY

A key component of the EIA process is to explore practical ways of avoiding or reducing potentially significant impacts of the potential project. Mitigation is aimed at preventing, minimising or managing significant negative impacts to as low as reasonably practicable (ALARP) and optimising and maximising any potential benefits of the potential project. The mitigation measures are established through the consideration of legal requirements, best practice industry standards and specialist inputs.

The mitigation hierarchy, as specified in IFC Performance Standard 1, which is widely regarded as a best practice approach to managing risks, is based on a hierarchy of decisions and measures, as described below. This is aimed at ensuring that wherever possible potential impacts are mitigated at source rather than mitigated through restoration after the potential impact has occurred. Any remaining significant residual impacts are then highlighted, and additional actions are proposed.

Avoid at Source; Reduce at Source: avoiding or reducing at source through the design of the project i.e. avoiding by siting or re-routing activity away from sensitive areas or reducing by restricting the working area or changing the time of the activity.
Abate on Site: add something to the design to abate the impact i.e. pollution control equipment.
Abate at Receptor: if an impact cannot be abated on-site then control measures can be implemented off-site i.e. traffic measures.
Repair or Remedy: some impacts involve unavoidable damage to a resource (i.e. material storage areas) and these impacts require repair, restoration, and reinstatement measures.
Compensate in Kind; Compensate through Other Means where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate i.e. financial compensation for degrading agricultural land and impacting crop yields.

Source: ERM, 2012

2. PROJECT DESCRIPTION

2.1 LOCATION

CNEL is considering plans to initiate an offshore exploration program within PEL 82 encompassing blocks 2112B and 2212A, situated in the Walvis Basin, Namibia. The license area spans approximately 11,400 km², located between 72 km and 300 km offshore, with water depths ranging from 200 m to 2,500 m. Initially, the plan is to conduct a one well campaign in the Gemsbok prospect location, coordinates: LAT: 21° 44' 48.15" S, LONG: 12° 27' 13.74" E; with water depths ranging from 900 – 1,500 m. Additional follow-up drilling could potentially include up to nine additional wells (total of 5 exploration and 5 appraisal wells).

2.2 MAIN PROJECT COMPONENTS

This section describes the main project components, these include the following:

- Drilling unit;
- Shore base;
- Personnel; and
- Infrastructure and services.

A summary of the project activities is provided in Table 2-1.

TABLE 2-1 SUMMARY OF MAIN PROJECT COMPONENTS

Purpose	To confirm and test the presence and quality of hydrocarbon resources
Potential number of exploration and appraisal wells	• Up to 5 exploration wells • Up to 5 appraisal wells
Size of Area of Interest for potential exploration drilling	Blocks 2112B and 2212A spanning approximately 11,400 km² located between 72 km and 300 km offshore
Well depth (below seafloor)	Variable depth of 1,500 to 4,000 m. A notional well depth of 4,000 m is assumed for the ESIA.
Water depth range	Water depth range of license block: 200 m to 2,500 m
Duration	• Mobilisation phase: up to 15 days • Drilling phase: ◦ Exploration well: up to 60 days (including abandonment) ◦ Appraisal well: up to 60 days (including abonnement) • Demobilisation phase: up to 15 days
Commencement of drilling and anticipated timing	• Commencement of drilling is not confirmed, but being considered in the 2026/27 timeframe for the first well.
Potential drilling fluids (muds)	• Riserless stage: Water-Based Muds (WBM). • Risered stage: Non-Aqueous Drilling Fluids (NADF) in a closed-loop system.
Drilling and support vessels	• Drillship or semi-submersible drill rig. • Three to four support vessels. These vessels will be in proximity of the drilling site, as well as moving

Purpose	To confirm and test the presence and quality of hydrocarbon resources
	equipment and materials between the drilling unit and the onshore base.
Operational safety zone	Minimum 500 m around drilling unit
Flaring	If hydrocarbons are discovered, an appraisal well may be considered that would include 1-2 well tests per well.
Logistics base	Walvis Bay
Logistics base components	Office facilities, warehouse, laydown area, mud plant
Support facilities	• Crew accommodation in Walvis Bay area. • Helicopter transport from Walvis Bay. • Fixed-wing transport from Windhoek.
Staff requirements	• Specialised drilling staff supplied with hire of drilling unit. • Additional specialised international and local staff at logistics base.
Staff changes	Rotation of staff every four weeks with transfer by helicopter to shore

2.2.1 DRILLING UNIT

Various types of drilling vessels are used worldwide in offshore drilling operations, with the type of unit typically dependent on water depths in which it needs to operate and marine operating conditions experienced at the well site. The potential drilling unit is a drillship or semi-submersible drill rig using Dynamic Positioning System (DPS). The DPS allows for minimal subsea disturbance due to its ability to operate without moorings. A significant benefit to using a drillship is the ease of mobility as it is a self-propelled vessel with the flexibility to move from location to location without the need of transport vessels. An example of drillship is presented in Figure 2.1.

FIGURE 2.1 EXAMPLE OF A DRILLSHIP

Source: Shutterstock, 2022

The use of a semi-submersible drilling unit may also be considered based on the availability of vessels (Figure 2.2). This type of drilling unit consists of a rig mounted on a floating structure supported by pontoons. When positioned at the well site, the pontoons are partially filled with seawater (ballasted) to submerge them to a specific depth below the sea surface, where wave motion is reduced. This submersion provides stability to the drilling vessel, thereby enhancing the efficiency of drilling operations.

FIGURE 2.2 EXAMPLE OF SEMI-SUBMERSIBLE DRILLING UNIT

Source: Huisman, 2025

2.2.1.1 SUPPORT VESSELS

The drilling unit will be serviced by up to four support vessels (refer to Figure 2.3). These vessels are expected to operate two to three rotations per week. They will be on standby at the drilling site as well as facilitate the transportation of equipment and materials between the drilling unit and the onshore base. The support vessels can also be utilized for medical evacuations or crew transfers if necessary and provide assistance in firefighting, oil containment and recovery, rescue operations in case of emergencies, and supply any additional equipment that may be needed.

FIGURE 2.3 EXAMPLE OF SUPPORT VESSEL

Source: Wärtsilä, 2025

2.2.1.2 HELICOPTERS

Helicopters are the preferred method for transporting personnel to and from the drilling unit. It is estimated that there could be up to four trips per week between the drilling unit and the helicopter support base in the Walvis Bay area (primary) or Windhoek (secondary). If required, helicopters can also be used for medical evacuations from the drilling unit to shore, both during the day and at night.

2.2.1.3 NAVIGATIONAL SAFETY ZONE

During the drilling operations, there will be a temporary. 500 m exclusion/safety one around the drillship, which will be enforced by a standby vessel. The exclusion zone would be described in a Notice to Mariners as a navigational warning.

The purpose of the exclusion zone is to prevent a vessel collision with the drillship during operations. Under the Marine Traffic Act, 1981 (No. 2 of 1981), as amended by the Namibia Ports Authority Act No. 2 of 1994, an “exploration platform” or “exploration vessel” used in prospecting for or mining of any substance falls under the definition of an “offshore installation” and as such it is protected by a 500 m exclusion zone. According to the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part B, Section II, Rule 18), a drillship involved in underwater operations is classified as a "vessel restricted in its ability to manoeuvre." This classification mandates that power-driven and sailing vessels must yield to such a vessel. Additionally, fishing vessels are required to avoid interfering with the well drilling operations as much as possible.

2.2.2 SHORE BASE

An onshore logistics base will be located in Walvis Bay. The shore base within the port authority boundaries and control will provide for the storage of various materials and equipment, including pipes, subsea equipment, drilling fluid, cement, chemicals, marine fuels, and water. It will also house a mud plant for mixing drilling fluids, which will be transported to and from the drilling vessel by sea. Additionally, the shore base will serve as office space equipped with communication systems, first response emergency facilities, and will provide accommodation as well as waste management services, vessel refuelling, and customs clearance services.

This base will include a yard area and a warehouse to store drilling materials such as hardware (tubular, wellhead), bulk materials (barite, bentonite, cement), and other minor equipment. A third-party service provider—yet to be selected—will be responsible for supplying additional resources, including a mud plant, essential materials, equipment, and logistical support.

Supply vessels providing fuel, food supplies, water, and other necessities to the drillship will also utilize the shore base.

Supply vessels are expected to occupy the quay for approximately 12 hours per trip, depending on the volume of materials to be loaded or unloaded and the time required for customs and sailing clearance. The shore base will feature a mooring area, a temporary office, and bunkering services for vessels.

The existing service infrastructure at the port is sufficient to provide the necessary onshore support for the project, and no additional permanent onshore infrastructure is anticipated to be required.

2.2.3 PERSONNEL

The shore base will be situated in Walvis Bay. In addition to the support services it will provide, it will also be used for offices (with communication and emergency procedures / facilities).

Shore-based staff will be accommodated in Walvis Bay area. This could be hotels, apartments or house rental. In addition, accommodation during crew changes may be required in Windhoek based on incoming or departure flight times. The only CNEL personnel stationed in Walvis Bay would be the logistics base personnel. Other CNEL representatives will be based in the Windhoek office. The number of personnel on the drilling unit will depend on the specific unit obtained for the potential activities. Most of the staff will be expatriates due to the short-term nature of the work and the specialized technical skills required. Drilling units typically come with a core team of technical specialists on board.

The number of personnel on supply vessels will vary based on the vessel size and the potential activities they support. All workers will receive health and safety training and be provided with Personal Protective Equipment (PPE) appropriate for their tasks.

2.2.3.1 CREW TRANSFERS

Transportation of personnel to and from the drillship would most likely be provided by helicopter operations from Walvis Bay area. Crews would generally work in 12 hour shifts in 4 week cycles. Crew changes would be staggered, and in combination with ad hoc personnel requirements. Thus helicopter operations to and from the drillship may occur up to 4 days per week between the helicopter support base and the drilling unit to shore.

2.2.4 INFRASTRUCTURE SUPPORT AND SERVICES

2.2.4.1 FRESH WATER

The project will require freshwater and some limited industrial water for making the waterbased drilling muds required to drill the well. This industrial water will be transported from shore.

The potable water for the personnel on board the drilling unit will be produced by the Mobile Offshore Drilling Unit (MODU), or bottled water will be made available.

2.2.4.2 FUEL

Estimates for the fuel (Marine Gas Oil (MGO)) use per day by the drillship and support vessels during transit, standby and drilling operations are provided in the Table 2-2 below.

TABLE 2-2 PROJECTED FUEL USAGE FOR DRILLING A SINGLE WELL

Discharge Source	Units of measurement	Duration	Consumption of marine fuel (t)	Jet-A-1 fuel consumption (t)
1 x Drilling unit	m^3/day	60 days	2,400	-
4 x Support vessels	m^3/day	60 days	800	-
Helicopter	m^3/flight	4 per week	-	51
Total			3,200	51

2.3 PROJECT ACTIVITIES

Project activities associated with drilling may include the following phases:

- Mobilisation of the supply vessels, operation of the shore-based facilities for handling support services needed by the drillship;
- Drilling of exploration well(s);
- Well execution (side track, logging, completion) options;
- Potential drilling of appraisal wells that may include well testing;
- Well abandonment; and
- Demobilisation of the drillship, vessel and local logistics base.

All activities will be conducted in conformity with recognised industry international best practice to provide safety, environmental protection and operational integrity.

2.3.1 MOBILISATION PHASE

The mobilisation phase will involve issuing necessary notifications, setting up the onshore base, hiring local service providers, sourcing and transporting equipment and materials from different ports and airports, arranging accommodation, and moving the drilling unit and support vessels to the drilling site.

2.3.1.1 VESSEL MOBILISATION AND SITE PREPARATION

The drilling unit and supply vessels may either sail directly to the well site from outside Namibian waters or from a Namibian port, depending on the selected drilling unit and its last location. The drillship will be equipped with navigation equipment for accurate station keeping above the well location (dynamic positioning – using thrusters). Both the drilling unit and support and supply vessels will need to undergo customs clearance.

Once in position, the drillship will carry out its pre-drilling activities comprising seabed survey; Remote Operated Vehicle (ROV) dive; positioning; beacon placement and dynamic positioning (DP) trials. These activities will be followed up with safety checks, drills, communication tests and drilling of the pilot hole.

Drilling materials, including casings, mud components, cement, and other equipment, will be transported into the country either on the drilling unit itself or via a container vessel directly to the onshore logistics base. From there, supply vessels will transfer these materials to the drilling unit.

2.3.2 DRILLING PHASE

Drilling is essentially undertaken in two stages, namely the riserless and risered drilling stages.

Riserless (Initial) Drilling Stage

The first, 36 inch ("), and second 26" sections of the potential well will be drilled riserless. During this section drilling mud returns are not flowed back to the drilling unit. The drilling of a well generally involves drilling a large diameter hole first and running a large diameter conductor casing which serves as structural pipe to support the load of the well control equipment and subsequent casing strings.

Closed-Loop Drilling Stage

Closed-loop drilling occurs for all sections below the 26" hole section. For deepwater well construction, after the riserless drilling stage, a drilling riser (ie a hollow tube known as the 'marine riser') is run between the drilling unit and the seabed so that weighted drilling fluid can be pumped through the drill pipe and out through the drill bit. It circulates all the way around up through the marine riser back to the drilling unit. Drilling fluid helps prevent the well from caving in and clears the rock bits or "cuttings" that are constantly being chipped away as the drill bit drills deeper into the ground to prevent them from building up on the bottom of the well.

The well is planning to be drilled to a total depth range of 1,500 to 4,000 m below mud line. The schematic of a drilling mud circulation system is illustrated in FIGURE 2.4.

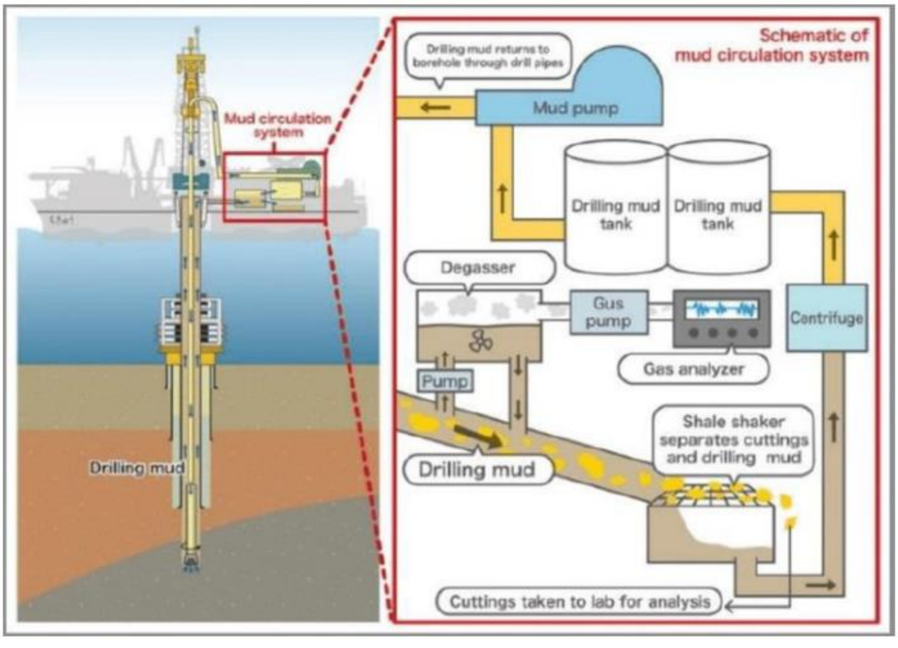
Once in position at the designated well location, drilling will commence. The well is drilled using a bit that chips off pieces of rock. The drill bit is connected to the surface by segments of hollow pipe, which together are called the drill string. The first and second drilling stages (riserless stage) are made by lowering the drill string from the drill deck to the seafloor and drilling into the seabed. All cuttings are set down directly onto the seafloor. Following these first two stages, a marine riser pipe connects the drilling floor of the drilling unit to the wellhead on the seafloor in order to collect drilling mud. Drilling is undertaken by lowering the drill string through the closed loop riser to the seafloor and rotating the drill string, causing the drill bit to crush the rock. Cuttings are removed from the bottom of the hole thanks to a drilling fluid containing clays, polymers, weighting agents and/or other materials suspended in a fluid medium. Drilling is stopped at regular intervals to allow new sections of pipe to be added to the drill string or to replace the drill bit.

As the well is drilled, metal casing is placed inside the well to line it and stabilize the hole to prevent it from caving in. The casing also isolates aquifers and hydrocarbon-bearing zones through which the well passes, thus preventing liquids or gases from entering the well prematurely. After each casing string is installed, it is cemented in place. The casing string also provides a firm point for the attachment of the BOP stack, which is where it will be located.

The conductor casing serves as a support during drilling operations, to flowback returns during drilling and cementing of the surface casing, and to prevent collapse of the loose soil near the surface. The lengths and diameters of each casing section of the well are established prior to drilling. The exact details are determined by the geological conditions through which the well is drilled and will be driven by the final desired hole diameter to drill the reservoir section.

The well will be drilled initially with water-based mud for the riserless sections and then NADF for the subsequent sections. Following installation of the wellhead, blowout preventor (BOP), and marine riser, forming a closed, circulating system between the well and drilling unit. The spent NADF will be recycled onboard the drilling unit through a dedicated mechanism where the NADF cuttings will be separated from NADF. Spent NADF will be collected in a fully enclosed skip and shipped to shore for disposal in an environmentally responsible manner, at a licensed waste management facility. NADF cuttings will be treated on the drilling unit to reduce oil content to <6.9% Oil On Cutting (OOC) and discharge the treated cuttings overboard.

FIGURE 2.4 DRILLING SCHEMATIC



Source: Apostolidou, Christina, 2019

Drilling Mud

Seawater with high viscous pills, sweeps, and WBM are used for drilling the tophole sections of the well, which are drilled riserless (that is without the marine riser installed) while NADF are used for the subsequent sections (with riser installed on top of wellhead and BOP).

Mud Management

Unused WBMs will be disposed of at sea after their use. During NADF drilling, drilling muds are circulated in a closed loop system which recycles the drilling muds and removes the drill cuttings. The returns from downhole (muds and cuttings) are routed to the shakers, which will physically separate the drill cuttings from the drilling muds that are then recycled.

Cuttings

During the riserless drilling stage (tophole section drilling) WBM and associated drill cuttings are discharged directly on the seabed in immediate proximity of the well. Cuttings with associated NADF are returned to the drilling unit and processed onboard as stated above (i.e. treated on the drilling unit to reduce oil content to <6.9% OOC and discharged overboard).

Cement

During drilling, the required cement volume will be pumped into the annular space between the casing and the borehole wall. The tophole sections however are cemented to seabed. An excess of cement, necessary to guarantee sufficient presence of cement through the overall annulus, will emerge out of the top of the well. In doing this, the conductor pipe and surface casing are cemented all the way to the seafloor.

After the riser has been installed, for the next phases cement jobs, the excess cement will be returned via the riser to the drilling vessel and treated using the solids control system. Unused cement slurry that has already been mixed is discharged overboard to avoid plugging the lines and tanks.

2.3.3 WELL LOGGING AND TESTING

Wireline logging is currently planned only in the success case. Data from Logging While Drilling (LWD) will be gathered during the drilling sections.

Well logging will be standard electric wireline logging. Logging instruments are attached to the bottom of a ‘wireline’ and lowered to the bottom of the well. The wireline containing a predetermined array of monitoring instruments is then slowly brought back up, the devices reading different data as they pass each formation and recording it on graphs, which can be interpreted by the geologist, geophysicist, and drilling engineer. The evaluation programme will include sidewall rotary coring; the cores will be recovered to the surface. There are no emissions to the environment associated with standard wireline logging operations. Recovery of fluid samples to surface using a Modular Formation Dynamics Tester (MDT), a type of wireline tester which allows samples of reservoir hydrocarbon to be brought to the surface in small, contained volumes.

Vertical Seismic Profiling (VSP) may be undertaken in any of the wells pending data needs for understanding the subsurface.

Well testing is conducted to assess the economic viability of a discovery before decommissioning. If hydrocarbons are discovered, an appraisal well may be considered that would include 1-2 well tests per well. Each test and associated flaring (it is unlikely that flaring will be undertaken), can last up to seven days, including five days of build-up and two days of flowing and flaring. During testing, any water from the reservoir may be separated from oily components and treated onboard to minimize hydrocarbons. Any treated water is then either discharged overboard or sent to an onshore facility for further treatment and disposal.

2.3.4 WELL PLUGGING AND ABANDONMENT

Once drilling is completed, and after well logging activities have been undertaken, the exploration well will be plugged and abandoned; irrespective of whether any hydrocarbons have been discovered in the reservoir sections.

Abandonment involves inserting cement plugs across all reservoir sections that were identified and an abandonment cap on top of the well following standard procedures. The well will be abandoned in accordance with the Chevron global technical standards and will meet or exceed any local required regulations. A minimum of two permanent barriers will be placed in the well between any reservoir sands and the seabed.

2.3.5 DEMOBILISATION PHASE

With the exception of the wellhead and potential cuttings depositions, there will be no further physical evidence of drilling on the seafloor. A final clearance survey check will be undertaken using an ROV. On completion of drilling activities, the drilling unit and support vessel will go off hire and will either leave the area or be contracted to other oil and gas exploration operators to continue similar operations.

Wireless monitoring gauges, operating at frequencies between 12.75 and 21.25 kHz, may be installed on wells that CNEL plans to revisit for future appraisal or production activities. These gauges will be positioned on the wellhead and remain there. However, monitoring gauges will not be installed on exploration wells designated for abandonment.

2.4 PROJECT SCHEDULE

The first drilling campaign is anticipated to start in the 2026/27 timeframe. The preliminary project schedule is provided in Table 2-3 below.

TABLE 2-3 PRELIMINARY PROJECT SCHEDULE

Project Phase / Activity	Anticipated Timeframe for a single well
Mobilisation Phase	Up to 15 days
Drilling Phase	Up to 60 days (including abandonment)
Appraisal Well	Up to 60 days (including abandonment and well testing if conducted)
Demobilisation Phase	Up to 15 days

2.5 PLANNED EMISSIONS, DISCHARGES AND WASTE MANAGEMENT

This section presents the main sources of emissions to air, discharges to sea and waste that would result from the planned drilling activities and associated operations.

All vessels would have equipment, systems and protocols in place for prevention of pollution by oil, sewage and garbage in accordance with MARPOL 73/78.

Waste disposal sites and waste management facilities would be identified, verified and approved prior to commencement of project activities.

2.5.1 AIR EMISSIONS

The principal sources of emissions to air from the potential exploration drilling campaign will be vessel propulsion systems and onboard power generation.

If well testing is conducted on the appraisal well, then emissions would be generated from hydrocarbon flaring for the limited duration of the well test.

Dynamically positioned vessels have relatively high fuel consumption and consequently high levels of corresponding air emissions. MGO would be used as fuel for all vessels resulting primarily in emissions of carbon dioxide (CO_2), sulphur oxides (SO_x), nitrogen oxides (NO_x) and carbon monoxide (CO). Relative to these pollutants, smaller quantities of non-methane volatile organic compounds (VOCs), methane (CH_4) and particulate matter (PM10/PM2.5) will also be released. These emissions are released during the normal operation of a marine vessel and have the potential to result in a short-term localised increase in pollutant concentrations. They also contribute to regional and global atmospheric emissions.

Helicopter emissions levels would depend on actual fuel consumption and hence would vary with flying time, payload, weather, speed etc.

The project is estimated to generate approximately 44,208 tonnes of CO_2 equivalent (tCO_2e) per year, calculated on a worst-case basis, ie. assuming four wells are drilled per year.

2.5.2 DISCHARGES TO SEA

2.5.3 DRILL CUTTINGS AND MUD DISPOSAL

During the drilling of the well, drill cuttings are produced as the rock is broken down in small rock particles by the drill bit advancing through the subsurface. The amount of drill cuttings that will be discharged during the drilling are described in Table 2-4.

TABLE 2-4 DRILL CUTTING DISCHARGES FOR A SINGLE WELL

Section and Bore Diameter (inches)	Section Length (m)	Discharge Depth (m) from Surface (MSL)	Cuttings	Mud		
			Volume / Mass Discharged (m^3 / MT)	Type of drilling fluid	Mass Discharged Mud (MT)	Mass Discharged Adhered Oil (MT)
Section 1 Drill 36"	85	Seafloor	58 / 165.49	WBM	468.43	N/A
Section 2 Drill 26"	938	Seafloor	463 / 1321.11	WBM	9962.95	N/A

Section and Bore Diameter (inches)	Section Length (m)	Discharge Depth (m) from Surface (MSL)	Cuttings	Mud		
			Volume / Mass Discharged (m^3 / MT)	Type of drilling fluid	Mass Discharged Mud (MT)	Mass Discharged Adhered Oil (MT)
Section 3 Drill 17.5"	2041	Surface	307 / 876	NADF	101.5	101.5
Section 4 Drill 12.25"	1417	Surface	104 / 296.75	NADF	37.5	37.5

Source: CNEL

The top-hole sections of the well are drilled without the marine riser installed, using sea water, high viscous pills, sweeps, and WBM while NADF systems are used for subsequent sections (with riser installed on top of wellhead and BOP).

During the riserless drilling stage (top-hole section drilling) fluid and cuttings are discharged directly on the seabed in immediate proximity of the well. Following installation of the riser (at the end of tophole sections) excess seawater stored in tanks is discharged.

During drilling using NADF, drilling muds and associated drill cuttings are circulated in a closed loop system which recycles the drilling muds and removes the drill cuttings. The returns from downhole (muds and cuttings) are routed to the shakers, which will physically separate the drill cuttings from the drilling muds.

Unused WBMs will be discharged to sea after their use, whereas NADF that cannot be further cleaned and recycled will be returned to shore. NADF retained on cuttings will returned to the drilling unit and processed onboard as stated above.

2.5.4 CEMENT

During drilling, cement and its additives are generally not released. However, in the initial cementing process, surface casing, surplus cement can flow out of the well's top and onto the seafloor to fully cement the conductor pipe to the seafloor. This process may involve pumping up to 150-200% of the necessary cement volume into the annulus (the space between the casing and the borehole wall). In the worst-case scenario, around 100 cubic meters of cement might be discharged onto the seafloor.

2.5.5 PRODUCED WATER

The volume of hydrocarbons (to be burned) and possible associated produced water from the reservoir which could be generated during well testing cannot be reliably predicted due to variations in gas composition, flow rates and water content. Burners are manufactured to make sure emissions are kept to a minimum. The estimated volume of hydrocarbons to be burned cannot be with much accuracy because the actual test requirements can only be established after the penetration of a hydrocarbon-bearing reservoir. However, an estimated 20 million standard cubic feet (MSCF) of gas per day and 20,400 barrels of oil could be flared per test.

If produced water is generated during well testing, it will be separated from the hydrocarbons and discharged to the sea.

2.5.6 LIQUID DISCHARGES

Table 2-5 shows types and disposal methods of liquid waste anticipated to be generated during the potential project activities. The disposal methods shall comply with Namibian regulations and MARPOL requirements.

TABLE 2-5 TYPES OF LIQUID WASTE AND THEIR DISPOSAL METHODS

Type	Potential disposal method
Wastewater	Wastewater will include brine (which is produced in the reverse osmosis process to produce freshwater on the drillship). Typically in well drilling operations, the production of freshwater is approximately 40 m^3 per day, leading to an estimated salt output of about 35 grams for every litre of water generated (equating to roughly 1,400 kg of salt/brine daily). The wastewater will be treated onboard via a dedicated and approved system prior to discharge in accordance with the requirements the International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78.
Bilge water	Bilge water will be collected and piped into a bilge holding tank on board the project vessels in accordance with MARPOL 1973/78 Annex 1. The fluid will be monitored and any oily water would be processed through a suitable separation and treatment system. Detergents used for washing exposed marine deck spaces will be managed as bilge water. The toxicity of detergents varies greatly depending on their composition. Water-based or biodegradable detergents are preferred for use due to their low toxicity. In certain cases of specific area cleaning, e.g., marine deck with no contamination of pollutants, using no toxic detergent, direct overboard discharge may be considered.
Galley waste	The disposal of galley waste into the sea is permitted under MARPOL 73/78 Annex V, only when the vessel is located more than three nautical miles (approximately 5.5 km) from land and the food waste has been ground or comminuted to particle sizes smaller than 25 millimeters (mm).
Ballast water	Ballast water is crucial for maintaining safe operating conditions on a ship. It helps reduce hull stress, provides stability, enhances propulsion and manoeuvrability, and compensates for weight changes due to fuel and water consumption. However, discharging ballast water can introduce foreign marine species, such as bacteria and larvae, into new environments, posing ecological risks. This is particularly relevant when moving a drilling unit to Namibia. To mitigate these risks, the 2004 International Convention for the Control and Management of Ships' Ballast Water and Sediments mandates that all ships must have a Ballast Water Management Plan. Ships using ballast water exchange must do so at least 200 nautical miles (approximately 370 km) from the nearest land in waters at least 200 meters deep when arriving from a different marine region. If this is not feasible, the exchange should occur as far from the nearest land as possible, with a minimum distance of 50 nautical miles (about 93 km) and preferably in waters at least 200 meters deep. Project vessels are required to adhere to these regulations.
Sewage and grey water	Sewage discharge from the project vessels and the drilling unit will meet the requirements of MARPOL 73/78 Annex IV. The drilling unit and all project vessels will have a valid International Sewage Pollution Prevention (ISPP) Certificate. The sewage discharged from vessels will be disinfected, comminuted and any effluent will not produce visible floating solids in, nor cause discoloration of the surrounding water. The treatment system will provide primary settling, chlorination, and de-chlorination. The treated effluent will then be discharged into the sea.

2.5.7 SHORE DISPOSAL

A number of other types of wastes generated during the drilling activities would not be discharged at sea but would be transported to shore for disposal. These wastes would be recycled or re-used if possible or disposed at an appropriate licensed municipal landfill facility (Walvis Bay has general and hazardous landfill sites) or at an alternative approved site. The services of a licensed waste contractor will be used to collect all operational waste for treatment, disposal or recycling.

Typical waste types generated by a drillship that are disposed of onshore include:

- Garbage (eg paper, plastic, wood and glass) including wastes from accommodation and workshops etc;
- Scrap metal and other material;
- Drums and containers containing residues (eg lubricating oil) that may have environmental effects;
- Used oil, including lubricating and gear oil; solvents; hydro-carbon based detergents, possible drilling fluids and machine oil;
- Chemicals and hazardous wastes (eg radioactive materials, neon tubes and batteries);
- Medical waste from treatment of personal onboard the vessel;
- Filters and filter media from machinery;
- Drilling fluid, including WBM, NADF, brine from drilling and completion activities.

Additionally, Naturally Occurring Radioactive Materials (NORM) can be found in subsurface rocks and fluids in oil and gas fields. While an exploration well can contain low levels of NORM, especially in the produced water, exploration wells are not subject to the long-term, high-volume flow conditions that cause significant build-up and therefore, considered as a low risk during exploration.

2.5.8 NOISE EMISSIONS

Underwater noise is generated from various sources during maritime operations. These include vessel propellers, positioning thrusters, drag on the riser, supply vessels, and drilling activities.

The sound levels vary significantly depending on the operational mode of each vessel. The VSP survey, in particular, produces short-term noise. The primary sources of noise are categorized as follows (values given below are representative values for a drilling program (OSPAR Commission, 2009)):

- Drilling Noise: Drilling units typically emit underwater noise ranging from 10 Hz to 100 kHz, with major frequency components below 100 Hz and average source levels up to 196.2 dB re 1 μPa at 1 m (rms), especially when bow thrusters are used.
- Propeller and Positioning Thrusters: The propellers and thrusters noise is mainly due to cavitation around the blades during high-speed transit or when thrusters operate under load to maintain vessel position. This broadband noise, with some low tonal peaks, can be heard over many kilometers. Supply and support vessels also contribute to overall propeller noise.
- Machinery Noise: Low-frequency machinery noise becomes dominant when vessels are stationary or moving slowly. This noise originates from large machinery like power generation units, compressors, and fluid pumps. Sound transmission occurs through

structural paths (machine to hull to water) and airborne paths (machine to air to hull to water). Machinery noise is typically tonal. An ROV will sweep the drilling site for debris, but this is not expected to be a significant noise source.

- Well Logging Noise: VSP surveys generate high-resolution geological images using a small dual airgun array with a total volume of 1,200 cubic inches of compressed nitrogen at about 2,000 psi. This produces significantly less energy than conventional seismic surveys. Airguns discharge approximately five times at 20-second intervals, repeated for different well sections, totalling around 250 shots. The VSP operations typically last 8 to 12 hours per well, generating intermittent short-term noise.
- Well Testing Noise: Flaring during well testing produces airborne noise above sea level.
- Subsea Equipment Noise: Equipment such as the drill string generates relatively low levels of underwater noise compared to drilling and dynamic positioning systems.
- Helicopter Noise: Helicopter operations contribute to both airborne and underwater noise.

The extent of project-related noise above background levels varies based on the vessels used, the number of supply vessels operating, weather conditions, and proximity to other vessel traffic. An Underwater Noise Modelling Study was undertaken in order to assess underwater noise transmission loss from the well site and results were compared with threshold values for marine fauna to determine potential impact zones (refer to section 2.7.1).

2.5.9 LIGHT EMISSIONS

For safe operations and navigation during nighttime, the drilling unit and supply vessels will use operational lighting. Efforts will be made to shield these lights to reduce their spill into the surrounding sea where possible.

2.6 UNPLANNED EMISSIONS AND DISCHARGES

This section presents the main sources of emissions that would result from unlikely unplanned/accidental events during the drilling activities and associated operations.

Two of the main types of accidental events that could occur while drilling wells that could result in a discharge of hydrocarbons or chemicals to the marine environment are:

- Loss of well containment; and
- Single-event/batch spills.

Loss of well containment is a continuous release, which could last for a measurable period of time, while a single-event spill is an instantaneous or limited duration occurrence. CNEL is committed to minimising the release of hydrocarbons and hazardous chemical discharge into the marine and onshore environments and avoiding unplanned spills.

In case of accidental events, CNEL will minimise any adverse effects to the environment and plans to accomplish this goal by:

- Incorporating oil and chemical spill prevention into the well design and drilling plans.
- Confirming that the necessary contingency planning has taken place to respond effectively in the event of an incident.

Prior to the commencement of drilling, CNEL will develop and implement an Oil and Chemical Spill Response Plan (OSRP) to address any accidental release of oil or chemicals offshore. In addition, precautionary measures will be taken to make sure that all chemicals and petroleum products stored and transferred both onshore and offshore are managed in a manner that minimises the risk of spills and environmental harm in the event of an accidental release.

Additionally, CNEL, is a member of Oil Spill Response Limited (OSRL) which provides advanced capping stacks to shut-in uncontrolled subsea wells in the event of a loss of containment. The primary capping stack, a 10K unit, is housed at OSRL's Saldanha Bay Base in South Africa and is available for global mobilisation. Additional stacks are located in Brazil, Norway, and Singapore.

In the event of a sub-sea loss of containment event, a number of critical resources would be mobilized to the location. These include debris removal, stabilization and monitoring equipment and the capping stack. The capping stack allows for the safe capture and/or closure of the oil flow. Before its arrival, a ROV inspects the seabed, removes debris and prepares the wellhead.

2.7 EMISSIONS/DISCHARGE MODELLING RESULTS

2.7.1 UNDERWATER NOISE MODELLING

Detailed modelling predictions were undertaken for noise emissions from impulsive (VSP) and non-impulsive (drilling unit and support vessels) signals (Appendix F). The zones of potential noise impact were estimated for different marine faunal species based on comparisons between established noise impact criteria for physiological and behavioural impacts (for marine mammals, turtles, fish and eggs and larvae[2]) and the modelled received noise levels. Thresholds were based on NOAA (2024), Southall et al. (2019), Popper et al. (2014) and Finneran et al. (2017).

Sound transmission loss modelling was undertaken for two source locations within PEL 82, at depths of 917 m and 1166 m, and the following scenarios:

- Exposure to 50 VSP pulses over two hours;
- Cumulative exposure to 250 VSP pulses over 12 hours, and
- Continuous non-impulsive noise - 24 hr exposure.

For impulsive noise (VSP), potential cumulative impacts were modelled assuming that the animals remain stationary within the potential impact zone whereas for continuous noise (drilling), the model assumes an animal swimming away from the source up to a distance of 50 km from the drilling location (taking into account swim speed) and then it remains stationary at this point for the rest of the 24-hour assessment period.

The extent of the potential impact zones for fish are due more to the cumulative exposure to noise from multiple VSP pulses than a single pulse, with maximum distances less than 100 m for impairment (TTS) and approximately 400 m for behavioural disturbance for fish with and without swim bladder. These results are summarised in Table 2-6.

The zones of potential impact from the non-impulsive sources (drilling unit and support vessels) were calculated as within 100 m (recoverable injury) and within 400 m (TTS) for hearing-sensitive fish[3]. Behavioural responses could be expected up to distances of 1 km.

2 The noise criteria for fish are presented in Tables 3.3 and 3.4 in the Noise Modelling Report.
[3] Fish with swim bladders that are involved in hearing detection (primarily pressure detection).

TABLE 2-6 LARGEST ZONES OF POTENTIAL IMPACT FROM MULTIPLE VSP PULSES FOR FISH.

Fish hearing group	Zones of potential impact – maximum horizontal distance from source to edge impact zone from cumulative (24-hour exposure) source pulses							
	Potential Mortal Injury			Impairment			Behavioural Response	
	Peak dB re 1µPa	SEL_{cum} dB re $1µPa^2·s$	Maximum distance (km)	Peak dB re 1µPa	SEL_{cum} dB re $1µPa^2·s$	Maximum distance (m)	RMS dB re 1µPa	Maximum distance (m)
Fish without swim bladder	>213	>219	<0.1	>213	>216	<0.1	150	0.4
Fish with swim bladder not involved in hearing	>207	210	<0.1	>207	203	<0.1	150	0.4
Fish with swim bladder involved in hearing	>207	207	<0.1	>207	203	<0.1	150	0.4
Fish eggs and fish larvae	>207	210	<0.1	-	-	-	-	-
Peak = peak sound pressure level; SELcum = weighted sound exposure level; RMS = root-mean-square sound pressure level; a dash indicates the threshold is not applicable/reached.								

2.7.2 DRILL CUTTINGS DISCHARGE MODELLING

Environmental Resources Management, Inc. (ERM) performed a particle discharge modeling study to understand the fate of the released material in the water column and deposited on the sea floor (Appendix D). Detailed modelling predictions using deterministic simulations for the fate of discharged cuttings and drilling muds were undertaken at one location in each of blocks 2212A and 2112B, at a depth of 1166 m and 917 m. The model assumed a release period over the first 21 days of March, June, September, and December in 2023.

The parameters used to quantify the potential impacts are total suspended solids (TSS) for the water column, depositional thickness and hydrocarbon concentration on the seabed for the benthic environment.

The details of the well profiles, drilling schedule, discharge rates of cuttings and mud (WBM, NADF with mineral and NABF), and their densities are presented in Table 2-4.

The higher density of drill cuttings and mud particles (relative to water) cause them to undergo a vertical descent through the water column upon their release. This descent can be several minutes to few hours for larger particles, and several hours to few days for tiny particles to reach the seabed when released near the surface, depending on the particle sizes and water depth. Tiny particles may at times travel upwards against gravity during their descent due to vertical dispersion. Released material will also migrate horizontally due to advection by local and regional currents. Thus, the dispersion of cuttings and muds is fundamentally a three-dimensional phenomenon requiring three-dimensional hydrodynamic fate and transport modeling.

To obtain the results for sediments, all sections were run together, but to get a better resolution for the water column, model runs were divided into riserless and closed-loop sections, i.e. discharged at the seabed and discharged at the sea surface, respectively.

2.7.2.1 SEDIMENTS

A sediment deposition thickness of 6.3 mm was used as the threshold for likely potential impacts to benthic organisms (smothering effects due to burial of organisms) due to instantaneous release of cuttings and mud. Another threshold of 5 cm within a month was used to assess the potential burial impact from continuous depositions. The depositional thickness due to the drilling-related discharges exceeded these threshold values. The area where deposition of cuttings and muds thickness is greater than 6.3 mm remained predominantly within a 500-meter radius of the potential second Well location (Block 2212A), and 50-meter radius of the Gemsbok Well location in Block 2112B (except for the June Scenario). The areas where depositional thickness exceed the thresholds are larger in Block 2212A due to the higher currents.

Table 2-7 summarizes the areas exceeding the thickness threshold for each scenario.

TABLE 2-7 SUMMARY OF CUTTINGS DEPOSITION RESULTS FOR GEMSBOK AND POTENTIAL SECOND WELLS

Well	Month	Area (m^2) with Thickness> 5 cm threshold	Area (m^2) with Thickness> 6.3 mm threshold
Gemsbok (in Block 2112B)	March	4,157	15,869
	June	4,943	33,948
	September	2,574	6,424
	December	2,189	4,451
Potential second well (in Block 2212A)	March	8,780	364,244
	June	13,212	219,030
	September	15,002	228,540
	December	15,814	243,553

Source: ERM

The total accumulated hydrocarbon concentration on the seabed was also examined for the release of cuttings and muds. This assessment assumed that cuttings with water-based muds (WBM) will be discharged during the drilling of the first and second sections (36” and 26” diameter sections respectively) of each well while cuttings with Non-Aqueous Base Fluid (NABF), which is the solvent (base oil) of Non-Aqueous Drilling Fluid (NADF), will be discharged for drilling the remaining sections (17.5” and 12.25” diameter section) of each well. The material will be brought to surface for treatment (e.g. shakers, dryer, etc.) and discharged near the water surface (assumed to be at the depth of 10 m for modeling purposes) during the drilling of Sections 3 and 4. NADF will be treated before being discharged to the ocean such that attached NABF is minimal.

The accumulated hydrocarbons on the seabed at the end of the 21-day simulation period for each of the two well locations were mapped to show the area where deposited hydrocarbon concentration exceeds 10 g/m^2. Table 2-8 summarizes the areas exceeding 10 g/m^2 (this is not a value related any environmental threshold) for each scenario. The hydrocarbon deposits identified by the modeling are locations where there are varying degrees of likelihood of impact proportional to the concentrations but clear determination of impacts cannot be made.

TABLE 2-8 SUMMARY OF NABF CONCENTRATION RESULTS FOR GEMSBOK AND POTENTIAL SECOND WELLS

Well	Month	Area (km^2) with NABF Concentration > 10 g/m^2
Gemsbok (in Block 2112B)	March	3.950
	June	6.860
	September	5.560
	December	0.619
Potential second well (in Block 2212A)	March	5.128
	June	7.201
	September	2.965
	December	2.943

Source: ERM

2.7.2.2 WATER COLUMN

Increases in the concentration of TSS will occur due to discharges of drill cuttings and muds. The highest concentration increases will exist at the point of discharge and decrease over time and distance, as the suspended solids plume dissipates and settles. Larger particles will settle out more quickly than fine particles, such that a TSS plume of tiny particles may linger and travel farther than plumes of larger grain sizes. As such, elevated TSS concentrations may form in regions where tiny, suspended particles linger in cloud form and mix with subsequent discharges.

TSS concentrations exceeded the 35 mg/L threshold criterion[4] near the seabed for both wells. However, the TSS concentration near the water surface did not exceed the 35 mg/L threshold during any of the four scenarios for either well location. The spatial extent of plumes (above TSS threshold levels of >35 mg/L) resulting from the riserless and risered sections of drilling for the two well locations under four simulated scenarios are summarized in Table 2-9.

The maximum area of TSS concentration exceeding the 35 mg/L TSS threshold near the seabed ranged from 0.136 km^2 (September) to 0.291 km^2 (December) at the potential second well site (Block 2212A) to between 0.024 km^2 (September) and 0.031 km^2 (June) at the Gemsbok well site (Block 2212B). The difference in extent of the plumes (above threshold level) at the two locations was due to the higher currents near the seabed in Block 2212A.

[4] For water column effects, the guidance value for excessive TSS provided by the MARPOL Resolution MEPC.159(55) (IMO 2006) is 35 mg/L for its maritime effluent discharge standard

TABLE 2-9 SUMMARY OF TOTAL SUSPENDED SOLIDS RESULTS NEAR SEABED AND WATER SURFACE FOR GEMSBOK AND POTENTIAL SECOND WELLS

Well	Month	Location of Water Column	Area (km^2) with TSS> 35 mg/L Threshold
Gemsbok (in Block 2112B)	March	Seabed	0.030
		Water Surface	N/A
	June	Seabed	0.031
		Water Surface	N/A
	September	Seabed	0.024
		Water Surface	N/A
	December	Seabed	0.025
		Water Surface	N/A
Potential second well (in Block 2212A)	March	Seabed	0.152
		Water Surface	N/A
	June	Seabed	0.171
		Water Surface	N/A
	September	Seabed	0.136
		Water Surface	N/A
	December	Seabed	0.291
		Water Surface	N/A

Source: ERM

2.8 OIL SPILL MODELLING

Chevron Namibia Exploration Limited II (CNEL) commissioned RPS Ocean Science, a Tetra Tech company, to conduct an oil spill modelling study for three hypothetical wells loss of containment (LOC) scenarios within the PEL 82 license area, covering Blocks 2112B and 2212A offshore Namibia. The scenarios, summarised in Table 2-10, considered potential LOCs at three well locations: Gemsbok (Block 2112B, 1,000 m water depth), potential second well (Block 2212A, 1,200 m water depth) and Shallow Well (Block 2112B, 300 m water depth).

Each scenario simulated a continuous release of light crude oil over a 30-day period, with the modelling extended to 60 days to assess long-term dispersion. Seasonal variability was incorporated by evaluating two distinct conditions: Summer (November to April) and Winter (May to October).

The modelling approach involved two tools. OILMAPDeep was used for near-field analysis, focusing on the vertical transport of oil and gas plumes immediately following release. OILMAP/SIMAP was applied for far-field analysis, which assessed the horizontal transport and weathering of oil over time. Environmental conditions in the region are characterised by prevailing winds from the south-southeast, which are typically stronger during winter months. Ocean currents vary from north to south via west, although wind drift was identified as the dominant mechanism influencing oil movement.

TABLE 2-10 SUMMARY OF OIL SPILL SCENARIOS

Release Location	Release Type	Season	Release Rate *(bbl/day)*	Release Duration *(days)*	Total Volume Spilled *(bbl)*	Simulation Duration *(days)*
Gemsbok	Subsurface Blowout (LOC)	Summer	18,668	30	560,040	60
Gemsbok	Subsurface Blowout (LOC)	Winter	18,668	30	560,040	60
Potential second well	Subsurface Blowout (LOC)	Summer	18,668	30	560,040	60
Potential second well	Subsurface Blowout (LOC)	Winter	18,668	30	560,040	60
Shallow Well	Subsurface Blowout (LOC)	Summer	18,668	30	560,040	60
Shallow Well	Subsurface Blowout (LOC)	Winter	18,668	30	560,040	60

Source: RPS Ocean Science, 2025

2.8.1 STOCHASTIC RESULTS

Stochastic modelling was used to assess the probability and spatial extent of oil exposure across the sea surface, shoreline and water column. Six scenarios were modelled, representing subsurface loss of containment at three well locations (Gemsbok, potential second well and Shallow Well) during both summer (November–April) and winter (May–October). Each scenario simulated a continuous release of 18,668 barrels per day of light crude oil over 30 days, with a total release volume of 560,040 barrels and a simulation duration of 60 days.

Key findings include:

- Surface oiling above the 10 g/m² threshold was consistently transported northwest due to prevailing offshore currents.
- Summer scenarios produced larger surface oiling footprints, extending up to 1,500 km.
- No shoreline oiling above threshold levels was predicted.
- Water column oiling above 1,000 µg/L remained within 10 km of the release locations.

2.8.2 DETERMINISTIC RESULTS

Deterministic modelling provided detailed insights into the maximum concentrations and environmental fate of hydrocarbons under defined worst-case conditions. Outputs included:

- Maximum surface oil concentration.
- Maximum total hydrocarbon concentration (THC) in the water column.
- Mass balance of oil fate.
- Vertical cross-section views of subsurface oiling.

The mass balance analysis tracked the transformation of oil into various environmental compartments, including surface oil, evaporated oil, entrained oil, degraded oil and shoreline deposition. Notably, no shoreline oiling was predicted in any scenario.

The table below summarises the fate, trajectory and shoreline impact predictions for six worst-case scenarios. Key findings across all scenarios include:

- Evaporation was the dominant fate mechanism, accounting for 34% to 50% of the released oil.
- Degradation via photo-oxidation and biodegradation ranged from 10% to 28%.
- Surface oil remaining at the end of the 60-day simulation ranged from approximately 13% to 35%, influenced by seasonal and wind conditions.
- No shoreline oiling was predicted in any scenario.
- Oil exhibited dynamic movement between surface and subsurface compartments throughout the simulation period.

The deterministic modelling indicates that, under worst-case conditions, oil released from the PEL 82 License Area would remain offshore, with limited environmental exposure beyond the immediate vicinity of the release. These findings support the conclusion that the risk of shoreline contamination and widespread ecological impact is low, assuming appropriate spill response measures are in place.

TABLE 2-11 SUMMARY OF WORST-CASE DETERMINISTIC MODELLING RESULTS

ID	Location	Season	Total Oil Released (bbl)	Fate Summary	Trajectory	Shoreline Impacts
1	Gemsbok	Summer	560,040	~37% evaporated, ~21% degraded, ~30% remained on surface	Surface oil transported ~350 km NW; water column oil within 50 km NW	None
2	Gemsbok	Winter	560,040	~34% evaporated, ~28% degraded, ~24% remained on surface	Surface oil transported ~175 km NW; water column oil within 50 km NW	None
3	Potential Second Well	Summer	560,040	~40% evaporated, ~18% degraded, ~35% remained on surface	Surface oil transported ~500 km NW; water column oil within 25 km NW	None
4	Potential Second Well	Winter	560,040	~35% evaporated, ~28% degraded, ~20% remained on surface	Surface oil transported ~175 km WNW; water column oil within 50 km NW	None
5	Shallow Well	Summer	560,040	~50% evaporated, ~10% degraded, ~27% remained on surface	Surface oil transported ~350 km NW; water column oil within 25 km N	None

ID	Location	Season	Total Oil Released (bbl)	Fate Summary	Trajectory	Shoreline Impacts
6	Shallow Well	Winter	560,040	~50% evaporated, ~15% degraded, ~13% remained on surface	Surface oil transported ~300 km NW/W; water column oil within 15 km W	None

Note: These results reflect the final distribution of oil at the end of the 60-day simulation and do not represent peak concentrations during the simulation period.

Source: RPS Ocean Science, 2025

3. DESCRIPTION OF BASELINE ENVIRONMENT

3.1 OVERVIEW OF NAMIBIAN FISHERIES

The Namibian fishing industry is a major contributor to the country's Gross Domestic Product (GDP), ranking among the top ten fishing countries globally (FAO, 2022). Supported by the high productivity of the Benguela upwelling ecosystem, abundant fish stocks have historically supported intensive commercial fisheries in Namibia. Although varying in importance at different times in history, Namibian fisheries have focused on demersal species, small pelagic species, large migratory pelagic fish, line-fish (caught both commercially and recreationally) and crustacean resources (e.g. lobster and crabs). Mariculture production is a developing industry based predominantly in Walvis Bay and Lüderitz Bay. The main commercial fisheries, targeted species and gear types are listed in Table 3-1.

TABLE 3-1 LIST OF FISHERIES THAT OPERATE WITHIN NAMIBIAN WATERS, TARGETED SPECIES AND GEAR TYPES

Sector	Gear Type	Target Species
Small pelagic	Purse-seine	• sardine (*Sardinops sagax*) • horse mackerel (*Trachurus capensis*)
Mid-water trawl	Mid-water trawl	• horse mackerel
Demersal trawl	Demersal trawl	• Cape hakes (*Merluccius paradoxus*, *M. capensis*) • monkfish (*Lophius vomerinus*)
Demersal longline	Demersal longline	• Cape hakes
Large pelagic longline	Pelagic longline	• albacore tuna (*Thunnus alalunga*) • yellowfin tuna (*T. albacares*) • bigeye tuna (*T. obesus*) • swordfish (*Xiphias gladius*) • shark spp.
Tuna pole	Pole and line	• albacore tuna
Deep-sea crab	Demersal longline trap	• red crab (*Chaceon maritae*)
Deep-water trawl	Demersal trawl	• orange roughy (*Hoplostethus atlanticus)* • alfonsino (*Beryx splendens*)
Rock lobster	Demersal trap	• rock lobster (*Jasus lalandii*)
Line-fish	Handline	• snoek (*Thyrsites atun*) • silver kob (*Argyrosomus inodorus*) • dusky kob (*A. coronus*)
Mariculture	Longlines, rafts	• Pacific and European oysters • black mussel • seaweed (*Gracilaria* sp.)

The management of fish stocks for commercial purposes is overseen by the Ministry of Fisheries and Marine Resources (MFMR), which receives guidance from the National Marine Information and Research Centre (NatMIRC) in Swakopmund under the Ministry. Total

Allowable Catches (TACs) are set every year by the Minister based on recommendations from an advisory council. Recent TACs are presented in Table 3-2.

TABLE 3-2 TOTAL ALLOWABLE CATCHES (TONS) FROM 2009/10 TO 2024/25 (MFMR, 2023).

Year	Sardine	Hake	Horse Mackerel	Crab	Rock Lobster	Monk
2009/10	17 000	149 000	230 000	2700	350	8 500
2010/11	25 000	140 000	247 000	2700	275	9 000
2011/12	25 000	180 000	310 000	2850	350	13 000
2012/13	31 000	170 000	310 000	3100	350	14 000
2013/14	25 000	140 000	350 000	3100	350	10 000
2014/15	25 000	210 000	350 000	3150	300	12 000
2015/16	15 000	140 000	335 000	3446	250	10 000
2016/17	14 000	154 000	340 000	3400	240	9800
2017/18	0	154 000	340 000	3400	230	9600
2018/19	0	154 000	349 000	3900	200	9600
2020/21	0	154 000	349 000	3900	180	9600
2021/22	0	154 000	330 000	4200	180	9600
2022/23	0	154 000	290 000	4200	180	9000
2023/24	0	154 000	270 000	4300	180	9000
2024/25	10 000	140 000	208 000	4000	180	9600

Note: Deepwater trawl TAC is currently not applied for Alfonsino and Orange roughy. There is no TAC (output control) for albacore tuna as this is an effort (input) controlled sector with no restriction on catch.

The Confederation of Namibian Fishing Industries represents commercial fisheries at the industry level, whilst sector-specific associations, such as the Namibian Hake Association and the Pelagic Fishing Association of Namibia, represent different fish species.

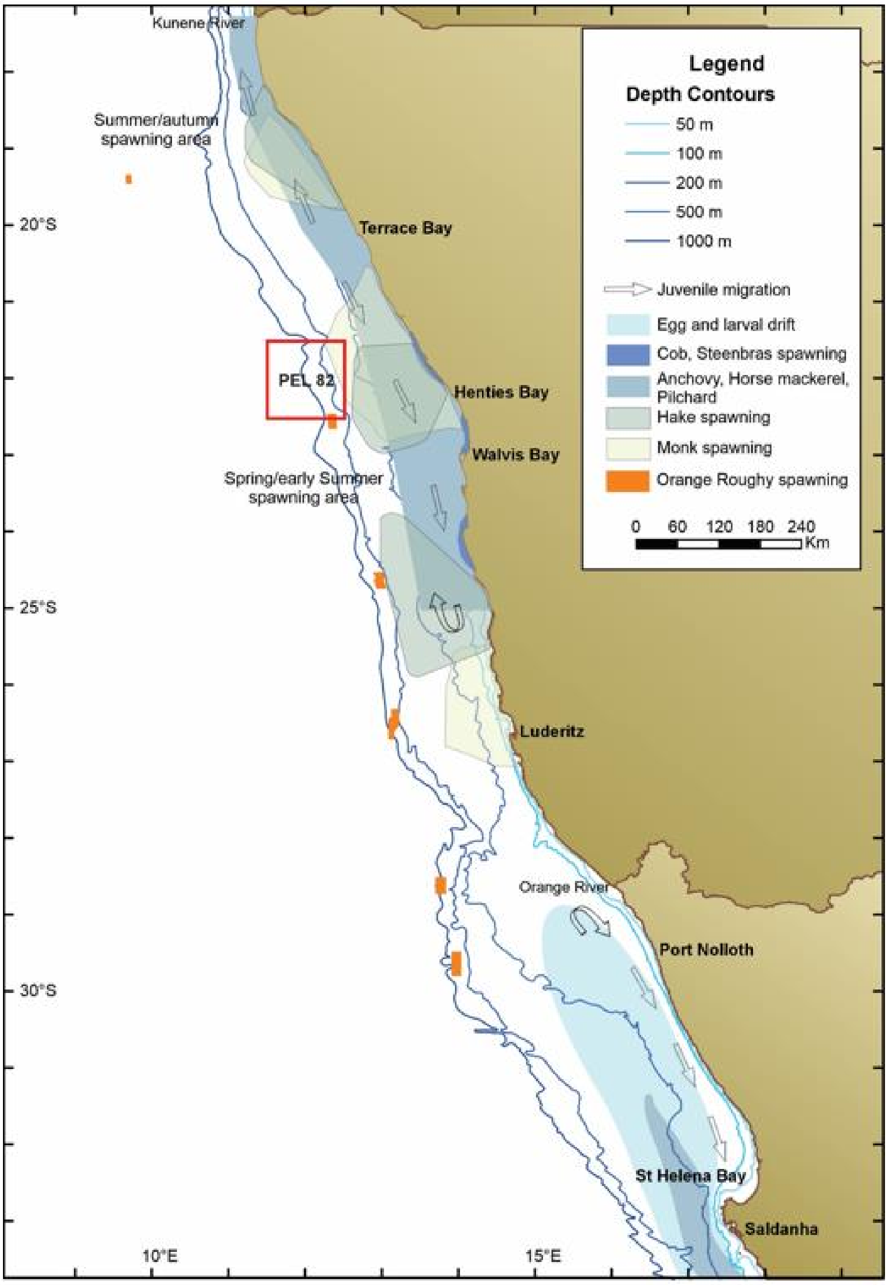
MFMR conducts regular research surveys to determine the biomass of demersal, midwater, and small pelagic species, covering the entire continental shelf from the Angolan to South African maritime borders. To preserve marine ecosystems, there is a strict prohibition on bottom trawling shallower than 200 m, enforced by Namibian regulations. Monitoring is undertaken by the Namibian compliance units and their Vessel Monitoring System (VMS).

Namibia has only two major fishing ports from which all the main commercial fishing operations are based namely, Walvis Bay and Lüderitz. In central Namibia, the major port is Walvis Bay, and it is from this port that the majority of fishing vessels operate. Most of the fishing conducted from this port is, for economic and logistical reasons, directed at fishing grounds in the central and northern part of Namibia and to a lesser extent the southerly fishing grounds towards the South African border.

3.2 STOCK DISTRIBUTION, SPAWNING AND RECRUITMENT

The principle commercial fish species in Namibia undergo a critical migration pattern which is central to the sustainability of the small pelagic and hake fisheries. Figure 3.1 indicates the major spawning grounds in Namibian waters.

FIGURE 3.1 PEL 82 IN RELATION TO MAJOR SPAWNING AREAS IN THE CENTRAL AND NORTHERN BENGUELA REGION (PISCES, 2025 ADAPTED FROM CRUIKSHANK 1990; HAMPTON 1992; HOLNESS ET AL. 2014)



In Namibian waters, hake spawning commences north of the powerful Lüderitz upwelling centre (27°S) and continues up to the Angola–Benguela Front (16–19°S). Sardines and horse mackerel also spawn in the region between Lüderitz and the Angola–Benguela front. Circulation patterns at depth reveal complex eddying and considerable southward and onshore transport beneath the general surface drift to the north-west (Sundby *et al.* 2001). As eggs drift, hatching takes place followed by larval development. Settlement of larvae occurs in the inshore areas. Sardine spawning peaks 30–80 km offshore during September–October off the central Namibian shelf, with larvae occurring slightly further offshore and recruits appearing close inshore, so there appears to be a simple inshore–offshore movement over the Namibian shelf. Spawning also occurs in mid-summer in the vicinity of the Angola–Benguela Front (Crawford *et al.* 1987). During late summer (December – March) warm water from the Angolan

Current pushes southwards into central Namibian waters, allowing pelagic spawning products to be brought into the nursery grounds off central Namibia. There is a high likelihood of substantial offshore transport associated with this convergent frontal region (Shannon 1985).

The stock distribution, spawning and recruitment of key target species are discussed below.

3.2.1 SARDINE

The Namibian sardine stock is distributed inshore of the 200 m isobath, from the Lüderitz upwelling cell into southern Angola. There was a rapid decline in the sardine stock in the late 1960s, following intense exploitation, ecosystem change and variability, and poor recruitment (Crawford *et al.,* 1987; Boyer *et al.,* 2001; Erasmus *et al.,* 2021). The status remains overexploited with a low biomass estimate and a significantly contracted distribution pattern compared to historical levels. It is reported that the stock has reduced by 99.5%, from an estimated 11 million tonnes in the 1960s to 50 000 tonnes in 2015 (Erasmus *et al.,* 2021). The fishery is currently closed following a moratorium that was implemented in 2018.

Following the collapse of the sardine stock, two main spawning areas have been described in the northern Benguela, one off central Namibia in the Walvis Bay region (22°S and 25°S) and another further north near Palgrave Point (19°S and 21°S) (King, 1977). The spawning season is thought to be between August and April, with peaks in September/October and March. Spawning peaks 30-80 km offshore with larvae occurring slightly further offshore and recruits appearing close inshore (Hutchings *et al.,* 2002). Recruitment varies considerably between years, with environmental variability and conditions playing an important role (Kirchner *et al.,* 2009). During late summer the warm Angolan Current pushes southwards, which brings eggs and larvae into nursery grounds off central Namibia (Hutchings *et al.,* 2002).

3.2.2 CAPE HORSE MACKEREL

Cape horse mackerel occurs predominantly north of 25°S, with juveniles present in the inshore pelagic regions up to the 200 m isobath and adult horse mackerel extending into waters up to 500 m deep. Concentrations are dense between Cape Cross and the Kunene River. Biomass estimates in this region are mostly low in summer, increasing in winter and early spring. Horse mackerel shoal in large numbers with a distinct diurnal vertical migration pattern, staying near the seabed during the day and rising in the water column to feed on zooplankton at night.

Horse mackerel spawn continuously from September to May, peaking from January and April (Klingelhoefer, 1994). Spawning occurs between Cape Frio (18°S) and Cape Cross (22°S), with the highest spawning intensity taking place 50-100 km from the shore (O'Toole, 1977).

3.2.3 LARGE PELAGIC SPECIES

Albacore tuna, yellowfin tuna, bigeye tuna, shark and swordfish are large pelagic species with an extensive offshore distribution ranging along the entire Namibian coastline. Seven species occur in Namibian waters; however, albacore tuna dominate the pole fishery and bigeye tuna dominate the longline fishery. The abundance of these species has a strong seasonal signal resulting in increased availability to the fisheries targeting them at different periods.

For the pole fishery, availability increases from summer and peaks late summer to early autumn.

- Albacore tuna spawn off Brazil just south of the equator and in the central Atlantic, where surface temperatures exceed 24°C (Manning, 1998). Bait boats using pole and line target albacore tuna primarily in southern Namibia from January to March. Aggregations of albacore tuna are known to occur in the vicinity of the Tripp Seamount and the highest catch levels are recorded in this area.

For the pelagic longline sector targeting bigeye tuna, yellowfin tuna, longfin tuna and swordfish, the availability of these target species is highest from April to September. The longline tuna fishing season peaks two to three months later than the fishery for albacore tuna.

- Bigeye tuna spawn across the east central Atlantic, North of 5°N in the warmest season when surface temperatures are above 24°C, and in the Gulf of Guinea (Manning, 1998).
- Yellowfin tuna are distributed between 10°S and 40°S in the south Atlantic, and spawn in the central Atlantic off Brazil in the austral summer (Penney *et al.* 1992). According to Crawford *et al.* (1987) juvenile and immature yellowfin tuna occur throughout the year in the Benguela system. After reaching sexual maturity they migrate (in summer) from feeding grounds off the West Coast of southern Africa to the spawning grounds in the central Atlantic.
- The availability of longfin tuna increases during the summer upwelling season due to the increased biological activity and bait fish (sardine and anchovy) abundance.
- Swordfish spawn in warm tropical and subtropical waters and migrate to colder temperate waters during summer and autumn months.

It is important to note that weather conditions play an important role in operations within the tuna fisheries (pole and line and longline). The high market price for tuna makes up for their relatively low catches off Namibia (Manning, 1998).

3.2.4 HAKE

Hake is the most commercially important Namibian fishery. Two species of hake are caught in Namibian waters: Cape/shallow-water hake and deepwater hake. These species display diurnal vertical migration, occurring in demersal waters in the daytime and moving to mid-water at night. Studies suggest that deepwater hake migrate to South Africa to spawn and do not spawn within Namibian waters. However, Cape hake has been shown to spawn within Namibian waters, from north of the powerful Lüderitz upwelling centre to the Angola-Benguela front (Kainge et al. 2007). This species displays variation in spawning, however spawning peaks during July to September along the shelf break off central Namibia (Jansen et al., 2015). The hake stocks extend along the entire Namibian shelf and slope approximately between the 100 m and 1000 m isobaths.

3.2.5 MONKFISH

Monkfish are found along the entire extent of the Namibian coast, with the fishery concentrated between 17°15'S and 29°30'S on the deeper continental shelf and upper slope between depths of 200 m to 500 m. Cape monkfish spawn throughout the year with a peak between July and September (Erasmus 2021). Cape monkfish appear to spawn throughout Namibian waters, with evidence of hotspot spawning aggregation between 21^{o} S and 25^{o} S (Erasmus, 2021).

3.2.6 DEEP-SEA CRAB

Deep-sea red crab stocks are distributed predominantly from 23°35'S northwards into Angolan waters, within a depth range of approximately 300 m to 1000 m. Highest densities occur along the northern range of its distribution, the Angolan border, to 18°S. Spawning takes place throughout the year (Le Roux 1997) in the shallower waters of the continental slope with adult females generally occurring at shallower depths to that of males.

3.2.7 ORANGE ROUGHY

Orange roughy has a discontinuous pattern of distribution along the continental slope. Aggregations of fish occur within four known spawning grounds (within designated Quota Management Areas) within Namibian waters. The species has a short, intense spawning period of about a month from July to August (Boyer and Hampton 2001) during which individuals aggregate. As a result of overexploitation of the stock(s), the fishery (which only existed for four years) has been closed since 2007; however, the stock is currently being assessed and the viability of re-opening the fishery is under consideration.

3.2.8 ROCK LOBSTER

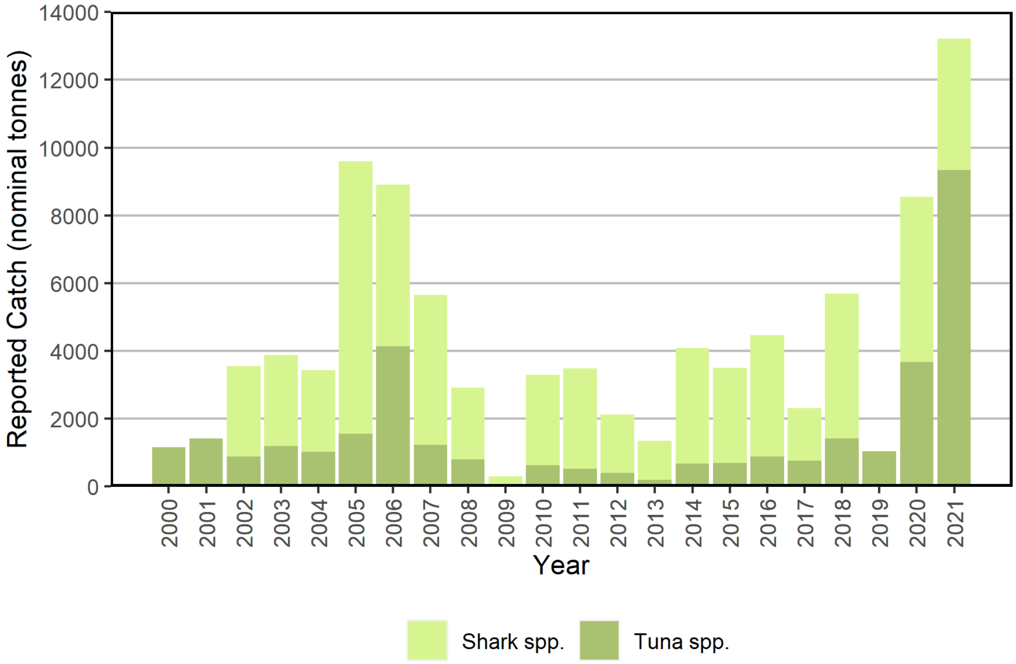
Namibian Cape Rock lobster is found from 25°S to 28°30'S at depths shallower than 100 m. The depth distribution of adults varies seasonally in response to changes in dissolved oxygen levels in the water. Adults moult during spring (males) and late autumn/early winter (females), with egg hatching peaking in October/November. Fishing activity is greatest over January and February with the number of active vessels declining towards the end of the fishing season in May.

3.3 COMMERCIAL FISHING SECTORS

3.3.1 LARGE PELAGIC LONGLINE

This sector makes use of surface long-lines to target migratory pelagic species including yellowfin tuna (*T. albacares*), bigeye tuna (*T. obesus*), swordfish (*Xiphias gladius*) and various pelagic shark species particularly blue shark and mako shark. Commercial landings of these species by the fishery are variable and Namibian-reported catch from 2000 to 2021 is shown in Figure 3.2 (ICCAT, 2023). There is provision for up to 26 fishing rights and 40 vessels (http://www.mfmr.gov.na/); however, 19 vessels were active during 2022 (ICCAT, 2023).

FIGURE 3.2 ANNUAL LONGLINE CATCH (NOMINAL TONNES) OF LARGE PELAGIC SPECIES REPORTED TO ICCAT BY THE NAMIBIAN LONGLINE FLEET BETWEEN 2000 AND 2021. SOURCE: ICCAT STATISTICAL BULLETIN (2023).



Tuna is targeted at thermocline fronts, predominantly along and offshore of the shelf break. Pelagic long-line vessels set a drifting mainline, up to 50-100 km in length, and are marked at intervals along its length with radio buoys (Dahn) and floats to facilitate later retrieval. Various types of buoys are used in combinations to keep the mainline near the surface and locate it should the line be cut or break for any reason. Between radio buoys the mainline is kept near the surface or at a certain depth by means of ridged hard-plastic buoys, (connected via a “buoy-lines” of approximately 20 m to 30 m). The buoys are spaced approximately 500 m apart along the length of the mainline. Hooks are attached to the mainline on branch lines, (droppers), which are clipped to the mainline at intervals of 20 m to 30 m between the ridged buoys. The main line can consist of twisted tarred rope (6 mm to 8 mm diameter), nylon monofilament (5 mm to 7.5 mm diameter) or braided monofilament (~6 mm in diameter). A line may be left drifting for up to 18 hours before retrieval by means of a powered hauler at a speed of approximately 1 knot. Refer to Figure 3.3 for a schematic diagram of pelagic longline gear and Figure 3.4 for photographs of an example of vessel, marker buoys and lines.

FIGURE 3.3 SCHEMATIC DIAGRAM OF GEAR TYPICALLY USED BY THE PELAGIC LONGLINE FISHERY (SOURCE: HTTP://WWW.AFMA.GOV.AU/PORTFOLIO-ITEM/LONGLINING).

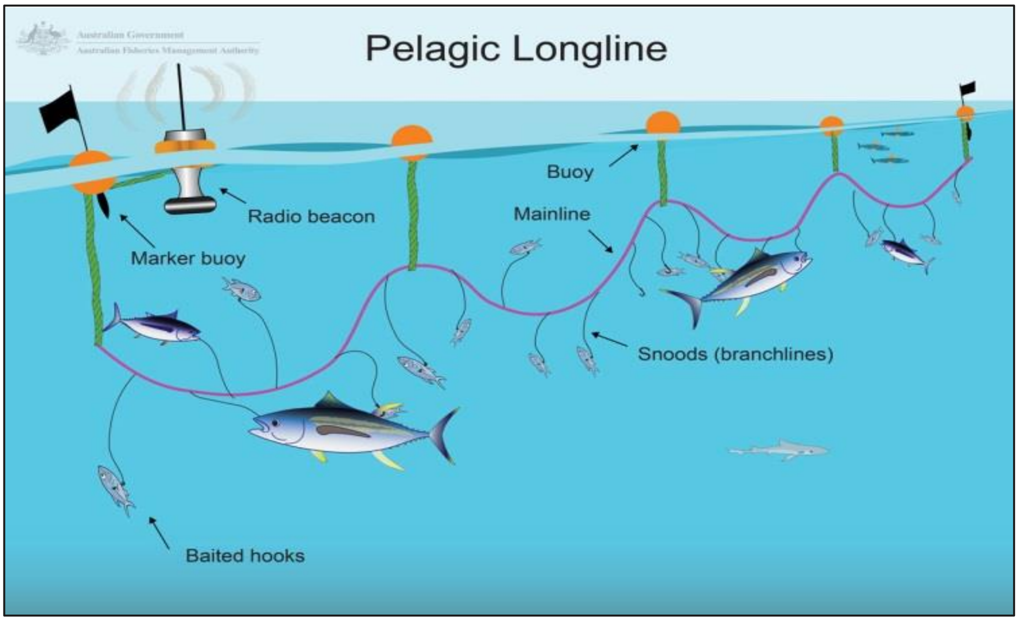


FIGURE 3.4 PHOTOGRAPHS SHOWING MARKER BUOYS (LEFT), RADIO BUOYS (CENTRE) AND MONOFILAMENT BRANCH LINES (RIGHT) (SOURCE: CAPMARINE, 2015).

Longline vessels targeting pelagic tuna species and swordfish operate extensively around the entire coast along the shelf-break and into deeper waters. The spatial distribution of fishing effort is widespread and may be expected predominantly along the shelf break (approximately along the 500 m isobath) and into deeper waters (2 000 m). Effort occurs year-round with a slight peak over the period March to May (see Figure 3.5). Figure 3.6 shows the spatial distribution of commercial catches along the Namibian coastline and in the vicinity of PEL 82. Fishing takes place across the entire license area. Over the period 2004 to 2019, an average catch of 71 tons per year was taken within the license area (2.46% of landings at a national scale). Average annual effort expended within the area amounted to ~48,000 hooks.

FIGURE 3.5 MONTHLY AVERAGE CATCH (BARS) AND EFFORT (LINE) RECORDED BY THE LARGE PELAGIC LONGLINE SECTOR WITHIN NAMIBIAN WATERS (2004 – 2019). SOURCE: MFMR (2019)

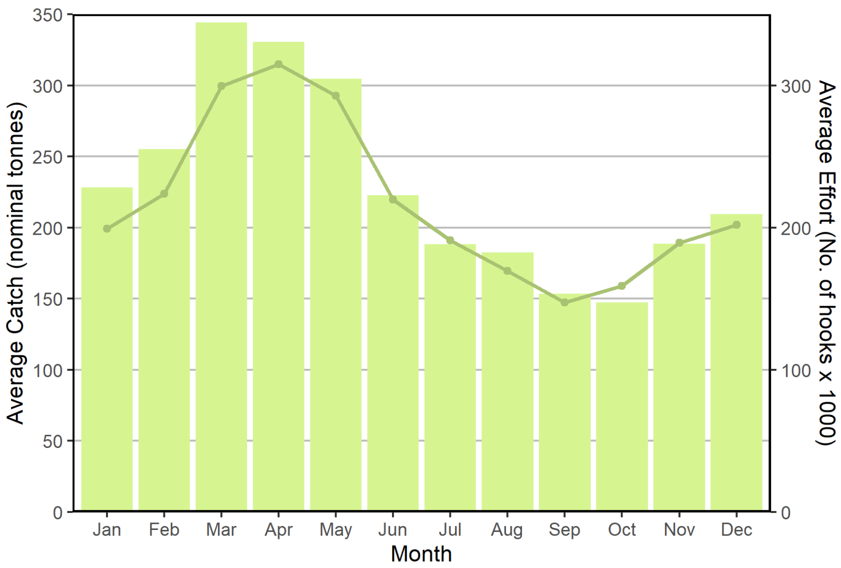
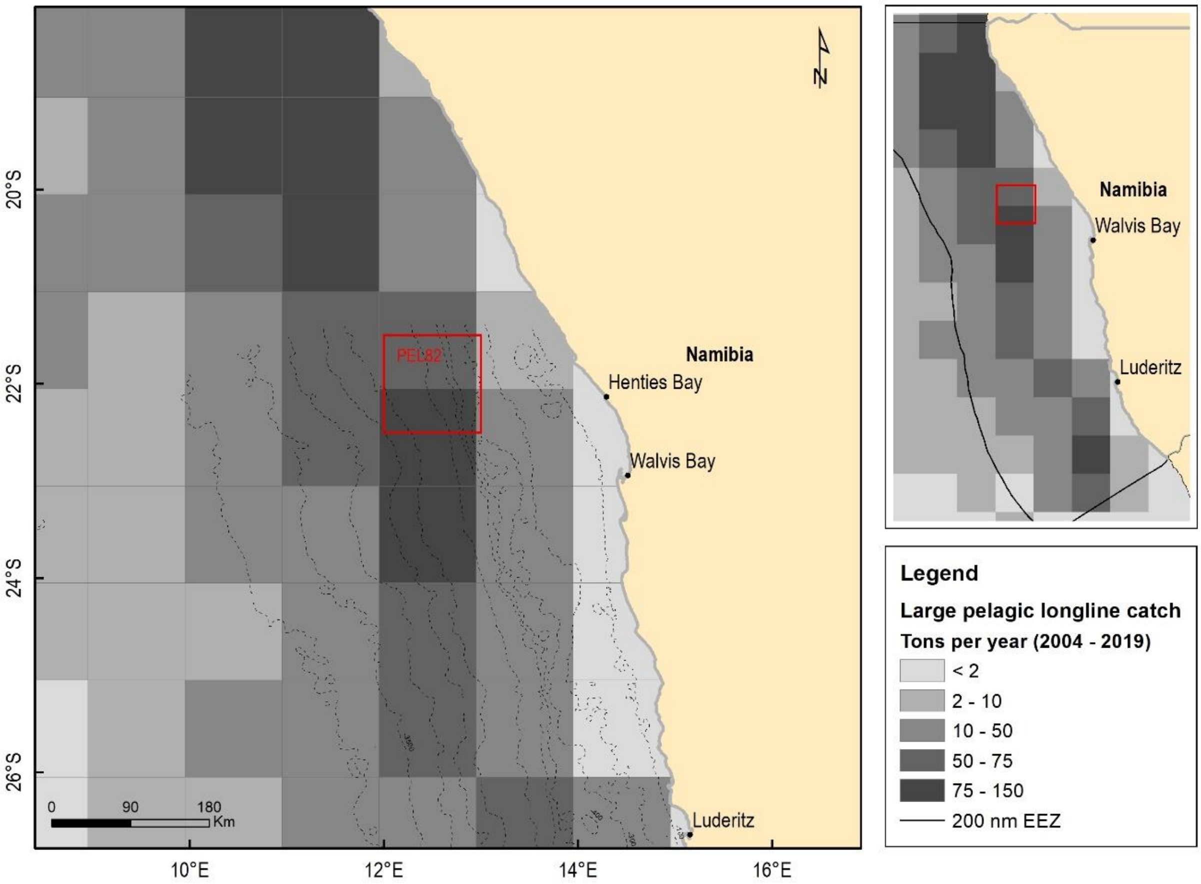


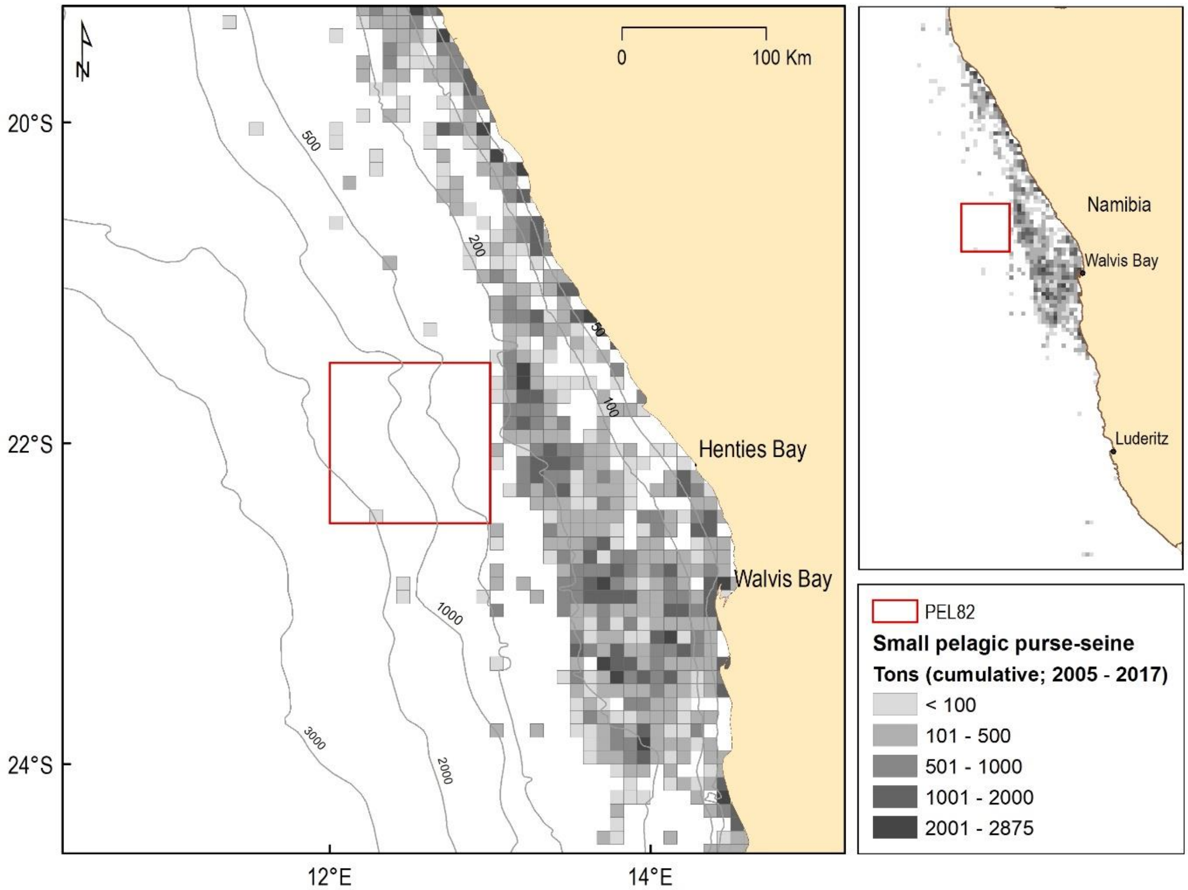
FIGURE 3.6 SPATIAL DISTRIBUTION OF CATCH RECORDED BY THE PELAGIC LONGLINE FISHERY (2004 – 2019) IN RELATION TO PEL 82 (DISPLAYED ON A 60 X 60 MINUTE GRID).



3.3.2 SMALL PELAGIC PURSE-SEINE

The pelagic purse-seine fishery is based on the Namibian stock of Benguela sardine (*Sardinops sagax*) (also regionally referred to as pilchard), and small quantities of juvenile horse mackerel. A moratorium was implemented on 01 January 2018 due to a significant population reduction, and extensive scientific studies are underway to ascertain the causes (MFMR 2015 and 15 February 2019). The extent of the stock distribution has effectively contracted since stock collapse, prior to which the historical distribution was throughout the Benguela system. Recent biomass surveys have shown small aggregations of the stock mostly located inshore of the 200 m isobath. Commercial fishing activity occurs primarily inshore of 200 m, northwards of 25°S to the Angolan border (see Figure 3.7). In 2025, the fishery was reopened with a quota allocation of 10 000 t. The main commercial fishing grounds are situated inshore of the license area and fishing grounds are not expected to overlap with PEL 82.

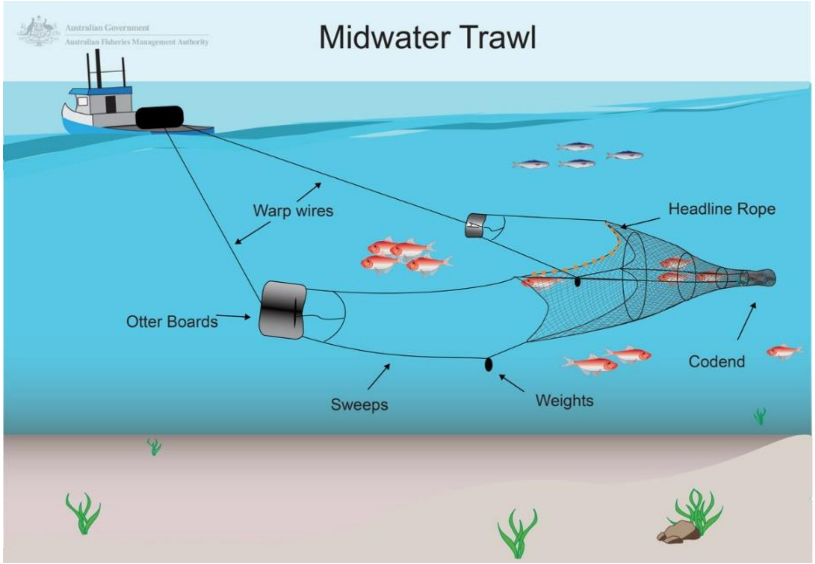
FIGURE 3.7 SPATIAL DISTRIBUTION OF SMALL PELAGIC PURSE-SEINE CATCH (2005 – 2017) IN RELATION TO PEL 82.



3.3.3 MID-WATER TRAWL

The fishery for Cape horse mackerel (*Trachurus capensis*) is the largest contributor by volume and second highest contributor by value to the Namibian fishing industry. The stock is caught by the mid-water trawl fishery (targeting adult horse mackerel) and pelagic purse-seine fishery (smaller quantities of juvenile horse mackerel). The midwater fishery operates using trawls within the water column to catch schools of adult horse mackerel (refer to FIGURE 3.8).

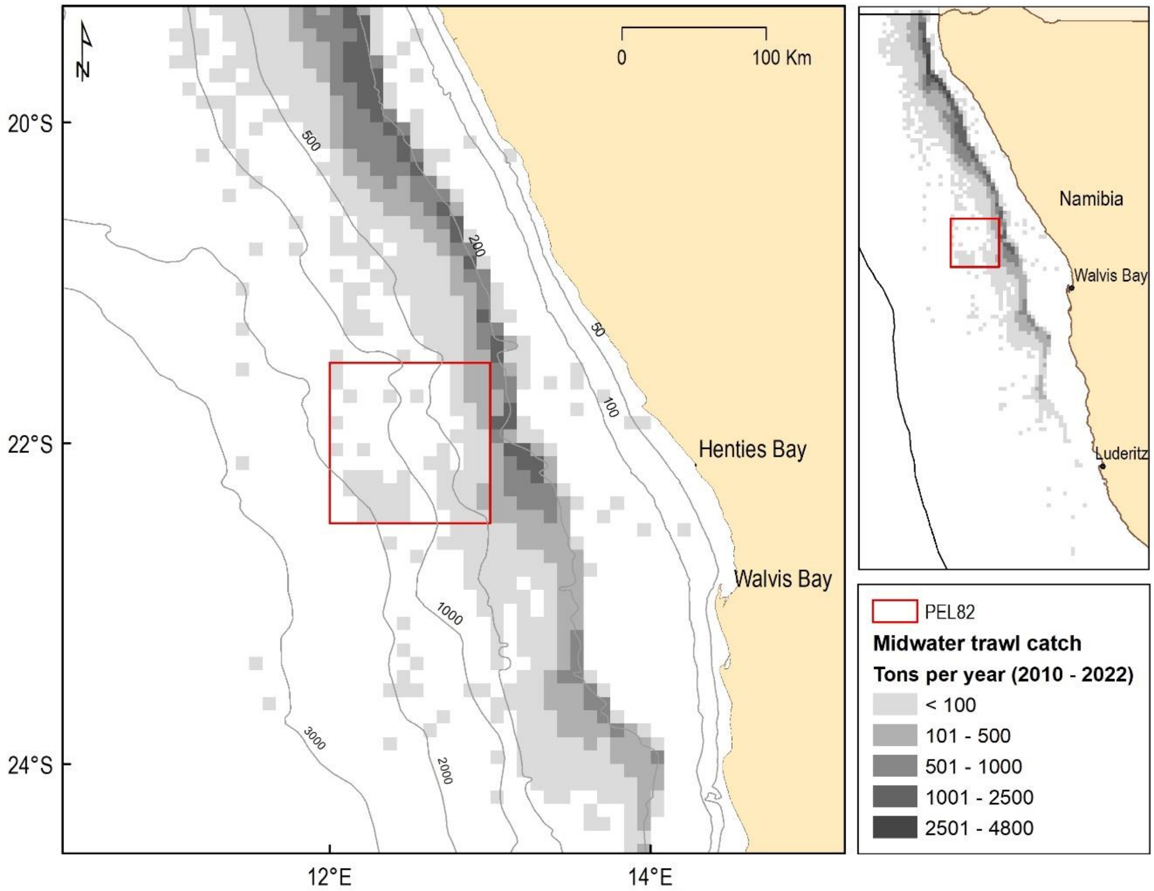
FIGURE 3.8 SCHEMATIC DIAGRAM SHOWING THE TYPICAL GEAR CONFIGURATION OF A MIDWATER TRAWLER.



SOURCE: WWW.AFMA.GOV.AU/FISHERIES-MANAGEMENT/METHODS-AND-GEAR/TRAWLING

The fishery operates year-round with relatively constant catch and effort values by month. The mid-water trawl fleet operates exclusively out of the port of Walvis Bay and fishing grounds extend north of 25ºS to the border of Angola. Juvenile Cape horse mackerel move into deeper water when mature and are fished mostly between the 200 m and 500 m isobaths towards the shelf break. The distribution of horse mackerel-directed fishing grounds in relation to PEL 82 is shown in Figure 3.9. The license area covers 3 338 km^2 (approximately 4.3%) of the total ground fished by the sector. Approximately 0.98% (2 573 tons per year) of national landings was caught within PEL 82, inshore of the 500 m depth contour (data range includes 2010 to 2022). Effort within the area was equivalent to 78 trawls per year or 1.05% of the total effort expended by the sector.

FIGURE 3.9 SPATIAL DISTRIBUTION OF MIDWATER TRAWL CATCH (2010 – 2022) IN THE VICINITY OF PEL 82.



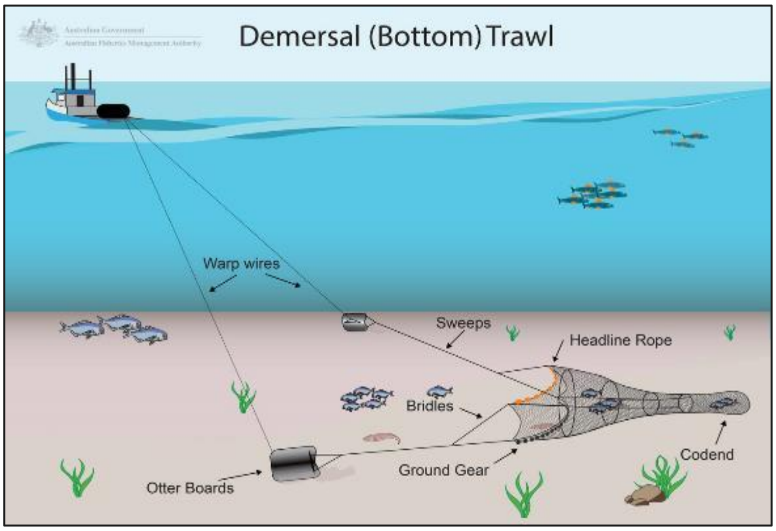
3.3.4 DEMERSAL TRAWL

The most economically important species in Namibia are shallow-water hake (*Merluccius capensis*) and deepwater hake (*Merluccius paradoxus*), which are managed as a single sector. At the peak of exploitation in the mid-1970s, catches of hake in Namibian waters reached almost 1 million tonnes, although some believe that this figure was underestimated. The directed hake trawl fishery is Namibia's most valuable fishery, with a current annual TAC of 154 000 tons.

The fleet of 71 demersal trawlers licensed to operate within the fishery primarily targets hake in deeper waters, while smaller trawlers fish inshore for monkfish, sole, and kingklip. The deep-sea fleet is divided into wet-fish and freezer vessels which differ in terms of the capacity for the processing of fish offshore (freezers process at sea and wet-fish vessel land fish at factories ashore for processing) and in terms of vessel size and capacity (shaft power of 750 – 3 000kW). Wet-fish vessels have an average length of 45 m, are generally smaller than freezer vessels which may be up to 90m in length. Whilst freezer vessels may work in an area for up to a month at a time, wet-fish vessels may only remain in an area for about a week before returning to port (catch is retained on ice). The majority of trawlers operate from the port of Walvis Bay, with fewer vessel operating from Lüderitz.

Trawl gear configurations are similar for both freezer and wet-fish vessels, the main elements of which are trawl warps, bridles and doors, a footrope, headrope, net and codend (see Figure 3.10). Generally, trawlers tow their gear at 3.5 knots for up to four hours per drag. When towing gear, the distance of the trawl net from the vessel is usually between two and three times the depth of the water. The horizontal net opening may be up to 50m in width and 10m in height. The swept area on the seabed between the doors may be up to 150 m. The opening of the net is maintained by the vertical spread of the trawl doors, which are in contact with the seafloor.

FIGURE 3.10 GEAR CONFIGURATION SIMILAR TO THAT USED BY THE OFFSHORE DEMERSAL TRAWLERS TARGETING HAKE



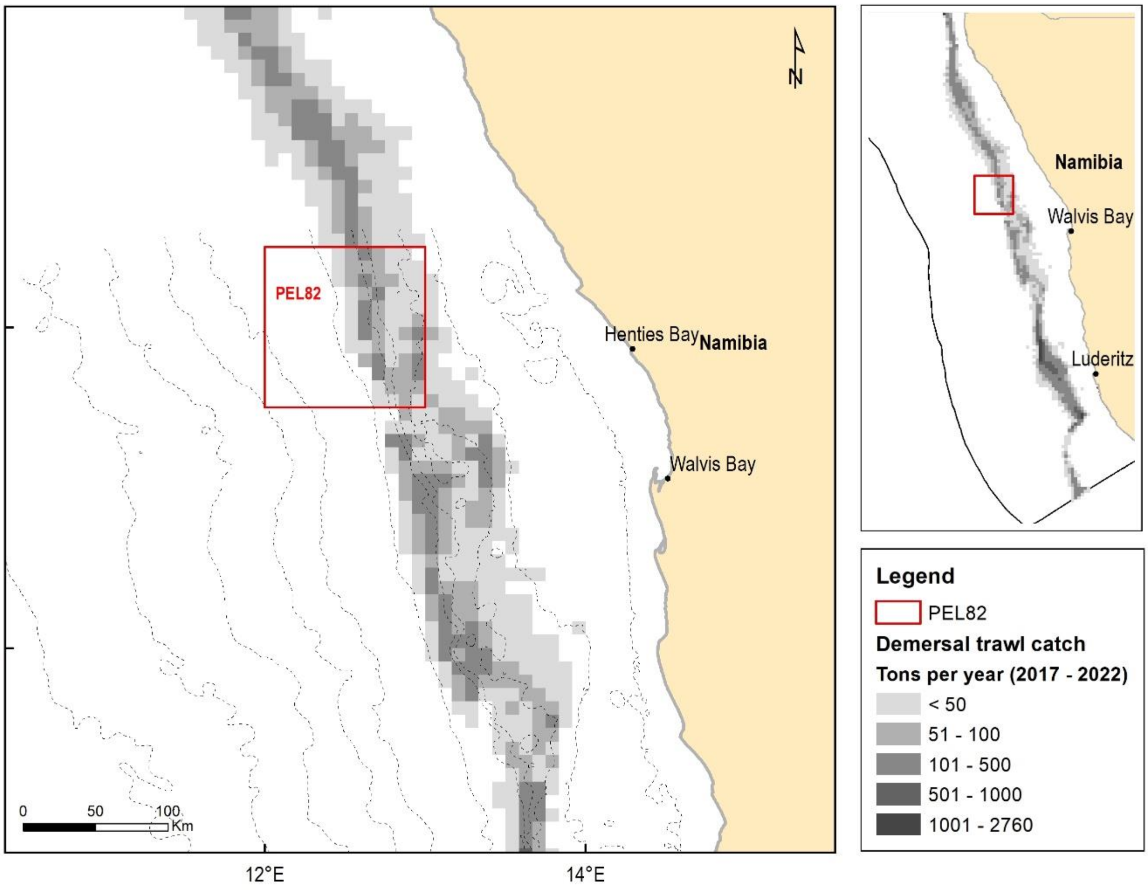
SOURCE: WWW.AFMA.GOV.AU/FISHERIES

Fishing effort is relatively constant throughout the year except for a closure for the month of October and relatively lower levels of effort expended during November and December.

Fishing grounds extend along the entire coastline following the distribution of hake and monkfish along the continental shelf at a depth range of 200 m to 780 m (refer to Figure 3.11). Demersal trawling is prohibited in waters shallower than 200 m5. The total extent of fishing grounds used by the demersal trawl fleet at a national scale is approximately 78,895 km2. The license area covers 5880 km2 (approximately 5.9%) of the total fishing ground used by the sector on a national scale). Over the period 2017 to 2022, 3.7 % of the total landings were caught within PEL 82 (4330 tons per year). Effort within PEL 82 amounted to 5.5% (5065 fishing hours) of the total effort expended by the sector.

[5] Namibia has a designated area closed to most “offshore” fishing activities under 200 m water depth i.e. to protect potential spawning areas as well as areas of high juvenile abundance for most demersal species, including hake. Demersal trawling is prohibited in waters shallower than 200 m.

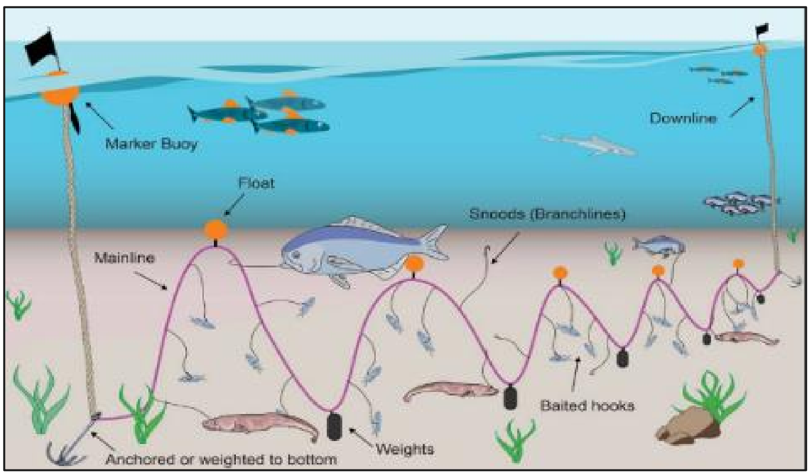
FIGURE 3.11 SPATIAL DISTRIBUTION OF HAKE CATCH BY DEMERSAL TRAWL VESSELS (2017 – 2022) IN RELATION TO PEL 82.



3.3.5 DEMERSAL LONGLINE

Similar to the demersal trawl fishery the target species of this fishery is the Cape hakes, with a small non-targeted commercial by-catch that includes kingklip. Longline vessels fish in similar areas targeted by the hake-directed trawling fleet, in a broad area extending from the 200 m to 650 m contour along the full length of the Namibian coastline. Landings by the sector have averaged ~10,000 tons per year over the period 2010 to 2023.

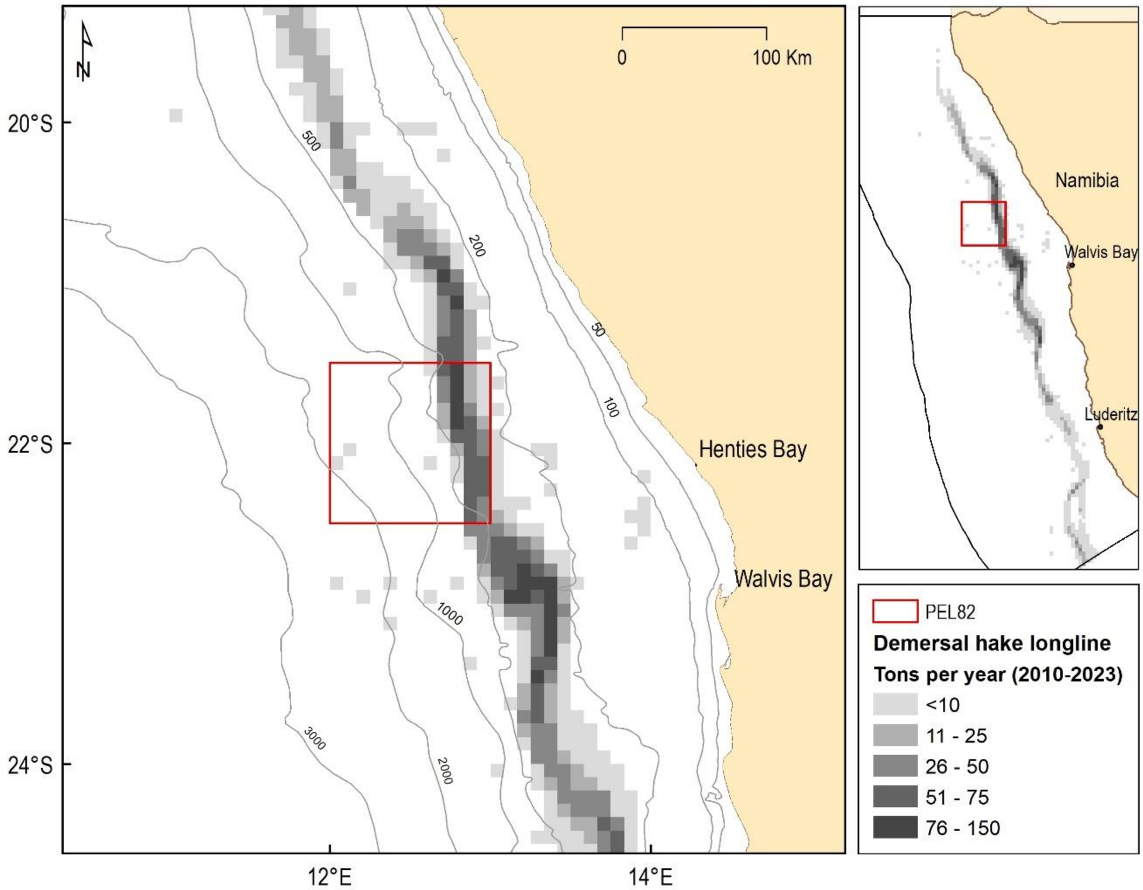
FIGURE 3.12 TYPICAL GEAR CONFIGURATION USED BY DEMERSAL LONGLINE VESSELS TARGETING HAKE



A demersal longline vessel may deploy either a double or single line which is weighted along its length to keep it close to the seafloor (see Figure 3.12). Steel anchors, of 40 to 60 kg are placed at the ends of each line to anchor it. These anchor positions are marked with an array of floats. If a double line system is used, top and bottom lines are connected by means of dropper lines. Since the top-line (polyethylene, 10 – 16mm diameter) is more buoyant than the bottom line, it is raised off the seafloor and minimizes the risk of snagging or fouling. The purpose of the top-line is to aid in gear retrieval if the bottom line breaks at any point along the length of the line. Lines are typically 20–30 nautical miles in length. Baited hooks are attached to the bottom line at regular intervals (1 to 1.5 m) by means of a snood. Gear is usually set at night at a speed of 5–9 knots. Once deployed the line is left to soak for up to eight hours before retrieval commences. A line hauler is used to retrieve gear (at a speed of approximately 1 knot) and can take six to ten hours to complete. During hauling operations the vessel's manoeuvrability is severely restricted. Long-line vessels are similar in size and power to wet-fish trawlers and may vary in length from 18m to 50 m and remain at sea for four to seven days at a time. The fleet comprises 18 vessels. Those based in Lüderitz mostly work South of 26°S towards the South Africa border while those based in Walvis Bay operate between 23°S and 26°S and North of 23°S.

Figure 3.13 shows the distribution of catch reported in relation to PEL 82. The license area covers approximately 4 610 km2 of fishing grounds which is equivalent to approximately 6% of the total area fished by the sector. Demersal longline activity takes place within the nearshore extent of PEL 82 up to the 450 m depth contour. Over the period 2010 to 2023 an average catch of 1699 tons was reported in the license area. This is equivalent to 17.09% of the total catch reported by the sector at a national scale.

FIGURE 3.13 SPATIAL DISTRIBUTION OF CATCH REPORTED BY THE DEMERSAL LONG-LINE FISHERY TARGETING CAPE HAKES (*M. CAPENSIS*; *M. PARADOXUS*) IN RELATION TO PEL 82 (2010 – 2023).



3.3.6 TUNA POLE-LINE

Poling for tuna is predominantly based on the southern Atlantic albacore (longfin tuna) stock (*T. alalunga*) and a small amount of skipjack tuna (*Katsumonus pelamis*), yellowfin tuna and bigeye tuna. Commercial landings of large pelagic species are variable and Namibian-reported catches reported by the pole sector (also referred to as "baitboat") are shown in Figure 3.14.

The fishery is seasonal with vessel activity mostly between November and May and peak catches in March and April (refer to Figure 3.15). Effort fluctuates according to the availability of fish in the area, but once a shoal of tuna is located a number of vessels will move into the area and target a single shoal which may remain in the area for days at a time. As such the fishery is dependent on window periods of favourable conditions relating to catch availability.

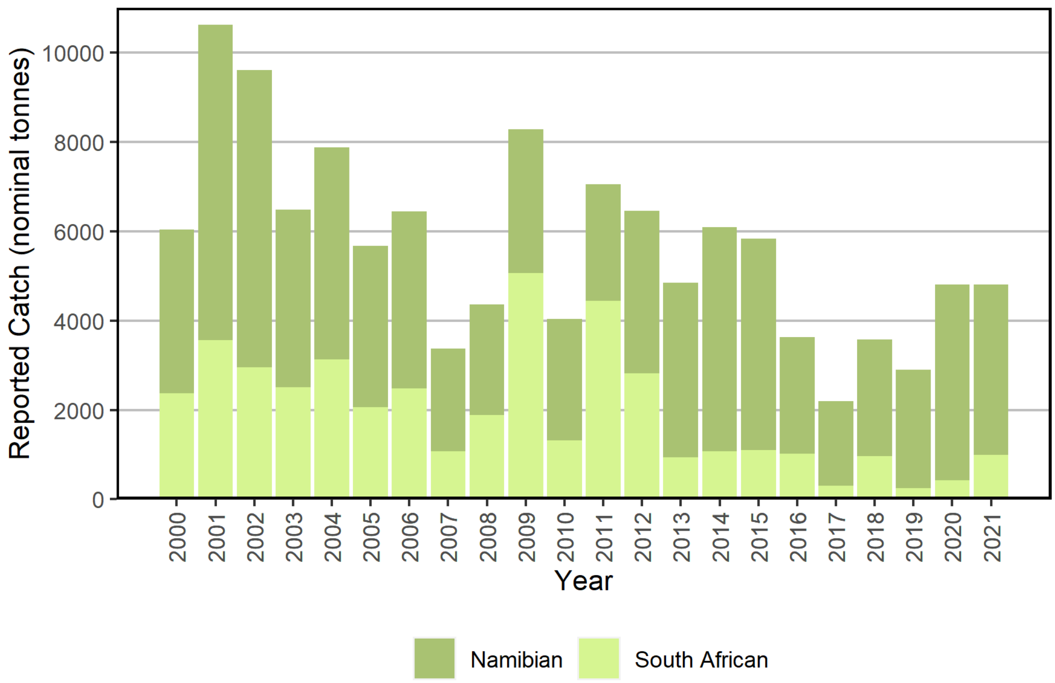


FIGURE 3.14 MONTHLY AVERAGE CATCH (BARS) AND EFFORT (LINE) RECORDED BY THE POLE-LINE SECTOR WITHIN NAMIBIAN WATERS FROM 2004 TO 2019 (SOURCE: MFMR, 2019).

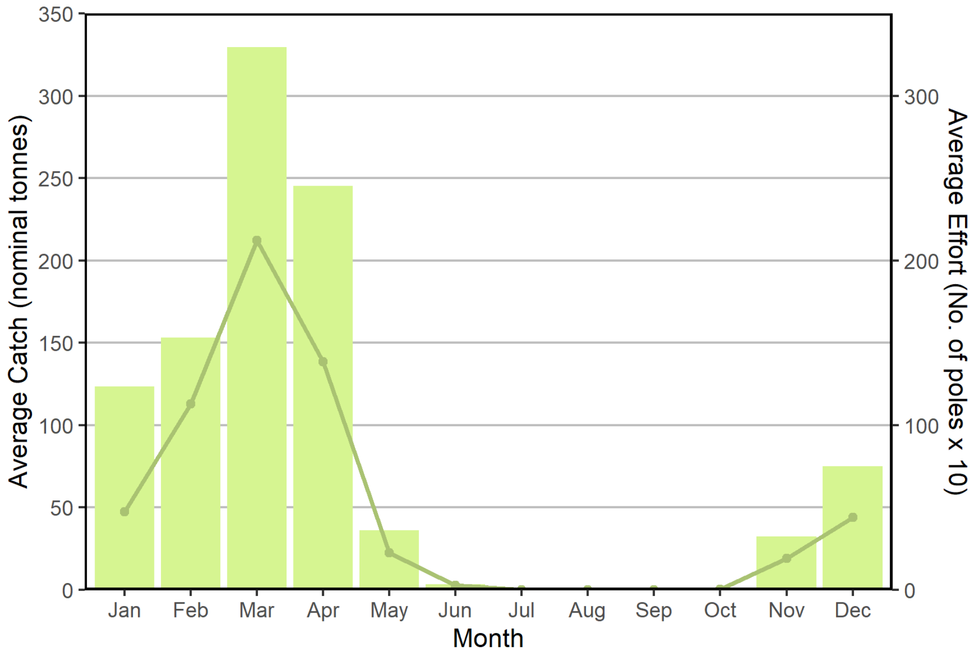
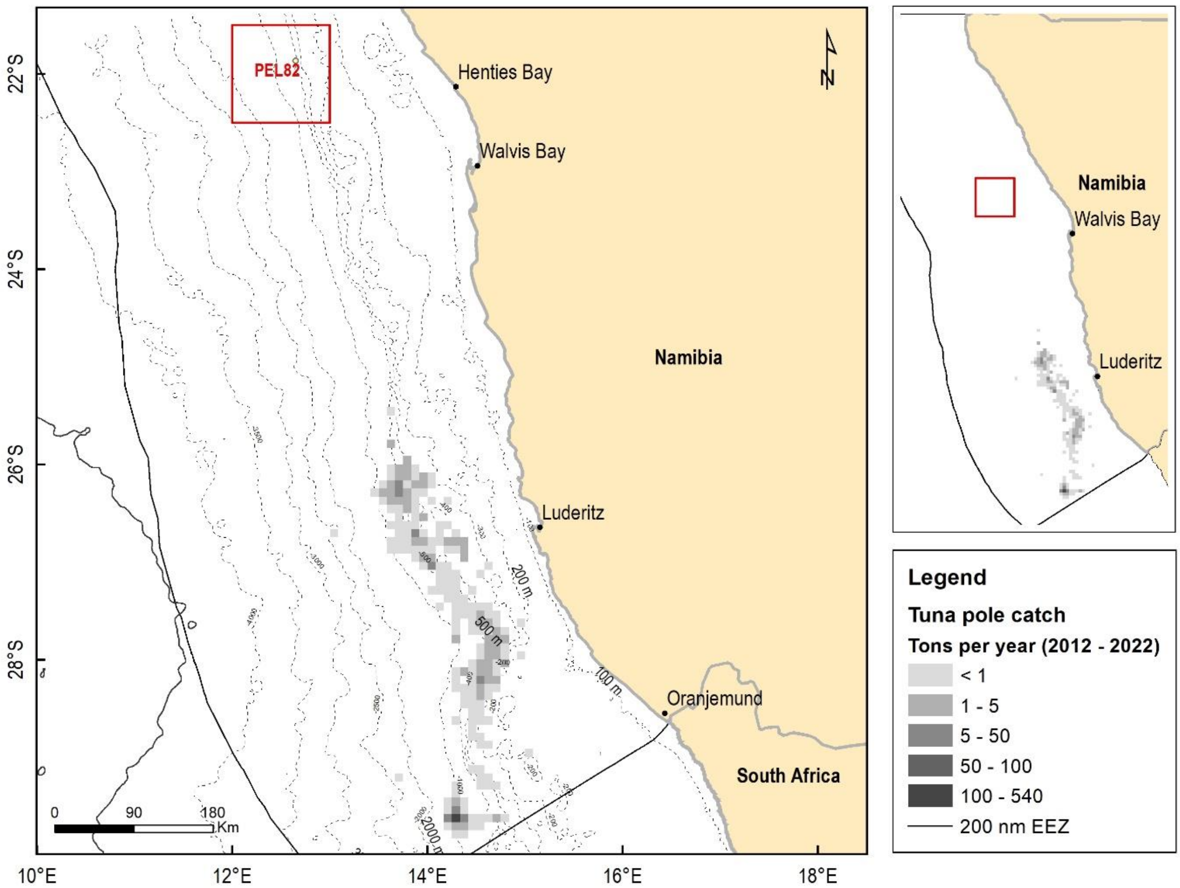


FIGURE 3.15 SCHEMATIC DIAGRAM OF TUNA POLE-LINE OPERATION

Source: http://www.afma.gov.au/portfolio-item/minor-lines

FIGURE 3.16 SPATIAL DISTRIBUTION OF CATCH REPORTED BY THE TUNA POLE AND LINE FLEET ALONG THE NAMIBIAN COASTLINE AND IN THE VICINITY OF PEL 82 (2012 – 2022).



Aggregations of albacore tuna occur in specific areas, in particular Tripp Seamount which is situated just north of the South Africa/ Namibia maritime border. Catches in this area are variable from year to year, although boats will frequent the area knowing that albacore aggregate around the seamount after migrating through South African waters. The southern boundary of the license area is situated approximately 800 km to the North of Tripp Seamount. The movement of albacore between South Africa and Namibia is not clear although it is believed that the fish move northwards following bathymetric features and generally stay beyond the 200 m depth contour.

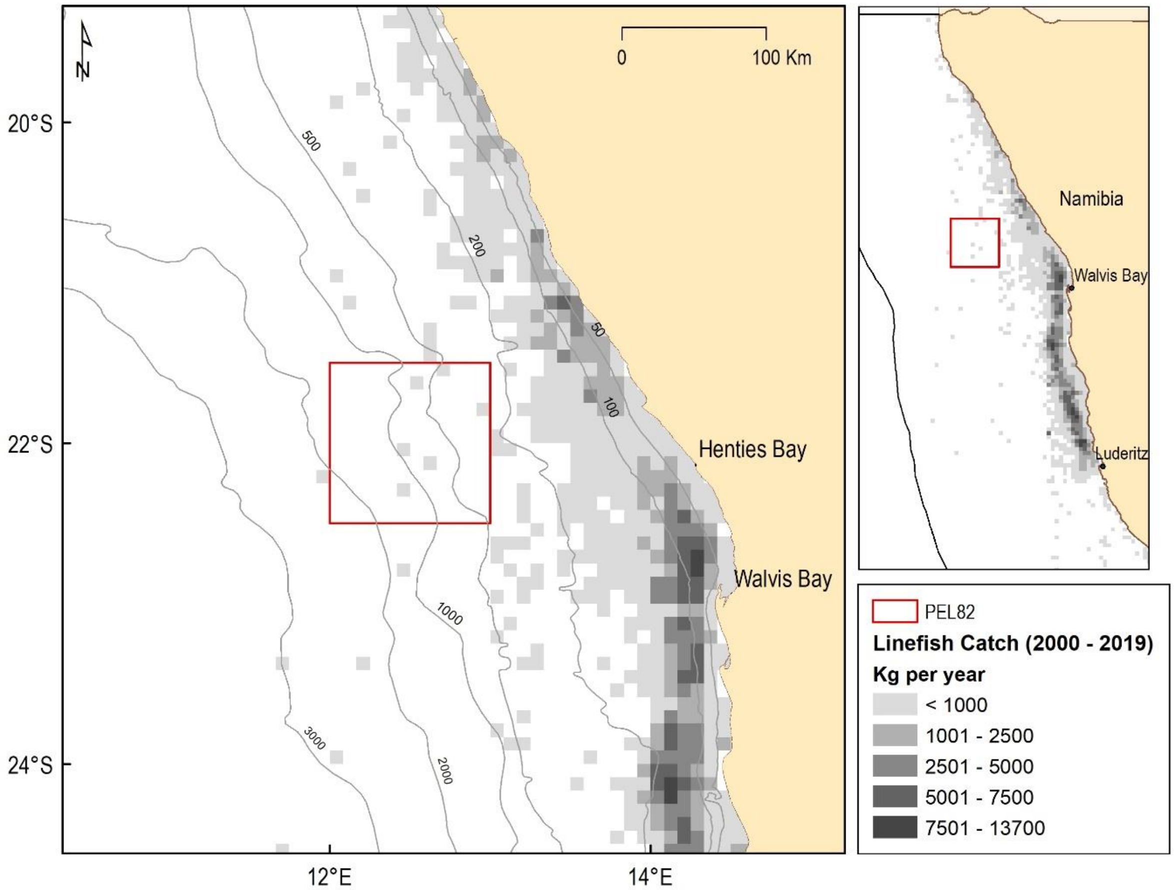
Figure 3.16 shows the spatial distribution of catch reported by the sector between 2012 and 2022. There is no expected overlap with PEL 82, which is located at least 360 km northwards of the expected fishing grounds of the tuna pole-line fishery.

3.3.7 LINEFISH

The traditional line fishery primarily targets snoek (Thyrsites atun) with bycatch of yellowtail, silver kob (Argyrosomus inodorus), dusky kob (A. coronus), and shark, which are sold on the local market. Snoek availability to the fishery is seasonal. Catches peak in late summer where after the fish migrate south into South African waters. The other species caught, such as kob and shark occurs year-round, but is in relatively small amounts. Operationally the fishery is limited in extent to Walvis Bay, Swakopmund and Henties Bay and also due to the small size of the boats does not operate much further than 12 nm offshore (i.e. 22 km). There is also a small component of the fishery operating out of Lüderitz in the South.

The distribution of linefish catch in relation to PEL 82 is shown in Figure 3.17. The sector operates inshore of the 200 m depth contour with incidental reports of fishing in deeper waters. Although there are incidental reports of fishing activity within PEL 82 it is likely that these are incorrectly reported fishing positions or errors in the transcription of records from logbooks to electronic database as it is unlikely that activity would be expected in waters deeper than 200 m.

FIGURE 3.17 SPATIAL DISTRIBUTION OF CATCH REPORTED BY SKI-BOATS OPERATING WITHIN THE LINE-FISH SECTOR ALONG THE NAMIBIAN COASTLINE IN RELATION TO PEL 82 (2000 – 2019).

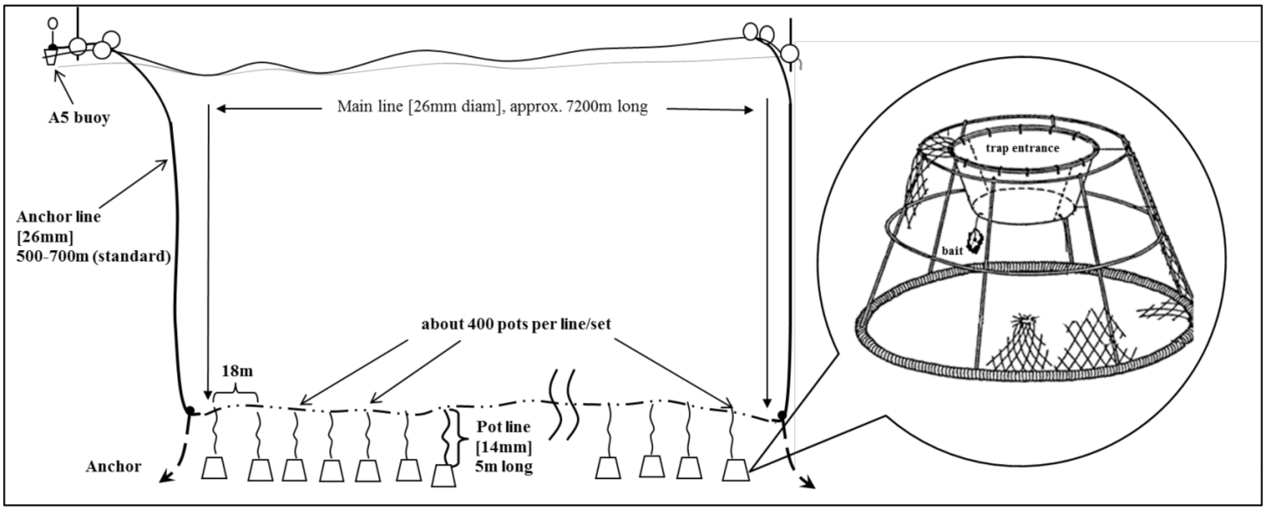


3.3.8 DEEP-SEA CRAB

The Namibian deep-sea crab fishery is based on two species of crab namely spider crab (*Lithodes ferox*) and red crab (*Chaceon maritae*). The commercial distribution of red crab extends from 23°35'S northwards into Angola at a depth range of 300 m to >1000 m. The fishery is located on the northern continental shelf-edge of Namibia's EEZ and operates from January to December each year. During the 2021 fishing season a total of six commercial vessels were active in the sector. Vessels operate from the port of Walvis Bay. The annual TAC is currently 4200 tons.

Method of capture involves the setting of a demersal long-line with a string of approximately 400 Japanese-style traps (otherwise known as "pots") attached to each line (Figure 3.18). Traps are made of plastic and dimensions are approximately 1.5 m width at the base and 0.7 m in height. They are spaced 15 m apart and typically baited with horse mackerel or skipjack. The line is typically 6000 m in length and weighted at each end by a steel anchor. A surface buoy and radar reflector mark each end of the line via a connecting dropper line that allows retrieval of the gear. Up to 1200 traps may be set each day (or two to three lines) and are left to soak for between 24 and 120 hours before being retrieved. There is a minimum operational depth of 400 m set for the fishery, which sets traps at depths of up to 1200 m.

FIGURE 3.18 SCHEMATIC DIAGRAM OF GEAR CONFIGURATION USED BY THE DEEP-SEA CRAB FISHERY

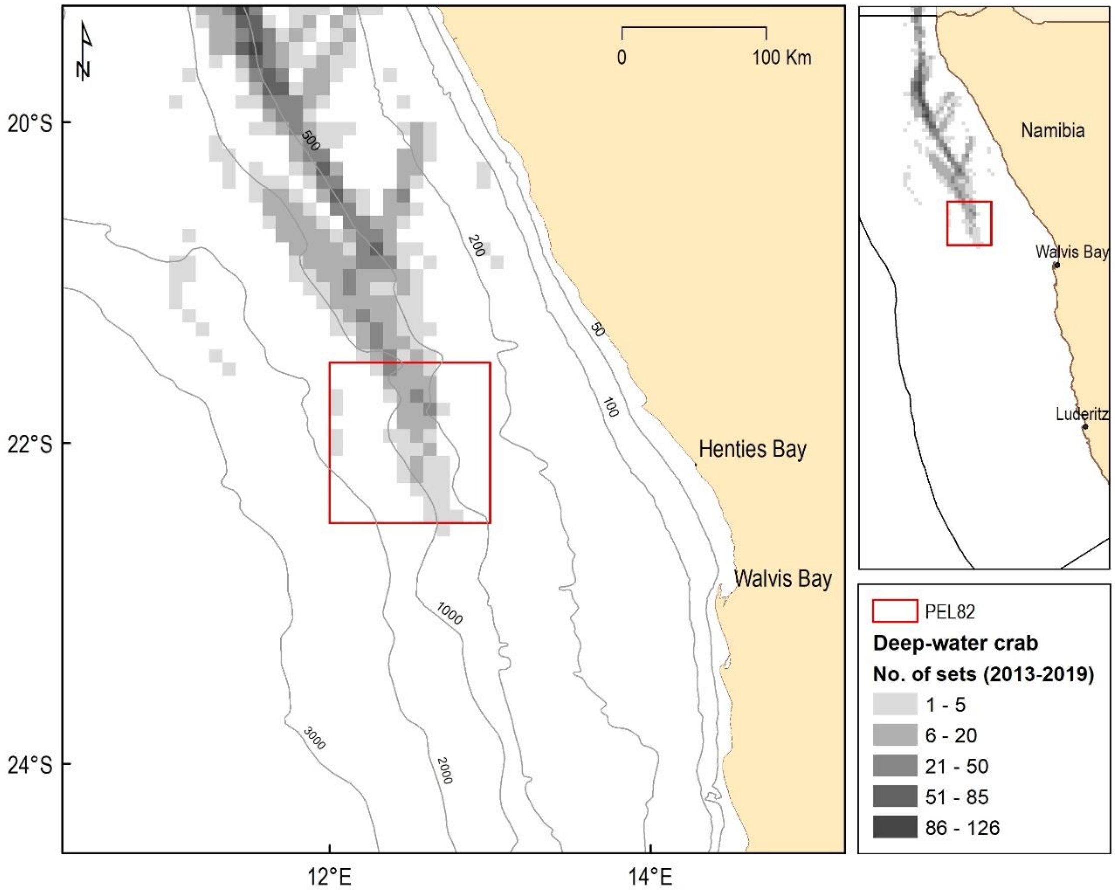


Source: SEAFO, 2018.

The distribution of commercial fishing effort by the deep-sea crab fishery in relation to PEL 82 is shown in Figure 3.19. The license area coincides with the southerly extent of fishing grounds where, during the period 2013 to 2019, an average of 49 lines were set per year. This is equivalent to 5.29% of the total effort expended by the sector at a national scale. Fishing activity within the license area took place across a depth range of 440 m to 1100 m. The average catch per unit effort within the license area was 4.9 kg[6].

[6] Data on the number of pots unavailable for current report.

FIGURE 3.19 SPATIAL DISTRIBUTION OF CATCH PER UNIT EFFORT REPORTED FOR THE DEEP-SEA CRAB FISHERY (2013 – 2019).

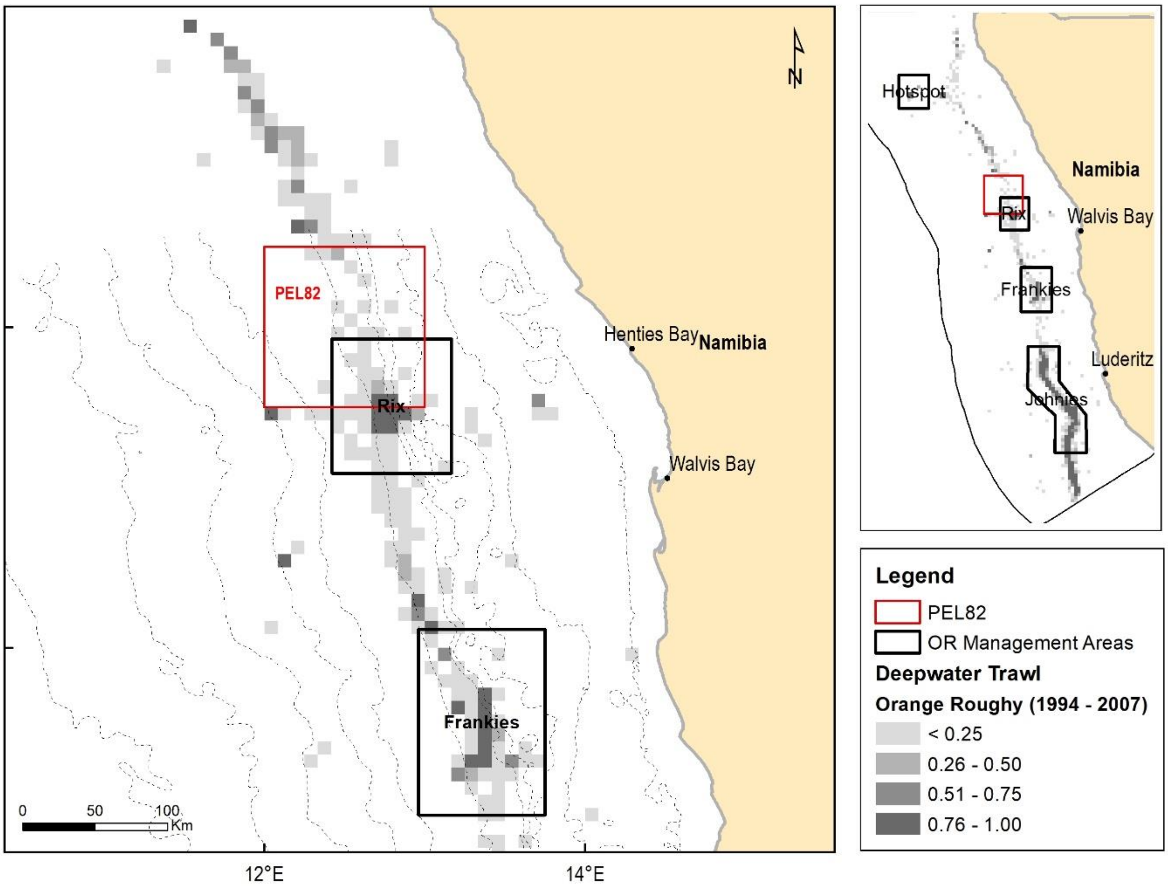


3.3.9 DEEP-WATER TRAWL

The deep-water trawl fishery is a small but lucrative fishing sector directed at the outer Namibian shelf from 400 m to 1500 m water depth targeting orange roughy (*Hoplostethus atlanticus*) and alfonsino (*Beryx splendens*). Both species are extremely long-lived and aggregate densely, leading to high catch rates. General aggregations of the stock occur between June and August. Fishable aggregations are usually found on hard grounds on features such as seamounts, drop-off features or canyons (Branch, 2001). Off Namibia, orange roughy has a restricted spawning period of less than a month in late July, when spawning takes place in dense aggregations close to the bottom in small areas typically between 10 and 100 km^2 in extent (Boyer and Hampton 2001). The fishery uses a similar gear configuration to that used by the demersal hake-directed trawl fishery. Alfonsino is taken primarily as a bycatch in the orange roughy fishery, although after the collapse of the orange roughy stock, the deep-water trawl boats continued to fish for alfonsino (which is a species more widely distributed than orange roughy and not as closely associated with bottom substrate). However, with the demise of the orange roughy, the economic incentives to fish in deep-water was lost and as a result alfonsino catches effectively stopped.

The fishery is split into four Quota Management Areas (QMA's) referred to as "Hotspot", "Rix", "Frankies" and "Johnies" (see Figure 3.20) and TACs are set for each specific QMA. The license area coincides with the QMA "Rix". The fishery has been closed since 2007; however, the stock is currently being assessed with a view to considering the viability of re-opening the fishery. Research surveys are undertaken in July each year by MFMR to assess the status of the resource.

FIGURE 3.20 MANAGEMENT AREAS USED BY THE DEEP-WATER TRAWL FISHERY IN RELATION TO PEL 82.



3.3.10 ROCK LOBSTER

The small but valuable fishery of rock lobster (*Jasus lalandii*) is based exclusively in the port of Lüderitz. The sector operates in water depths of between 10 and 80 m. Within Namibian waters, the lobster stock is commercially exploited between the Orange River border in the south to Easter Cliffs/Sylvia Hill north of Mercury Island (approximately 25°S). The fishery is spatially managed through the demarcation of catch grounds by management area.

The catch season is a six-month period with a closed period extending from 1 May to 31 October and highest activity levels are experienced over January and February. During the 2021/2022 fishing season 18 vessels were active in the fishery and the TAC was set at 180 tons. The full TAC was landed with a total effort of 61,477 trap-fish-days.

PEL 82 is situated at least 360 km from the northern-most extent of commercial fishing grounds and there is therefore no spatial overlap between the license area and the sector.

3.3.11 FISHERIES RESEARCH

MFMR conducts regular research (biomass) surveys for demersal, mid-water and small pelagic species. In some years the Benguela Current Commission may conduct "transboundary" surveys. Swept-area biomass surveys for hake are conducted annually to obtain an index of abundance, determine the geographical distribution and collect biological information of the stock. These surveys are normally carried out over the period of one month during January and February and cover the entire continental shelf from the Angolan to the South African maritime border. The method of abundance estimation from these surveys is based on depth stratification and trawls range in depth from 100 m to 600 m. During trawling the vessel tows the net for a period of 30 minutes at a speed of approximately 3 knots.

Scientific acoustic surveys are carried out between February and March each year to estimate the biomass of small pelagic species (using the survey vessel F/V *Welwitchia*). The vessel surveys along pre-determined transects that run perpendicular to depth contours (East-West / West-East direction). These surveys cover the Namibian shelf from the coastline to the 500 m depth contour (and up to the 2000 m contour northwards of 18°30´S).

4. IMPACT ASSESSMENT

This section presents the assessment for planned activities (refer to Section 4.1) and for unplanned events (refer to Section 4.2).

4.1 ASSESSMENT OF PLANNED ACTIVITIES (NORMAL OPERATIONS)

The assessment of planned activities is presented for each project phase (refer to Sections 4.1.1 and 4.1.2), as well as for potential cumulative impacts (refer to Section 4.1.3).

4.1.1 DRILLING PHASE

4.1.1.1 DISPLACEMENT OF FISHING VESSELS

Impact Description

According to the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part B, Section II, Rule 18), a drillship involved in underwater operations is classified as a "vessel restricted in its ability to manoeuvre." This classification mandates that power-driven and sailing vessels must yield to such a vessel. Additionally, fishing vessels are required to avoid interfering with the well drilling operations as much as possible.

During the drilling operations, there will be a temporary exclusion zone of minimum 500 m around the drillship (0.785 km^2 or 78.5 ha), which will be enforced by a standby vessel. The operator may request a larger navigational safety zone of 2 Nm (3.7 km) around the drillship which would result in an exclusion area of 43 km^2. The navigational safety zone would be communicated as a navigational warning via SANHO. All unauthorised vessels would be requested to stay clear of the navigational safety zone for the duration of the drilling operations.

The temporary exclusion of fisheries from the navigational safety zone could result in the displacement of fishing effort into alternative areas or, if no alternative areas are available, the loss of catch (direct negative impact).

Several fisheries sectors operate on a regular basis within the PEL 82 area; namely demersal trawl (hake and monk-directed), mid-water trawl, large pelagic longline, demersal longline and deep-sea crab. Table 4-1 lists the proportion of catch taken by each sector within the license area[7] and within the indicative exclusion zones. Since the exact well locations are currently unknown and could be located anywhere within the license area, the worst-case scenario presented above assumes the drilling unit is centred in the most heavily fished area within the license area.

[7] Note that the exclusion zone will not impact the entire license area at any one time, only the area around the drillship.

TABLE 4-1 SUMMARY OF PROPORTIONAL CATCH AND EFFORT, BY FISHING SECTOR, WITHIN PEL 82, THE 500 M EXCLUSION ZONE AND 2 NM (3700 M) NAVIGATIONAL SAFETY ZONES.

Sector	Percentage (%) of Total Catch		
	Within PEL 82	Within 500 m exclusion zone	Within 3700 m navigational safety zone
Large Pelagic Longline	2.46	<0.01	1.18[8]
Small Pelagic Purse-Seine	0	0	0
Midwater Trawl	0.98	<0.01	0.14
Demersal Trawl	3.7	<0.01	0.15
Demersal Longline	17.09	<0.01	1.01
Tuna Pole-Line	0	0	0
Linefish	<0.1	0	0
Deep-sea Crab	5.29[9]	<0.01	0.37
Deep-water Trawl	0	0	0
Rock Lobster	0	0	0

Impact Assessment

The navigational safety zone around the drillship will present a direct impact on fishing activity. Fishing operations will be precluded within this area resulting in an area of influence of between 0.785 km^2 (500 m radius) and 43 km^2 (2 Nm radius). The potential impact is considered to be local in extent. It is understood that potentially up to 10 wells may be drilled over a 3 to 5 year period and would not be drilled simultaneously. The potential impact is considered to be of short-term duration (up to 90 days per well) to medium-term duration (over the 3 to 5 year cumulative period) and fully reversible (ends once the drillship moves off location after the well has been plugged and abandoned). The probability of the impact materialising is considered likely.

The following fisheries sectors routinely operate within the license area; large pelagic purse-seine, demersal longline, demersal trawl and deep-water trawl. Midwater trawl and tuna pole-line vessels operate less frequently in the area. The scale of the potential impact (measured as percentage of total catch taken within an indicative navigational safety zone around the drillship) is expected to be higher for the longline sectors (~1.2% for large pelagic longline, ~1% for demersal hake longline, ~0.4% for deep-sea crab) than the trawl sectors (~0.2% for midwater trawl and demersal trawl). The assessment of the following sectors shows no evidence of recent operations within PEL 82: small pelagic purse-seine, tuna pole-line, linefish, deep-water trawl (fishery has been closed since 2007) and rock lobster. Refer to section 3.3 for a description of the areas of operation for each of these sectors.

8 Due to the large area covered by drifting pelagic long-line gear, fishing operations could potentially be affected beyond the limits of a 500 m exclusion zone. A pelagic long-line vessel would realistically not be able to deploy gear within a distance of approximately 50 km of a drillship. The area of impact has been raised accordingly for this sector.

9 Percentage effort was used for deep-sea crab sector as catch data unavailable for the current report.

The displacement of fishing activity is expected to result in a minor disruption to normal fishing operations as the overlap is low for all affected sectors. Due to the short-term duration (90 days per well, with a maximum of four wells per year over 3 to 5 years) the potential impact is considered to be of small to small magnitude. It is likely that affected sectors would be able to redirect fishing effort to alternative locations for the duration of well-drilling activities. The sensitivity of each fishery is regarded as its ability to adapt to change. In the event that fishing vessels can plan to avoid the area and continue operations elsewhere, the sensitivity of the sector would be rated as low. Based on the small impact magnitude and low sensitivity of the affected fishery sectors, the potential impact is assessed to be of overall minor significance (refer to Table 4-2).

TABLE 4-2 POTENTIAL IMPACT OF EXCLUSION OF FISHING FROM SAFETY NAVIGATIONAL ZONE

Characteristic	Without Mitigation	With Mitigation (Residual Impact)
Type	Direct - Impacts that result from a direct interaction between the project and fishing operations	Direct
Duration and Reversibility	Short term - 90 days per well, with a maximum of four wells per year over 3 to 5 years Fully reversible – The navigational safety zone will be lifted once the drillship moves off location during demobilisation.	Short term Fully reversible
Probability/ Likelihood	Likely – the impact is expected to occur on the following sectors: • Large pelagic longline • Demersal longline • Deepsea crab • Demersal trawl • Midwater trawl	Likely
Extent	Local - Impacts that are limited to the project site and adjacent areas (up to a distance of 2 Nm from the drilling location; 43 km^2).	Local
Scale	The proportion of catch taken within area of influence (the “size of the impact”; see Table 4.1): • Large pelagic longline 1.18% • Demersal longline 1.01% • Deep-sea crab 0.37% • Demersal trawl 0.15% • Midwater trawl 0.14%	
Irreplaceable loss of resources	Fishing vessels can plan to avoid the area and continue operations elsewhere.	Low – Fully Reversible
Magnitude	Small. Localized, short-term, minor change to fishing operations/minor to moderate disruption in access. Reversible.	Small

Characteristic	Without Mitigation	With Mitigation (Residual Impact)
Sensitivity	Low - The impact is not expected to result in permanent loss (i.e. fully reversible)	Low
Significance	Minor - Inconvenient operational impacts that last 90 days per well and/or are reversible	Minor

Mitigation Measures

The potential for mitigation includes effective communications with fishing sectors which could allow vessel operators the opportunity to plan fishing operations in areas unaffected by the presence of the drillship. Thus, it may be possible for operators to relocate fishing effort into alternative areas if adequate information is provided ahead of the project. Recommended mitigation measures are listed in Table 4-3.

TABLE 4-3 RECOMMENDED MEASURES TO MITIGATE THE POTENTIAL IMPACT OF TEMPORARY EXCLUSION OF FISHING OPERATIONS.

No	Mitigation Measure	Classification
1	Distribute a Notice to Mariners to key stakeholders prior to the well-drilling operations 3 weeks prior to operations and on completion of the campaign. Stakeholders include the relevant fishing industry associations: Confederation of Namibian Fishing Association and Namibian Hake Association, Namibian Crab Association / Taiyo Namibia (Pty) Ltd, Midwater Trawling Association, Large Pelagic and Hake Longlining Association of Namibia. Other key stakeholders: Directorate of Maritime Affairs, South African Navy Hydrographic Office (SANHO), Namibian Ports Authority and the MFMR Monitoring, Control and Surveillance Unit in Walvis Bay (Vessel Monitoring System).	Avoid / Reduce at source
2	Request, in writing, SANHO to broadcast a navigational warning via Navigational Telex (Navtext) and navigational warnings twice daily on Channel 16 VHF.	Avoid
3	Manage the lighting on the drilling unit and support vessels to make sure that it is sufficiently illuminated to be visible to fishing vessels and compatible with safe operations.	Abate on site
4	Notify fishing vessels at a radar range <24 Nm from the drillship via radio regarding the safety requirements around the drillship. If possible, transmit/broadcast the virtual safety navigational zone surrounding the rig on the AIS system, so nearby vessels will see not only the vessel location but also the restricted zone surrounding the vessel on their AIS displays.	Abate on site
5	Implement a grievance mechanism that allows stakeholders to register specific grievances related to operations; by ensuring they are informed about the process and that resources are mobilised to manage the resolution of all grievances, in accordance with the Grievance Management procedure.	Abate on site/Abate offsite

4.1.1.2 UNDERWATER RADIATED NOISE

Impact Description

The project activities that will generate an increase in underwater noise include the operation of the drillship and support vessels at the drill site, the transit of support/supply vessels between the drilling unit and port, and Vertical Seismic Profiling (VSP) which may be undertaken during wireline testing of the well-bore.

Exposure to high sound levels can result in physiological injury to marine fauna through a number of avenues, including shifts of hearing thresholds (as either permanent (PTS) or temporary threshold shifts (TTS), tissue damage and non-auditory physiological effects as well as behavioural effects in marine animals, including fish.

In order to assess the potential noise impacts on fish, an Underwater Sound Transmission Loss Modelling (STLM) study was undertaken to determine the potential zones of impact for relevant fish species of concern for the major noise sources associated with the potential drilling programme (ERM, 2025). The results from this study, which are summarised in Section 2.7.1, were used to inform the below assessment.

The assessment assumes that the drilling contractor will make sure that the potential project is undertaken in a manner consistent with good international industry practice and Best Available Techniques (BAT).

For this assessment, underwater noise is separated into non-impulsive and impulsive noise. Non-impulsive noises are typically continuous and produce sounds that can be narrowband, or tonal, and brief or prolonged. It does not have the high peak sound pressure with rapid rise time typical of impulsive sounds (e.g., drilling and vessel engines). Impulsive noises are typically very short (in seconds), broadband and have high peak pressure with rapid time and decay back to ambient levels (e.g., noise from vertical seismic profiling).

Table 4-4 presents the relevant effects thresholds set out by Popper *et al*. 2014, for drilling and continuous noise. The guidelines define quantitative thresholds for three effects: mortality and potential mortal injury, recoverable injury and TTS.

TABLE 4-4 CRITERIA FOR ONSET OF INJURY TO FISH DUE TO CONTINUOUS SOUND

Type of Animal	Mortality and potential mortal Injury	Recoverable Injury	TTS
Fish: no swim bladder (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low
Fish: swim bladder is not involved in hearing (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low
Fish: swim bladder involved in hearing (primarily pressure detection)	(N) Low (I) Low (F) Low	170 dB RMS for 48h	158 dB RMS for 12h
Eggs and larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low
Notes: RMS sound pressure levels dB re 1 μPa. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high,			

Type of Animal	Mortality and potential mortal Injury	Recoverable Injury	TTS
moderate, low) is given for animals at three distances from the source defined as near (N), intermediate (I), and far (F).			

Source: Popper *et al.* 2014

The injury criteria adopted for impulsive noise sources in this assessment are shown in Table 4-5.

TABLE 4-5 ADOPTED CRITERIA FOR INJURY FOR FISH DUE TO IMPULSIVE SOUND

Type of Animal	Mortality and Potential Mortal Injury	Recoverable Injury (TTS)
Fish: no swim bladder (particle motion detection)	>219 dB SELcum or >213 dB Peak	>216 dB SELcum or >213 dB Peak
Fish: swim bladder not involved in hearing (particle motion)	210 SELcum or >207 dB Peak	203 dB SELcum or >207 dB Peak
Fish: swim bladder involved in hearing (primary pressure detection) juveniles and eggs	207 SELcum or >207 dB Peak	203 dB SELcum or >207 dB Peak
Fish: Eggs and Larvae	210 SELcum or >207 dB Peak	(N/A – moderate potential near to source)

Source: Popper et al 2014.

Non-Impulsive underwater noise

Non-impulsive underwater noise related to this project includes mobilisation, operation and demobilisation of the drilling unit and support vessels.

Given the shipping traffic in PEL 82, the ambient noise levels are expected to be at most 10 dB higher than the lowest level, within 90 and 120 dB re 1 µPa for the 10-10 kHz frequency range.

The presence and operation of the drilling unit and support vessels during transit to the drill site, during drilling activities on site, and during demobilisation will introduce a range of underwater noises into the surrounding water column that may potentially contribute to and/or exceed ambient noise levels in the area. The noise emissions from the drillship are predominantly generated by propeller and thruster cavitation especially when the dynamic-positioning system is operating, with a smaller fraction of sound produced by transmission through the hull, such as by engines, gearing, and other mechanical systems. For non-impulsive drilling noise, it is assumed that the source SEL levels are equivalent to their corresponding RMS SPL source levels, considering the consistency and longer durations of the typical continuous drilling noise emissions. The overall noise level from combined noise emissions from drillship and four support vessels is approximately 202 dB re 1 *µ*Pa @ 1 m RMS. The noise generated by the drillship and support vessels, thus would be audible for considerable ranges before attenuating to below threshold levels.

The noise exposure criteria provided by Popper *et al.* (2014) and the modelling results are summarised in Section 2.7.1. Based on the results of the STLM study, predicted RMS levels show the criterion for recoverable injury (170 dB re 1 µPa RMS for 48 hours) will be met at distances within 0.1 km from the source, for both drilling locations. The TTS criterion (158 dB re 1 µPa RMS for 12 hours), will be met at distances less than 0.4 km from both the drilling locations. The potential behavioural impact zones for fish (150 dB re 1 μPa RMS) are predicted at distances up to 1 km from both drilling locations. Potential behavioural responses include moving away from the noise source and may involve a change in activity state (e.g. feeding, travelling).

Impulsive underwater noise

Impulsive underwater noise related to this project includes vertical seismic profiling (VSP). This activity may be undertaken (in the event that hydrocarbons are discovered) during logging and testing of the well (after drilling has been completed). The source levels for the VSP G-Gun array show the Peak level to be 242 dB re 1 μPa at 1 m, the RMS 230 dB re 1 μPa at 1 m, and the SEL 221 dB re $\mu Pa^2 \cdot s$ at 1 m.

The signal from VSP operations is highly directional in the downward vertical direction to make sure adequate seabed penetration for optimal seismic data acquisition. As a result, levels of underwater sound transmitted in the horizontal plane is less than an omni-directional source of equivalent source level (such as underwater noise generated from thrusters used for dynamic positioning systems in offshore drilling operations).

PTS-onset and TTS-onset thresholds differ between impulsive and non-impulsive noise. Peak sound pressure levels for impulsive noise resulting in mortality or potential mortal injury for fish eggs and larvae, and fish range from 207 - 213 dB re 1 μPa, with TSS in fish occurring at cumulative sound exposure levels of above 186 dB re 1 $\mu Pa^2 \cdot s$.

The greatest risk of physiological injury from VSP sound sources is for species with swim-bladders (e.g. hake and other demersal species targeted by demersal longline and demersal trawl fisheries, small pelagic species targeted by the midwater and purse-seine fisheries). In many of the large pelagic species, the swim-bladders are either underdeveloped or absent, and the risk of physiological injury through damage of this organ is therefore lower (Pisces, 2024). Although the risk of mortality or permanent injury is lower than that of the former group, fish without swim bladders are still at risk at close range to impulsive sounds for TTS, behavioural changes and masking effects (Popper et al., 2014). Fish without swim bladders and crustaceans are less susceptible to noise-induced reaction on behaviour than fish with swim bladders. However, two of the four tuna species targeted by the pelagic longline and pole-line fisheries, *Thunnus albacares* (yellowfin tuna) and *T. obesus* (bigeye tuna), do have swim bladders (Collette and Nauen 1983) and so may be physically vulnerable. As most targeted fish species likely to be encountered within the license area are highly mobile, they would be expected to move away from the sound source before trauma could occur. However, this assessment is based on the assumption of the worst-case scenario that the animal does not move away from the noise source.

The largest zone of potential impact[10] from cumulative exposure (2-hour and 24-hour exposure) causing physical injury or impairment was < 100 m both for fish with and without swim bladders. The potential behavioural[11] impact zones for fish (150 dB re 1 μPa RMS) are predicted at distances up to 0.4 km from the source at both of the well locations.

[10] Maximum horizontal distance from source to edge of impact zone

[11] Behavioural responses vary but may include leaving the area of the noise source, changes in vertical and horizontal distribution, activity level and schooling behaviour.

As shown in Table 4-1, the levels of fishing activity for all overlapping sectors within similar distances are low.

Impact Assessment

The potential impact is considered to be of short-term duration (up to 90 days per well for non-impulsive underwater noise and up to 24-hours per well for VSP operations) and fully reversible (ends once the drillship moves off location after the well has been plugged and abandoned). The probability of the impact materialising is considered likely.

Based on the underwater noise modelling, behavioural disturbance to fish due to non-impulsive noise (i.e. drilling and vessel presence) may occur within a 1 km radius of the drillship. This results in an potential impact zone of approximately 3 km^2. The potential impact is therefore considered to be local in extent. The direct area of influence falls within the effective navigational safety zone for the sectors that operate within PEL 82 i.e. pelagic longline, demersal trawl, demersal longline, midwater trawl and deep-sea crab (refer to section 4.1.1.1). The noise-induced behavioural disturbance of fish is considered a minor disruption as the overlap is low for all affected sectors and the area of influence falls within the vessel exclusion zone. Consequently, the potential impact is considered to be of small magnitude. It is likely that affected sectors would be able to redirect fishing effort to alternative locations for the duration of well-drilling activities. The sensitivity of each fishery is regarded as its ability to adapt to change. In the event that fishing vessels can plan to avoid the area and continue operations elsewhere, the sensitivity of the sector would be rated as low. Given the small impact magnitude and low sensitivity of the affected fisheries, the potential impact is considered minor before mitigation and incidental after mitigation.

TABLE 4-6 POTENTIAL IMPACT OF UNDERWATER RADIATED NOISE ON FISHING OPERATIONS

Characteristic	Without Mitigation	With Mitigation (Residual Impact)
Type	Direct - Impacts that result from a direct interaction between the project and fishing operations	Direct
Duration and Reversibility	Short term - Impacts last for up to four months per well. Localized, low intensity and fully reversible. Fully reversible – The navigational safety zone will be lifted once the drillship moves off location during demobilisation.	Short term Fully reversible
Probability/ Likelihood	Likely – the impact is expected to occur on the following sectors: • Large pelagic longline • Demersal longline • Deepsea crab • Demersal trawl • Midwater trawl	Likely
Extent	Local - Impacts that are limited to a distance of <1 km (non-impulsive noise) and <0.4 km (impulsive noise) from the drillship.	Local

Characteristic	Without Mitigation	With Mitigation (Residual Impact)
Scale	The proportion of catch taken within area of influence (the "size of the impact"; see Table 4.1): • Large pelagic longline <0.01% • Demersal longline <0.01% • Deep-sea crab <0.01% • Demersal trawl <0.01% • Midwater trawl <0.01%	
Irreplaceable loss of resources	Fishing vessels can plan to avoid the area and continue operations elsewhere.	Low – Fully Reversible
Magnitude	Small – Localized, short-term, minor change to fishing operations/minor disruption in access. Reversible within months	Negligible
Sensitivity	Low - The impact is not expected to result in permanent loss (i.e. fully reversible)	Low
Significance	Minor - Inconvenient operational impacts that are short-term and reversible	Incidental

Mitigation

The mitigation measures listed in Section 4.1.1.1 will make sure that the fisheries sectors are aware of the drilling operations and are able to redirect fishing activity in alternative areas. In addition, it is recommended that soft-start procedures be implemented during operation of VSP (see Table 4-7).

TABLE 4-7 RECOMMENDED MEASURES TO MITIGATE THE POTENTIAL IMPACT OF UNDERWATER RADIATED NOISE ON FISHING OPERATIONS

No	Mitigation Measure	Classification
1	Soft start procedures: Gun test followed by full VSP logging phase: acoustic source must be initiated at the lowest power setting, with gradual ramp-up of the acoustic source over a 20-minute period until the full operating power level is reached. For single gun tests prior to VSP logging phase: If a gun test will be less than 20-minutes in duration, a soft start procedure of equal time duration must be followed (e.g. a 10-min gun test should be preceded with a 10-min soft start only). Operating procedures: whilst the VSP acoustic source is operating, both during soft start procedures and survey operations, the acoustic source must be shut down if mass mortality of fish species is sighted.	Abate on site

4.1.1.3 DRILLING DISCHARGES

Impact Description

Drill cuttings and adhered mud discharges will create a footprint on the seabed. The deposition of cuttings and adhered muds may result in physical damage and habitat loss or disruption over a defined area of the seabed. Excessive burial by drilling mud and cuttings may cause some benthic organisms to be immobilized and smothered. The potential severity of burial impacts depends on the sensitivity of the benthic organism, thickness of deposition, amount of oxygen-depleting material, and duration of the burial. The results of the drill cuttings discharge modelling predict deposition of cuttings and muds thickness greater than 6.3 mm predominantly within 50 m radius of the Gemsbok Well location (Block 2112B) and a 500 m radius of the a potential second well location (Block 2212A).

Increases in the concentration of TSS will occur due to discharges of drill cuttings and muds. The highest concentration increases will exist at the point of discharge and decrease over time and distance, as the suspended solids plume dissipates and settles. Larger particles will settle out more quickly than fine particles, such that a TSS plume of tiny particles may linger and travel farther than plumes of larger grain sizes. As such, elevated TSS concentrations may form in regions where tiny, suspended particles linger in cloud form and mix with subsequent discharges. Increases in TSS may decrease water clarity and clog fish gills.

Cuttings containing NADF will be treated through the onboard systems (shakers and dryers). The NABF portion of the NADF that remains will be reduced to minimize base fluid retention on cuttings (average, by mass). These NABF made of hydrocarbons, once settled to the seabed, degrade over time, and may enter the pore water within the sediments or become dissolved in the water column, depending on each specific hydrocarbon’s tendency to remain partitioned to the solids.

Potential impacts related to the hydrocarbons are typically related to aromatics. The NABF to be used is assumed to be considered “low toxicity” due to the very low percentage of aromatics within the hydrocarbon mixture. Low toxicity Group III NABF (as defined by the International Association of Oil and Gas Producers, OGP 2003) includes fluids produced by chemical reactions and highly refined mineral oils that contain levels of total aromatics below 0.5 percent and total polycyclic aromatic hydrocarbon (PAH) levels below 0.001 percent (Sanzone et al. 2016). Although low toxicity, other potential impacts may occur as the hydrocarbons degrade and consume dissolved oxygen in the sediments. Dissolved oxygen in the overlying water column can replenish the deficit.

TSS concentrations exceeded the 35 mg/L threshold criterion near the seabed for both wells. However, the TSS concentration near the water surface did not exceed the 35 mg/L threshold during any of the four scenarios for either well location. The areas where TSS exceeds the 35 mg/L threshold for Gemsbok Well (in Block 2112B) are smaller compared to the respective areas for the potential second well (in Block 2212A) in their respective scenarios

Impact Assessment

The effects of sediment deposition at the seabed extend to potential smothering of benthic communities and associated trophic level cascade effects which could affect normal feeding patterns of certain fish species. Benthic and demersal species that spawn, lay eggs or have juvenile life stages dependent on the seafloor habitat may be negatively affected by the smothering effects of drill cuttings. The major fish spawning areas occur further inshore on the shelf; however there is minor overlap of PEL 82 with the spawning distributions of hake, monk and orange roughy, therefore they these resources may be susceptible to disturbance by depositional footprints from drill cuttings.

It is unlikely that the distribution and abundance of commercial fish species will be significantly impacted by the deposition of well drill cuttings during this project except in the immediate area. The increase in water turbidity (resulting from the suspension of fine particulate matter) could lead to avoidance behaviour by fish. The magnitude of the impact on fishing in and adjacent to PEL 82 is considered Small.

Drilling operations are expected to last approximately 90 days per well, with around 21 days allocated for drilling and discharge activities. Up to 10 wells may be drilled over a period of 3 to 5 years, and as a result, the impact duration is classified as short-term. The risks associated with the water column are temporary, generally persisting for only a few days as TSS are likely to disperse quickly due to prevailing currents.

The direct area of influence was determined through drill cuttings discharge modelling (refer to Section 2.7.2). The results demonstrate that the deposition footprint is primarily confined within a 50 m radius of the Gemsbok Well in Block 2112B and within a 500 m radius of the potential second well in Block 2212A. Therefore, the potential impact is considered to be local in scope.

The modelling results predict differences in the extent of the depositional areas according to season (see section 2.7.2). However the timing of drilling activities to avoid taking place during certain seasons is only considered significant in Block 2212A which shows the largest footprint for depositional thickness during March.

Based on the impact magnitude and receptor sensitivity, the potential impact on fisheries is assessed to be of minor significance (refer to Table 4-8).

TABLE 4-8 POTENTIAL IMPACT OF THE ACCUMULATION OF CEMENT AND DRILL CUTTINGS DISCHARGED DURING WELL-DRILLING

Characteristic	Without Mitigation	With Mitigation (Residual Impact)
Type	Indirect - Impacts that follow on from the direct interactions between the project and its environment as a result of subsequent interactions within the environment (e.g. viability of a species population resulting from loss of part of a habitat as a result of the project occupying the seabed).	Indirect
Duration and Reversibility	Short term - Impacts last for up to four months per well. Localized, low intensity and fully reversible.	Short term
Probability/ Likelihood	Occasional - Conditions may allow the impact to occur on the following demersal sectors: • Demersal longline • Deepsea crab • Demersal trawl	Occasional
Extent	Local - Impacts that are limited to a distance of <500 m (2212A) and <50 m (2112B)	Local
Scale	The proportion of catch taken within area of influence (the "size of the impact"): • Demersal longline <0.01% • Deep-sea crab <0.01% • Demersal trawl <0.01%	

Characteristic	Without Mitigation	With Mitigation (Residual Impact)
Irreplaceable loss of resources	Low	Low
Magnitude	Small - Localized, short-term, minor changes in ecosystem components	Small
Sensitivity	Low - The impact is not expected to result in permanent loss (i.e. fully reversible)	Low
Significance	Minor - Inconvenient operational impacts that last less than one year and/or are reversible	Minor

Mitigation Measures

The following measures are recommended to reduce the toxicity and bioaccumulation effects on marine fauna (Table 4-9), which indirectly affects fishing.

TABLE 4-9 RECOMMENDED MEASURES TO MITIGATE THE POTENTIAL IMPACTS OF THE ACCUMULATION OF CEMENT AND DRILL CUTTINGS DISCHARGED DURING WELL-DRILLING

No	Mitigation Measure	Classification
1	• Conduct careful design of pre-drilling site surveys to collect sufficient information on seabed habitats, including mapping of sensitive and potentially vulnerable habitats within 500 m of a potential well site, aiming to select level areas for spudding and well head installation. • If sensitive habitats (such as hard grounds), sensitive species (e.g., cold-water corals, sponges), or significant structural features are detected, adjust the well position to beyond 500 m, or implement technologies, procedures, and monitoring to reduce risks and assess potential damage.	Avoid/reduce at source
2	Careful selection of drilling fluid additives taking into account their concentration, toxicity, bioavailability and bioaccumulation potential; Use only, PLONOR (Pose Little Or No Risk) chemicals, low-toxicity, low bioaccumulation potential and partially biodegradable additives are used, where practicable. Maintain a full register of Safety Data Sheets (SDSs) for all chemical used, as well as a precise log file of their use and discharge.	Avoid/reduce at source
3	If NADFs are used for drilling the risered sections, conduct regular maintenance of the onboard solids control package and avoid inappropriate discharge of NADF cuttings	Abate on site
4	Monitoring requirements: • Test drill cuttings daily for retained oil content to check specified discharge standards are maintained (average residual oil on cuttings <6.9%) at the end of the well. • Test barite for heavy impurities prior to mixing barite on location. • Test any other discharged fluids for visible oil contamination (static sheen). • Where practical, monitor sediment deposition and hydrocarbon concentrations. • Monitor cement returns with an ROV and stop cement pumping if significant discharges are detected on the seafloor. Monitor (using ROV) hole wash out to reduce discharge of fluids, as far as possible.	Reduce at source / abate on site

4.1.2 DEMOBILISATION PHASE

4.1.2.1 REDUCED FISHING GROUNDS

Impact Description

The project activities that are likely to cause reduction in fishing grounds could arise during the demobilisation phase of the Project. The direct area of influence would be the navigational safety zone around abandoned wellheads. Once installed, the wellhead locations would be marked onto navigational charts as a navigational hazard. Where abandoned wellheads coincide with trawl grounds, they would be fitted with an over-trawlable abandonment cap to minimise the risk of damage to demersal trawl gear. Demersal trawlers may not tow nets along the seabed (no anchoring or trawling) within a radius of 500 m from wellheads. Fishing operations would be precluded within this area resulting in an area of influence of 0.785 km^2 per well and up to 7.85 km^2 for up to 10 wells. The exclusion zone will not apply to fisheries that do not tow nets along the seabed (ie surface or mid-water fishing operations).

A trawler would be required to avoid, circumnavigate, or “fly” its gear so as to avoid contact with the wellhead – this refers to shortening the trawl warps and hauling the gear up off the ground until clear of the obstruction. Precision placement of the gear is possible even at depth due to the sensors attached to the gear. Therefore, the potential impact to fisheries would equate to exclusion from fishing ground and an associated loss in catch over the time that gear is lifted off the seabed. In the event that several wellheads or other obstructions are present in close proximity, there is the potential of a cumulative impact where the ground between the exclusion zones may become unfishable due to the distance required to raise and lower fishing gear.

Impact Assessment

The potential impact is considered to be local in extent both for a single wellhead and for the cumulative effect of up to 10 wellheads. The duration of the impact (to demersal trawl only) would be long-term. The exclusion zone would not apply to fisheries that do not tow nets along the seabed. The demersal trawl sector operates within PEL 82 between the 200 m and 780 m seabed contours where nets are towed along depth contours i.e. in a north/south or south/north direction. Considering wellhead abandonment, the impact would be limited to the immediate area of the wellhead/s and the cumulative exclusion areas for up to 10 wellheads could affect up to 0.09% of fishing grounds / catch (Table 4-10). Due to the proximity of PEL 82 to the port of Walvis Bay, vessels frequently operate within the area and the avoidance of obstructions and lifting nets up over multiple wellheads along trawling lanes may cause disruption to normal fishing operations. Localized, long-term, minor disruption to fishing operations could lead to an impact of small to medium magnitude and overall minor significance, given the medium sensitivity of the sector.

There would be no expected potential impact on the sector in areas where the seabed depth exceeds 800 m.

TABLE 4-10 SUMMARY OF PROPORTIONAL CATCH FOR THE DEMERSAL TRAWL SECTOR WITHIN PEL 82, THE EXCLUSION ZONES FOR A SINGLE WELLHEAD AND UP TO 10 WELLHEADS.

Sector	Percentage (%) of Total Catch		
	Within PEL 82	Within 500 m exclusion zone (per well)	Within 500 m exclusion zone (10 wells)
Demersal Trawl	3.7	<0.01	0.09

TABLE 4-11 POTENTIAL IMPACT OF REDUCED FISHING GROUNDS

Characteristic	Without Mitigation	With Mitigation (Residual Impact)
Type	Direct - Impacts that result from a direct interaction between the project and fishing operations	Direct
Duration and Reversibility	Long term -Impact lasts more than three years and less than ten years. Reversible but may require significant effort.	Not Reversible assuming worst-case scenario (wellheads not removed).
Probability/ Likelihood	Likely – the impact is expected to occur on the following sectors: • Demersal trawl	Likely
Extent	Local - Impacts that are limited to the project site and adjacent areas. Exclusion distance of 500 m from well (0.785 km^2 per well and up to 7.85 km^2 cumulative for 10 wells).	Local
Scale	The proportion of catch taken within area of influence (the “size of the impact”; see Table 4.10): • Demersal trawl 0.01 – 0.09%	
Irreplaceable loss of resources	Wellheads present an obstruction to trawling resulting in a low to moderate risk of irreplaceable loss of resource. Fishing vessels can avoid exclusion zone and continue operations elsewhere.	Low to Moderate
Magnitude	Small to Medium – Localized, long-term, minor change to fishing operations/minor disruption in access.	Small to Medium
Sensitivity	Low to Medium – Low to Moderate risk of irreplaceable loss of resource	Low to Medium
Significance	Minor	Minor

Mitigation Measures

In-built control measures (Table 4-12):- The position of abandoned wellheads would be charted as a navigational hazard. Where abandoned wellheads coincide with trawl grounds, they would be fitted with an over-trawlable[12] abandonment cap to minimise the risk of damage to demersal trawl gear. Avoidance of the wellheads by trawl operators would be necessary despite the placement of abandonment caps.

It is recommended that CNEL consult with the trawling industry regarding removal of wellheads that are situated in priority fishing lanes.

TABLE 4-12 RECOMMENDED MEASURES TO MITIGATE THE POTENTIAL IMPACT OF REDUCED FISHING GROUND.

No	Mitigation Measure	Classification
1	Abandoned well location must be surveyed and accurately charted. If indicated, fit wellheads (in water depth less than 800 m) with an over-trawlable structure to minimise the risk of damage to demersal trawl gear, as well as potential damage to the wellheads.	Avoid/reduce at source
2	Removal of wellheads: Consultation with the trawling industry should wellheads coincide with trawling grounds	Avoid/reduce at source

4.1.3 PLANNED OPERATIONS: CUMULATIVE IMPACTS

The potential impacts arising during planned operations have been identified as 1) temporary 500 m exclusion zone and wider 3 700 m safety zone around drilling unit; 2) presence of subsea infrastructure - permanent exclusion around wellheads (up to 10 wellheads) on the seafloor; 3) release of drill cuttings into the marine environment and 4) the generation of underwater noise during drilling and VSP. Each of these potential impacts have been rated as being of Minor Significance. The sum of these potential impacts may result in a cumulative effect when impacts are additive or sequential. During the drilling phase of the project, the results of modelling assessments show that the areas of influence of underwater noise and drilling discharges fall within (i.e. do not exceed) the navigational safety zone at the drilling location. Therefore the potential impacts during the drilling phase would not be expected to be additive or sequential, and would be rated as being of overall Minor Significance and reversible. The potential impact relating to the well abandonment (up to 10 wellheads), which present an obstruction to bottom trawling activities, is considered to be a long-term impact of minor to moderate significance. The potential cumulative impact arising from planned operations is therefore considered to be of overall minor to moderate significance (Table 4-13).

TABLE 4-13 SUMMARY TABLE LISTING POTENTIAL IMPACT SIGNIFICANCE OF PLANNED ACTIVITIES ON FISHERIES

Potential impact	Initial Significance	Residual Significance
Drilling Phase		
Temporary Safety Zone around Drillship	Minor	Minor
Discharge of Drill Cuttings	Minor	Minor
Underwater Radiated Noise – Drilling and Vessel Operations	Minor	Incidental
Underwater Radiated Noise - VSP	Minor	Incidental

[12] The term over-trawlable does not mean that fishing would continue uninterrupted. Trawlers would avoid contact with the wellhead/abandonment cap to minimise risk of damage to trawl gear.

Potential impact	Initial Significance	Residual Significance
Demobilization Phase		
Subsea Infrastructure – Permanent exclusion to trawling around wellheads (up to 10)	Minor	Minor

4.2 ASSESSMENT OF UNPLANNED EVENTS

4.2.1 WELL LOSS OF CONTAINMENT EVENTS

Impact Description

The greatest environmental threat from offshore drilling operations is the risk of a major spill of crude oil occurring either from a well loss of containment (LOC) event. It is the uncontrolled release of crude oil and/or natural gas from a well after pressure control systems have failed.

As per the project description, the drilling contractor will make sure that the potential drilling campaign is undertaken in a manner consistent with good international industry practice and BAT.

The primary safeguard against a well loss of containment event during well-drilling is the column of drilling fluid in the well, which maintains hydrostatic pressure on the wellbore. Under normal drilling conditions, this pressure should balance or exceed the natural rock formation pressure to help prevent an influx of gas or other formation fluids. As the formation pressures increase, the density of the drilling fluid is increased to help maintain a safe margin and prevent “blow-outs.” However, if the density of the fluid becomes too heavy, the formation can be damaged and fracture. If drilling fluid is lost in the resultant fractures, a reduction of hydrostatic pressure occurs. Maintaining the appropriate fluid density for the wellbore pressure regime is therefore critical to safety and wellbore stability. Abnormal formation pressures are detected by primary well control equipment (pit level indicators, return mud-flow indicators and return mud gas detectors) on the drillship. The drilling fluid is also tested frequently during drilling operations and its composition can be adjusted to account for changing downhole conditions. The likelihood of a well LOC event is further minimised by installation of a BOP on the wellhead at the start of the risered drilling stage. The BOP is a secondary control system, which contains a stack of independently operated cut-off mechanisms, to provide redundancy in case of failure. The BOP is designed to close in the well to prevent the uncontrolled flow of hydrocarbons from the reservoir. A well LOC event occurs in the highly unlikely event of these pressure control systems failing.

If the BOP does not successfully shut off the flow from the well, the drillship would disconnect and move away from the well site while crews mobilise a capping system. The capping system would be lowered into place from its support barge and connected to the top of the BOP to stop the flow of oil or gas.

CNEL will be a member of Oil Spill Response Limited (OSRL), which provides expertise, equipment, oiled wildlife recovery and access to the global dispersant stockpile. CNEL will have access to a Capping Stack, in the event of a well loss of containment , compatible with the installed wellhead. Capping Stacks are designed to shut-in an uncontrolled subsea well in the unlikely event of a well loss of containment event, and are located in key global locations for fast mobilisation and onward transportation by sea in the event of an incident. This would significantly reduce the spill period.

Additional project controls include the development and implementation of a Shipboard Oil Pollution Emergency Plan (SOPEP), Oil Spill Response Plan (OSRL) and Source Control Contingency Plan (SCCP).

These controls have been considered in the pre-mitigation impact rating.

Diesel, hydraulic fluid and/or oil released into the marine environment would have an immediate and direct effect on water quality and detrimental effects on marine fauna. These could range from mortality (due to toxicity or suffocation) to sub-lethal physiological damage and long-term effects including disruption of behavioural mechanisms, reduced tolerance to stress, and incorporation of carcinogens into the food chain (Thomson et al. 2000). If the spill reaches the coast, it can result in the smothering of sensitive coastal habitats. If the spill occurs at the drilling unit, it may be more difficult to contain and would more readily disperse but would not reach the shore due to the offshore location of the drill site.

There are several possible direct and secondary potential impacts of hydrocarbon spills on fisheries:

- Contamination of Product: Oil spills in marine environments can lead to the contamination of fish and seafood products. Fish exposed to oil spills may absorb toxic substances, such as polycyclic aromatic hydrocarbons (PAHs), which can accumulate in their tissues (Gracia et al. 2020). This contamination poses significant risks to human health if contaminated fish are consumed. Studies have shown that PAHs can cause various health issues, including carcinogenic effects and reproductive toxicity (Short, 2017; Sandifer *et al.*, 2021). Furthermore, the presence of oil residues can render fish visually unappealing and unsuitable for sale, leading to financial losses for fishing operations (Pascoe and Innes, 2018).
- Avoidance of Contaminated Fishing Areas: Potential impacts on fisheries livelihoods from oil spills have included periodic closure of fishing grounds for clean-up and rejuvenation, long-term displacement from fishing areas to minimize pollution effects, lost jobs and unemployment, and lost seafood markets and revenues (Levy and Gopalakrishnan, 2010; Watts and Zalik, 2020). Following an oil spill, fishing vessels may avoid areas affected by contamination to prevent the capture of contaminated fish and provide product safety (Gracia et al. 2020; Andrews, N. et al. 2021). This avoidance behaviour can disrupt fishing operations, as vessels may need to relocate to alternative fishing grounds, resulting in increased fuel costs and reduced catch efficiency (Gracia et al. 2020). Studies have documented the displacement of fishing activities away from oil-affected areas following major spills, such as the Deepwater Horizon oil spill in the Gulf of Mexico (Pascoe and Innes, 2018; Andrews, N. et al. 2021). Avoidance of contaminated areas may also lead to competition among fishing vessels for access to unaffected fishing grounds, exacerbating resource conflicts and management challenges. Additionally, fish species have been shown to avoid areas contaminated with PAHs (Schlenker *et al.*, 2019).
- Loss of Marketable Product: In cases where fish are exposed to oil spills and subsequently captured by fishing operations, there is a risk of product rejection due to contamination. Fish contaminated with oil residues may fail to meet quality standards set by regulatory agencies and seafood markets, resulting in the rejection of entire catch batches (Challenger and Mauseth, 2011; Gracia et al. 2020). This rejection not only leads

to financial losses for fishing operations but also undermines consumer confidence in seafood products sourced from affected regions. Studies have shown that seafood market demand can decline significantly in the aftermath of oil spills, particularly in regions directly impacted by contamination (Challenger and Mauseth, 2011; Gracia et al. 2020). Loss of market access can have long-term economic consequences for fishing communities reliant on seafood trade.

- Indirect Impact on Fisheries from Contamination: The introduction of oil into marine ecosystems can lead to a range of adverse effects on phytoplankton. Petrogenic carbon may contain toxic compounds such as PAHs and heavy metals, which can inhibit photosynthesis, disrupt cellular processes, and impair growth and reproduction in phytoplankton species (Quigg *et al.*, 2021; Gracia et al. 2020; Tang *et al.*, 2019). Additionally, the physical presence of oil slicks can block sunlight, thereby reducing light availability for photosynthesis and further suppressing phytoplankton productivity (Quigg *et al.*, 2021; Gracia et al. 2020; Tang *et al.*, 2019). The reduced productivity is likely to lead to reduced productivity on higher trophic levels, such as economically important fish species.

Impact Assessment

Based on modelling result, an unplanned, large-scale well LOC event of 30-days duration is likely to result in extensive offshore oil contamination. However, due to the prevailing wind and currents in the region, it is unlikely that oil contamination would extend inshore of the 500 m depth contour and no simulations resulted in oil reaching the shoreline, regardless of the season. The footprint of surface water contamination was oriented to the northwest of the release location with total hydrocarbons in the water column remaining local to the spill site.

The Area of Influence (extent) was established based on oil spill modelling results. To determine the potential National and transboundary impacts, we consider the possible area of contamination of fishing grounds based on the footprint of the different spill probabilities (see Table 4-14). For ease of reference here is an indication of the results of the oil spill modelling for the project (showing seasons with largest footprint of % probability of oil on surface without and with response) namely during the summer season at the second well location.

TABLE 4-14 SUMMARY OF POTENTIAL OIL SPILL CONTAMINATION OF FISHING GROUNDS (KM^2) BASED ON STOCHASTIC MODELLING RESULTS (SECOND WELL RELEASE POSITION, SUMMER SEASON).

Sector	Oil Spill Contamination	Probability of Surface Oiling			
Namibia		1%	10%	50%	90%
Large Pelagic Longline	Contaminated surface area of fishing ground (km^2)	135115	75789	8925	1271
	Proportion of total fishing grounds	16.6%	9.3%	1.1%	0.2%
Small Pelagic Purse-Seine	Contaminated surface area of fishing ground (km^2)	640	-	-	-
	Proportion of total fishing grounds	1.3%	-	-	-
Midwater Trawl	Contaminated surface area of fishing ground (km^2)	5218	798	318	-

Sector	Oil Spill Contamination	Probability of Surface Oiling			
	Proportion of total fishing grounds	8.4%	1.3%	0.5%	-
Demersal Trawl	Contaminated surface area of fishing ground (km^2)	11703	799	-	-
	Proportion of total fishing grounds	15.3%	1.0%	-	-
Demersal Longline	Contaminated surface area of fishing ground (km^2)	3038	-	-	-
	Proportion of total fishing grounds	6.6%	-	-	-
Tuna Pole-Line	Contaminated surface area of fishing ground (km^2)	1941**	-	-	-
	Proportion of total fishing grounds	8.5%	-	-	-
Linefish	Contaminated surface area of fishing ground (km^2)	-	-	-	-
	Proportion of total fishing grounds	-	-	-	-
Deep-sea Crab	Contaminated surface area of fishing ground (km^2)	16181	5763	717	79
	Proportion of total fishing grounds	46.9%	16.7%	2.1%	0.2%
Deep-water Trawl	Contaminated surface area of fishing ground (km^2)	8336	2088	79	-
	Proportion of total fishing grounds	21.8%	5.5%	0.2%	-
Rock Lobster	Contaminated surface area of fishing ground (km^2)	-	-	-	-
	Proportion of total fishing grounds	-	-	-	-

Note: Dash indicated the threshold is not met
** outside EEZ (Frio Ridge Seamount)

Operators avoid polluted areas that contaminate fishing gear and affect cooling water intake systems. Based on the extent of surface oiling probabilities of a large scale well LOC event, there is a 50% probability that surface water contamination would extend into fishing grounds for the following sectors (the proportion of total fishing ground contamination is shown in parentheses):- deep-sea crab (2.1%), large pelagic longline (1.1%), midwater trawl (0.5%), deep-water trawl (0.2%; noted that the fishery is currently closed). There is a 10% probability that demersal trawl (1.0%) would be affected and a 1% probability that small pelagic purse-seine (1.3%), demersal longline (6.6%) and tuna pole-line[13] (8.5%) would be affected. There is no risk of contamination predicted for the linefish and rock lobster fishing grounds.

With respect to the potential impact of contamination of biologically sensitive areas, spawning areas for the main commercial fish species occur predominantly inshore of PEL 82. There a degree of overlap with spawning locations for hake, monkfish and orange roughy. Plankton abundance is expected to be comparatively low within the license area although the drift of spawn and related products (eggs, larvae, juveniles) would be expected throughout. Due to the nature of the origin of these spawn products, they are expected to be widely dispersed and unlikely to significantly impact recruitment to the fishery.

[13] Fishing outside the Namibian EEZ takes place at Frio Ridge Seamount

None of the modelled simulations resulted in oil extending into the closed fishing areas (shallower than 200 m depth contour) intended for the protection of nursery areas for numerous fish species. The peak nursery period for juvenile fin fish occurs from November through to March. Thereafter most juvenile small pelagic species migrate southwards and out of the bays. Juvenile hake migrate offshore and into deeper water and also migrate to the bottom i.e. move into demersal stages of their life cycles. The effect of a large scale contamination event at the drilling location could be potentially serious for the small pelagic fisheries as these species remain largely pelagic (surface dwelling) in their adult stages. This would be particularly so if the event occurred at peaks of larval drift and settlement into nursery areas (most likely from November through to March). Mortality of varying scales would be expected on eggs and larvae and this would ultimately impact the biological resources upon which the commercial fisheries in the area depend. Note also that the effect can occur over a number of years depending on the life cycle of the different species. Anchovy recruit to the commercial fishery in their first year, sardine in their second year and hake in their third year therefore the recruitment effect of the impacts on different fisheries may occur at different times for different short and long-lived species. There is no potential impact expected on the mariculture sector as the results of the modelling report do not show any probability of oil contamination at the coastline.

Large scale effects would also be likely to include area closures and exclusion of fisheries from areas that may be polluted or closed to fishing due to contamination of sea water by the oil or the chemicals used for cleaning oil spills. Operators of fishing vessels would also avoid areas of large scale contamination. Not only is it likely that fishery resources would move out of an area, but operators also avoid polluted areas that contaminate fishing gear and affect cooling water intake systems. Table 4-15 shows the impact ratings on all fisheries combined of the potential effects of a large scale oil spill.

Assuming the worst-case scenario, the potential impact of a well loss of containment event of hydrocarbons would likely persist over the short term, with the extent ranging from local to regional, dependent on the fishing sector. The potential impacts of a well loss of containment event can therefore be expected to be of medium magnitude and the sensitivity of the fisheries sectors is rated as medium (limited capacity to adapt/recover). In the event of a major oil spill, the potential impact on fisheries before mitigation are thus considered to be of major significance. With the implementation of best management practices, the residual potential impact could be reduced to moderate significance for deep-sea crab and of minor significance for large pelagic longline, small pelagic purse-seine, midwater trawl, demersal trawl, demersal longline, tuna pole-line and deep-water trawl. There is no potential impact expected on the linefish and rock lobster sectors.

TABLE 4-15 POTENTIAL IMPACT OF A MAJOR OIL SPILL FOLLOWING A WELL LOSS OF CONTAINMENT

Characteristic	Without Mitigation	With Mitigation (Residual Impact)
Type	Direct - Impacts that result from a direct interaction between the project and fishing operations	Direct
Duration and Reversibility	Short term - impacts last for 6 months or less. Localized, low intensity and fully reversible.	Short term

Characteristic	Without Mitigation	With Mitigation (Residual Impact)
	Medium-term (e.g. 3 to 6 years)	
Probability/ Likelihood	Likely – The impact is expected to occur on the following sectors (50 % probability): • Deep-sea crab • Large pelagic longline • Midwater trawl • Deep-water trawl Unlikely - Reasonable to expect the impact will not occur (1% probability). • Demersal trawl • Tuna pole-line • Small pelagic purse-seine • Demersal longline	Likely
Extent	Local - impacts that are limited to the project site and adjacent areas. Regional - impacts that affect regionally important environmental resources or are experienced at a regional scale i.e., extend to areas outside the project site.	Local
Scale	The proportion of total fishing grounds contaminated by surface oiling (the “size of the impact”; see Table 4.15)	
Irreplaceable loss of resources	Low – Fully Reversible: Fishing vessels can plan to avoid the area and continue operations elsewhere.	Low – Fully Reversible
Magnitude	Medium - Regional, measurable, recoverable changes in ecosystem structure or function. Moderate scale and intensity. Reversible within 1–3 years.	Small - Localized, medium-term, minor change to fishing operations/minor to moderate disruption in access. Reversible.
Sensitivity	Medium - Low capacity to accommodate the effect and limited ability to recover/adapt.	Medium
Significance	Major - Local-to-regional (sub-national) or medium-term (e.g. 3 to 6 years) recoverable	Moderate – Deep-sea crab Minor - Large pelagic longline, Midwater trawl, Deep-water trawl, Demersal trawl, Tuna pole-line, Small pelagic purse-seine, Demersal longline No Impact – Linefish, Rock lobster

Mitigation Measures

Mitigation measures would require the implementation of an oil spill contingency plan including specialised well capping facilities for uncontained loss of containment. In addition to the best industry practices and the project standards, the following measures are recommended to manage the potential impacts associated with well LOC events (refer to Table 4-16).

TABLE 4-16 RECOMMENDED MEASURES TO MITIGATE THE POTENTIAL IMPACT OF A WELL LOSS OF CONTAINMENT

No	Mitigation Measure	Classification
1	Develop well-specific Source Control Contingency Plans (SCCP), including oil wildlife response actions, aligned with the National OSCP (Oil Spill Contingency Plan). Tailor plans to local oceanographic and meteorological conditions, environmental receptors and spill response resources.	Avoid / Abate on and off site / Restore
2	Assess onshore and offshore response resources (equipment and personnel), their location (local/international) and mobilization timeframes.	
3	Select response strategies that minimise mobilisation time, using the best combination of local and international.	
4	Develop intervention plans for sensitive areas and integrate these into the response strategy.	
5	If response time cannot prevent shoreline oiling, commit to additional proactive measures including: • Pre-mobilising dispersant stock on support vessels. • Contracting additional response vessels and aircraft. • Ensuring SSDI kit is on standby and rapidly deployable. • Improving dispersant spray capability. • Schedule joint oil spill exercises to test Tier 1, and 3 responses. Maintain a support vessel within proximity of the drilling unit, equipped for: • Dispersant spraying. • Mechanical dispersion (via propellers or firefighting equipment). • Carrying at least 4 m³ of dispersant onboard. • Control and contain spills at sea using recovery techniques, when sea state permits. • Use drifter buoys and SAR-based satellite monitoring to track spill behaviour and optimise response. • Establish a functional grievance mechanism: • Inform stakeholders of the process. • Mobilise resources for grievance resolution. • Follow the Grievance Management Procedure.	
6	Schedule an oil spill exercise to test the Tier 1 & 3 responses.	Abate on site / Restore
7	Check contract arrangements and service agreements are in place for: • Capping stack (e.g. in Saldanha Bay and international locations). • SSDI kit and surface response equipment. • Dispersants and response vessels. • Use low-toxicity dispersants that dilute rapidly and only with MFMR approval.	Abate on site / Restore
8	Use low toxicity dispersants that dilute rapidly and only with MFMR approval.	Abate on and off site

No	Mitigation Measure	Classification
9	Contracted support vessels will be equipped for dispersant spraying, mechanical dispersion (via propellers and/or firefighting equipment). It should have at least 5 m^3 of dispersant onboard for initial response.	Abate on site
10	Spill Control and Monitoring: • Control and contain the spill at sea using recovery techniques, when sea state permits. • Use drifter buoys and SAR-based satellite monitoring to track spill behaviour and optimise response	Abate on site /Abate off site
11	Stakeholder Engagement: • Establish a functional grievance mechanism • Inform stakeholders of the process • Mobilise resources for grievance resolution • Follow the grievance management procedure.	Abate off site

4.3 CUMULATIVE IMPACTS

The potential impacts on each of the above fishing sectors could be increased due to the combination of impacts from other projects that may take place during the same period. Cumulative impacts include past, present and future planned activities which result in change that is larger than the sum of all the impacts. Cumulative effects can occur when impacts are 1. additive (incremental); 2. interactive; 3. sequential or 4. synergistic and would include anthropogenic impacts (including fishing and hydrocarbon industries) as well as non-anthropogenic effects such as environmental variability and climate change (Augustyn et al., 2018).

In Namibia, a number of wells have recently been drilled in the Orange Basin by TotalEnergies in Blocks 2912 and 2913B (2021-2024), Shell in PEL39 (2021-2023) and GALP in PEL83 (2024). Harmattan Energy and Rhino Resources are undertaking an ESIA processes to conduct exploration drilling in License Blocks 2813B and Block 2914A, respectively. A number of seismic surveys were also undertaken in the southern Namibian offshore from 2022 to 2025 and it is expected that further seismic acquisition and well drilling activities will continue in the next few years. The possible range of the future exploration and production activities that could arise will vary significantly in scale, location, extent, and duration depending on whether a resource(s) is discovered, its size, properties and location, etc. As these cannot at this stage be reasonably defined, it is not possible to undertake a reliable assessment of the potential cumulative environmental impacts. However, recent hydrocarbon discoveries from the Orange Basin indicate that further oil and gas exploration and potentially production will likely occur. Alternatively, it is also possible that the potential, or future, exploration fails to identify an economic petroleum resource, in which case the potential impacts associated with the production phase would not be realised. Table 4-17 lists recent applications for petroleum exploration rights in Namibia, indicating which of these have been undertaken. Concurrent activities could add to the potential cumulative impact on fisheries.

TABLE 4-17 APPLICATIONS FOR PETROLEUM EXPLORATION RIGHTS IN NAMIBIA (SINCE 2014).

Year	Right holder / operator	Block	Activity	Approval	Conducted / completed
2024	GALP Namibia	PEL83	Exploration drilling and 3D seismic acquisition	Yes	3D seismic acquisition and well drilling completed in 2024/2025
2024	Rhino Resources Namibia Ltd	Block 2914A	Exploration drilling	Yes	Estimated 2025
2023	TEEPNA	Block 2912	Exploration drilling	Yes	2023
2023	PGS	Blocks 2713, 2712A&B, 2812A&B, 2813A&B, 2814B, 2714A&B, 2614, 2613, 2612A&B	3D Seismic	Yes	3D: 2022-2023
2022	Searcher	Blocks 2614, 2613, 2612A&B, 2714A&B, 2713, 2712A&B, 2812B, 2813A, 2814A&B, 2912, 2913B, 2914A&B	2D and 3D Seismic	Yes	3D: 2023
2020	Tullow Namibia/ Harmattan	Block 2813B (PEL90)	3D Seismic	Yes	3D: 2023
2020	TGS Namibia	Blocks 2711, 2712A, 2712B, 2713, 2811, 2812A, 2812B, 2913B	3D Seismic	Yes	Yes
2020	TEEPNA	Block 2912, 2913B (PEL91; PEL56)	3D Seismic	Yes	3D: 2022/2023/ 3D Ongoing: 2023/2024 (ECC extension)
2019	TEEPNA	Block 2913B (PEL56)	Exploration drilling	Yes	Ongoing (2022 commencement)
2019	Galp Namibia	PEL83	Exploration drilling	Yes	No (Applying for ECC extension)
2018	Shell Namibia	PEL39	3D Seismic	Yes	Ongoing (applying for ECC extension)
2017	Shell Namibia	PEL39	Exploration drilling	Yes	Ongoing
2016	Spectrum	Southern Namibia regional	2D Seismic	Yes	2D: April 2019
2014	Shell Namibia	2913A; 2914B	3D Seismic	Yes	3D: 2015

5. CONCLUSIONS AND RECOMMENDATIONS

TABLE 5-1 SUMMARY TABLE LISTING POTENTIAL IMPACT SIGNIFICANCE OF PLANNED AND UNPLANNED ACTIVITIES ON FISHERIES

Potential impact	Initial Significance	Residual Significance
Drilling Phase		
Temporary Safety Zone around Drillship	Minor	Minor
Discharge of Drill Cuttings	Minor	Minor
Underwater Radiated Noise – Drilling and Vessel Operations	Minor	Incidental
Underwater Radiated Noise - VSP	Minor	Incidental
Demobilization Phase		
Subsea Infrastructure – Permanent exclusion to trawling around wellheads (up to 10)	Minor	Minor
Unplanned Events		
Minor Oil Spill	Minor	Minor
Major Oil Spill	Major	Moderate to Minor

TABLE 5-2 RECOMMENDED MITIGATION MEASURES

No		Mitigation Measure	Classification
	Phase: Drilling		
1	Displacement of fishing vessels	Distribute a Notice to Mariners to key stakeholders prior to the well-drilling operations 3 weeks prior to operations and on completion of the campaign. Stakeholders include the relevant fishing industry associations: Confederation of Namibian Fishing Association and Namibian Hake Association, Namibian Crab Association / Taiyo Namibia (Pty) Ltd, Midwater Trawling Association, Large Pelagic and Hake Longlining Association of Namibia. Other key stakeholders: Directorate of Maritime Affairs, South African Navy Hydrographic Office (SANHO), Namibian Ports Authority and the MFMR Monitoring, Control and Surveillance Unit in Walvis Bay (Vessel Monitoring System).	Avoid / Reduce at source
2		Request, in writing, SANHO to broadcast a navigational warning via Navigational Telex (Navtext) and navigational warnings twice daily on Channel 16 VHF.	Avoid
3		Manage the lighting on the drilling unit and support vessels to make sure that it is sufficiently illuminated to be visible to fishing vessels and compatible with safe operations.	Abate on site
4		Notify fishing vessels at a radar range <24 Nm from the drilling unit via radio regarding the safety requirements around the drilling unit.	Abate on site

No		Mitigation Measure	Classification
5		Implement a grievance mechanism that allows stakeholders to register specific grievances related to operations; by ensuring they are informed about the process and that resources are mobilised to manage the resolution of all grievances, in accordance with the Grievance Management procedure.	Abate on site /Abate offsite
6	Underwater radiated noise	Soft start procedures: • Gun test followed by full VSP logging phase: acoustic source must be initiated at the lowest power setting, with gradual ramp-up of the acoustic source over a 20-minute period until the full operating power level is reached. • For single gun tests prior to VSP logging phase: If a gun test will be less than 20-minutes in duration, a soft start procedure of equal time duration must be followed (e.g. a 10-min gun test should be preceded with a 10-min soft start only). Operating procedures: whilst the VSP acoustic source is operating, both during soft start procedures and survey operations, the acoustic source must be shut down if mass mortality of fish species is sighted.	Abate on site
7	Drilling discharges	• Pre-drilling site surveys should be carefully designed to make sure that drilling locations are positioned at least 500 meters away from any vulnerable habitats (e.g., hard grounds), sensitive species (e.g., cold-water corals, sponges), or significant structural features. • If sensitive and potentially vulnerable habitats are detected, adjust the well position accordingly to beyond 500 m or implement appropriate technologies, operational procedures and monitoring surveys to reduce the risks of, and assess the damage to, vulnerable seabed habitats and communities.	Avoid/reduce at source
8		Careful selection of drilling fluid additives taking into account their concentration, toxicity, bioavailability and bioaccumulation potential; Use only, PLONOR (Pose Little Or No Risk) chemicals, low-toxicity, low bioaccumulation potential and partially biodegradable additives are used, where practicable. Maintain a full register of Safety Data Sheets (SDSs) for all chemical used, as well as a precise log file of their use and discharge.	Avoid/reduce at source
9		If NADFs are used for drilling the risered sections, conduct regular maintenance of the onboard solids control package and avoid inappropriate discharge of NADF cuttings.	Abate on site
10		Monitoring requirements: • Test drill cuttings daily for retained oil content to check specified discharge standards are maintained (average residual oil on cuttings <6.9%) at the end of the well. • Test barite for heavy impurities prior to mixing barite on location. • Test any other discharged fluids for visible oil contamination (static sheen). • Where practical, monitor sediment deposition and hydrocarbon concentrations.	Reduce at source / abate on site

No		Mitigation Measure	Classification
		• Monitor cement returns with an ROV and stop cement pumping if significant discharges are detected on the seafloor. • Monitor (using ROV) hole wash out to reduce discharge of fluids, as far as possible.	
11	Minor accidental oil spill during bunkering or vessel collision	Check personnel are adequately trained in both accident prevention and immediate response, and resources are available on each vessel	Avoid
12		Obtain permission from MFMR to use low toxicity dispersants. Use cautiously	Avoid
13		Make sure offshore bunkering is not undertake in the following circumstances: wind force and sea state conditions of ≥6 on the Beaufort Wind Scale; during any workboat or mobilisation boat operations; during helicopter operations; during the transfer of in-sea equipment; and at night or times of low visibility.	Avoid
14	Loss of equipment to sea	Ensuring that loads are lifted using the correct lifting procedure and within the maximum lifting capacity of the crane system.	Avoid
15		Minimise the lifting path between vessels.	Avoid
16		Undertake frequent checks to make sure items and equipment are stored and secured safely on board each vessel.	Avoid
17		Retrieval of lost objects / equipment, where practicable, after assessing the safety and metocean conditions. Establish a hazards database listing the type of gear left on the seabed and / or in the area with the dates of abandonment / loss and locations and, where applicable, the dates of retrieval.	Repair / restore
18		Notify SANHO of any hazards left on the seabed or floating in the water column, and request that they send out a Notice to Mariners with this information.	Repair / restore
	Phase: Decommissioning		
19	Reduced fishing grounds	Abandoned well location must be surveyed and accurately charted with the SANHO. Fit wellheads (in water depth less than 800 m) with an over-trawlable structure to minimise the risk of damage to demersal trawl gear, as well as potential damage to the wellheads.	Avoid/reduce at source
20		Removal of wellheads: Consultation with the trawling industry should wellheads coincide with trawling grounds	Avoid/reduce at source

6. REFERENCES

Boyer, D.C., and I Hampton. 2001. “An overview of the living marine resources of Namibia. A decade of Namibian Fisheries Science .” S. Afr. J. mar. Sci (23).

Boyer, D.C., H.J. Boyer, I. Fossen, and Kreiner. 2001. “ Changes in abundance of the northern Benguela sardine stock during the decades 1990–2000 with comments on the relative importance of fishing and the environment. .” A Afr. J. of Mar. Sci. 23: 67–84.

Branch, T. A. 2001. “A review of orange roughy Hoplostethus atlanticus fisheries, estimation methods, biology and stock structure.” S. Afr. J. mar. Sci. 23: 181 – 203.

Breuer, E, A.G Stevenson, J.A Howe, J Carroll, and G. Shimmield. 2004. “Drill cutting accumulations in the Northern and Central North Sea: A review of environmental interactions and chemical fate. .” Marine pollution bulletin. 48. 12-25. 10.1016/.

Collette, B.B, and C.E. Nauen. 1983. Scombrids of the world : an annotated and illustrated catalogue of tunas, mackerels, bonitos, and related species known to date. v. 2. Rome: Food and Agriculture Organization of the United Nations.

Crawford, R. J. M, L.V. Shannon, and D.E Pollock. 1987. “The Benguela ecosystem. 4. The major fish and invertebrate resources.” Oceanogr. Mar. Biol. Ann. Rev. 25: 353 - 505.

Cruikshank, R.A. 1990. “nchovy distribution off Namibia deduced from acoustic surveys with an interpretation of migration by adults and recruits.” S. Afr. J. Mar. Sci 9: 53-68.

Erasmus, V.N. . 2021. “Uncoupling the exploitation and climate change effects on the biology of Cape monkfish, Lophius vomerinus Valenciennes 1837 in Namibia. .” Thesis submitted in fulfilment of PhD, Rhodes University.

Esbaugh, A.J, E.M Mager, J.D Stieglitz, R Hoenig, T.L Brown, B.L French, T.L Linbo, C Lay, H Forth, and N.L et al. Scholz. 2016. “The effects of weathering and chemical dispersion on Deepwater Horizon crude oil toxicity to mahi-mahi (Coryphaena hippurus) early life stages.” Science of The Total Environment 644-651.

Evans, K., R.D. McCauley, P. Eveson, and T PATTERSON. 2018. “ A summary of oil and gas exploration in the Great Australian Bight with particular reference to southern bluefin tuna. .” Deep-Sea Research Part II 157-158: 190-202.

FAO. 2022. Country Profile Fact Sheets. Fisheries and Aquaculture Division. https://www.fao.org/fishery/en/facp/nam.

ITOPF (International Tanker Owners Pollution. 2014. Effects of Oil Pollution on Fisheries and Mariculture. 11:12: Technical Information Paper (TIPS), 11: pp12.

Fishing Industry Handbook South Africa, Namibia and Moçambique 47th edition. 2019. Cape Town, South Africa: George Warman Publications.

Hampton, I. 1992. “The role of acoustic surveys in theassessment of pelagic fish resources on the South Africancontinental shelf.” S. Afr. J. Mar. Sci. 12:1031–1050.

Hutchings, L., L. E. Beckley, M. H. Griffiths, M. J. Roberts, S. Sunby, and C. Van Der Lingen. 2002. “Spawning on the edge: spawning grounds and nursery areas around the southern African coastline. .” Marine and Freshwater Research 53(2), 307-318.

ICCAT. 2023. Statistical Bulletin Vol 48. . https://www.iccat.int/sbull/SB48-2023/index.html.

J., Richardson W., Charles R. G. J., Charles I. M., and Denis H.T. 2013. "Marine mammals and noise." Academic press.

Jansen, T., P Kainge, L. Singh, M. Wilhelm, D. Durholtz, T. Stromme, J. Kathena, and V Erasmus. 2015. "Spawning patterns of shallow-water hake (Merluccius capensis) and deep-water hake (M. paradoxus) in the Benguela Current Large Marine Ecosystem infered from gonadosomatic indices." Fisheries Research 1;172:168-80.

Kainge P, Kjesbu OS, Thorsen A, Salvanes AG (2007) Merluccius capensis spawn in Namibian waters, but do M. paradoxus?. African Journal of Marine Science. Dec 1;29(3):379-92.

K.W, Lan, Lee M.A, Lu H.J, Shieh W.J, Lin W.K, and Kao S.C. 2011. "Ocean variations associated with fishing conditions of yellowfin tuna (Thunnus albacares) in the equatorial Atlantic Ocean." ICES J Mar Sci 68(6): 1063-1071.

King, D. P. F. 1977. "Influence of temperature, dissolved oxygen and salinity on incubation and early larval development of the South West African pilchard Sardinops ocellata Invenstl ." Rep. Sea Fish. Brch S. Afr. 114 (35 pp.).

Kirchner, C. H., C. H. Bartholomae and A. Kreiner. 2009. "Use of environmental parameters to explain the variability in spawner recruitment relationships of Namibian sardine Sardinops sagax. ." African Journal of Marine Science 31(2), 157-170.

Klingelhoeffer, E. 1994. "Emphasis on distribution and abundance. ." Namibian Brief: Focus on Fisheries and Research 18: 79-81.

Lan, K.W, M.A Lee, H.J Lu, W.J Sheih, W.K Lin, and S.C. Kao. 2011. "Ocean variations associated with fishing conditions of the yellowfin tuna (Thunnus albacares) in the equatorial Atlantic Ocean." ICES J Mar Sci 68(6):1063 -1071.

Langangen, O, E Olsen, J Ohlberger, N.A. Yaragina, F.B Vikebo, B Bogstad, N.C. Stenseth, and D.O Hjermann. 2017. "The effects of oil spills on marine fish: Implications of spatial variation in natural mortality." Marine Pollution Bulletin 102-109.

Le Roux, L. 1997. "Stock assessment and population dynamics of the deep-sea red crab Chaceon maritae (Brachyura, Geryonidae) off the Namibian Coast ." M.Sc. thesis, Univerisity of Iceland 88 pp.

Lehodeya, P., Alheit, I., Barange, M., Baumgartner, T., Beaugrande, G., Drinkwater, K., Fromenting, J., Hareh,. S., Ottersen, G., Perry, R., Royj, C., Vand der Lingen, C. & F. Werner. 2006. "Climate Variability, Fish, and Fisheries." Journal of Climate 5009-5030.

Manning, P. R. 1998. "Managing Namibia's marine fisheries: Optimal resource use and national development objectives. ." London School of Economics and Political Science (United Kingdom).

Ministry of Fisheries and Marine Resources. 2021. Current Status Report: Knowledge Baseline for Marine Spatial Planning in Namibia. Second Edition. . Windhoek: Namibia.: MFMR.

O'Toole, M. J. 1977. " Investigations into some important fish larvae in the south east Atlantic in relation to the hydrological environment. ." PhD thesis, University of Cape Town, South Africa.

Pearson, W.H. 2014. “Comment on "multitissue molecular, genomic, and developmental effects of the Deepwater Horizon oil spill on resident gulf killifish (Fundulus grandis).” Environ. Sci. Technol 48: 7677–7678.

Punt, A.E, A. J Penney, and R. W. Leslie. 1996. “Abundance indices and stock assessment of south Atlantic albacore (Thunnus alalunga.” Col. Vol. Sci. Pap. ICCAT Madrid, Spain. 43: 361-371.

Shannon L.V. and Pillar S.C. 1986. The Benguela ecosystem 3. Plankton. In Oceanography and Marine Biology. An Annual Review 24. Barnes M. (Ed.). Aberdeen; University Press: 65-170.

Shannon, L. V., & Field, J. G. (1985). Are fish stocks food-limited in the southern Benguela pelagic ecosystem?. Marine Ecology Progress Series, 7-19.

Shomura, R.S., J. Majkowski, and R.F. Harman. 1995. Summary report of the second FAO expert consultation on interactions of Pacific tuna fisheries. Shimizu, Japan: FAO, Roma (Italia).

Sundby, S., Boyd, A. J., Hutchings, L., O’Toole, M. J., Thorisson, K., & Thorsen, A. (2001). Interaction between Cape hake spawning and the circulation in the Northern Benguela upwelling ecosystem. African Journal of Marine Science, 23, 317-336.

Teal, J.M, and R.W. Howarth. 1984. “Oil spill studies: A review of ecological effects .” Environmental Management 27-43.

Thomson, D. R., R. A. Davis, R. Bellore, E. Gonzalez, J. Christian, V. Moulton, and K. Harris. 2000. Environmental assessment of exploration drilling off Nova Scotia. LGL Limited for Canada-Nova Scotia Offshore Petroleum Board.

W.J, Richardson, Charles R.G, Charles I.M, and Denis H.T. 2013. “Marine mammals and noise.” Academic press.

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APPENDIX A CONVENTION FOR ASSIGNING IMPACT ASSESSMENT RATINGS

A1 IMPACT ASSESSMENT METHODOLOGY

This chapter outlines the methodology and approach taken in the ESIA report.

IMPACT ASSESSMENT METHODOLOGY

During scoping, a preliminary analysis was undertaken of the ways in which the project may interact (positively and negatively) with environmental and socioeconomic resources or receptors. The potential impacts that were identified as potentially significant during the scoping process provided focus for the specialist studies for the detailed ESIA Report. Each of the potential impacts identified is assessed using the following methodology.

IMPACT IDENTIFICATION AND CHARACTERISATION

An 'impact' is any change to a resource or receptor caused by the presence of a project component or by a project-related activity. Potential impacts can be negative or positive. Potential impacts are described in terms of their characteristics, including the impact type, and their spatial and temporal features (namely extent, duration, reversibility and scale). Terms used in the characterisation of impacts within this study are described in Table A1

TABLE A1 POTENTIAL IMPACT CHARACTERISTICS

Characteristic	Definition	Term
Type	A descriptor indicating the relationship of the impact to the project (in terms of cause and effect).	Direct - Impacts that result from a direct interaction between the project and a resource/receptor (e.g. between occupation of the seabed and the habitats which are affected). Indirect - Impacts that follow on from the direct interactions between the project and its environment as a result of subsequent interactions within the environment (e.g. viability of a species population resulting from loss of part of a habitat as a result of the project occupying the seabed). Induced - Impacts that result from other activities (which are not part of the project) that happen as a consequence of the project. Cumulative - Impacts that arise as a result of an impact and effect from the project interacting with those from another activity (including those from concurrent or planned future third-party activities) to create an additional impact and effect.
Duration and Reversibility	Duration - The time period over which a resource / receptor is affected. Reversibility - The degree to which an impact can be undone or recovered from. This includes consideration of the natural resilience of the affected resource or receptor, the availability of restoration measures	Temporary - impacts are of short duration and intermittent or occasional. Localized and fully reversible within a short timeframe. Short term - impacts last for 6 months or less. Localized, low intensity and fully reversible. Medium term - impacts last more than 6 months and up to 3years. Regional in extent, moderate intensity and reversible with intervention. Long term -Impacts last more than three years and less than ten years. May affect ecosystem or community function. Reversible but may require significant effort. Permanent - impacts cause a lasting change beyond 10 years. High intensity and scale. Irreversible or only partially reversible.

Characteristic	Definition	Term
	and the timeframe required for recovery.	
Probability/ Likelihood	The chance or frequency with which an impact may occur.	Rare - The impact is rare or unheard of. Remote - The impact has occurred once or twice in the industry. Unlikely - Reasonable to expect the impact will not occur. Seldom - Exceptional conditions may allow impact to occur. Occasional - Conditions may allow the impact to occur. Likely - The impact is expected to occur.
Extent	The reach of the impact (i.e. physical distance an impact will extend to)	On-site - impacts that are limited to the project site. Local - impacts that are limited to the project site and adjacent areas. Regional - impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries, habitat type/ecosystems, i.e., extend to areas outside the project site. National - impacts that affect nationally important environmental resources or affect an area that is nationally important/ or have macro-economic consequences. Trans-boundary/International - impacts that affect internationally important resources such as areas protected by international conventions or impact areas beyond the national boundary of the country in which the project is based.
Scale	Quantitative measure of the impact	The size of the impact (e.g., area damaged or impacted, the fraction of a resource that is lost or affected, etc.). This characteristic has no fixed designations as it is intended to be a numerical value.
Irreplaceable loss of resources	The degree to which the impact may cause permanent loss of unique or sensitive resources.	Evaluate the uniqueness and sensitivity of affected resources. Identify if the impact could lead to permanent loss of critical habitats, cultural heritage, or ecosystem services.

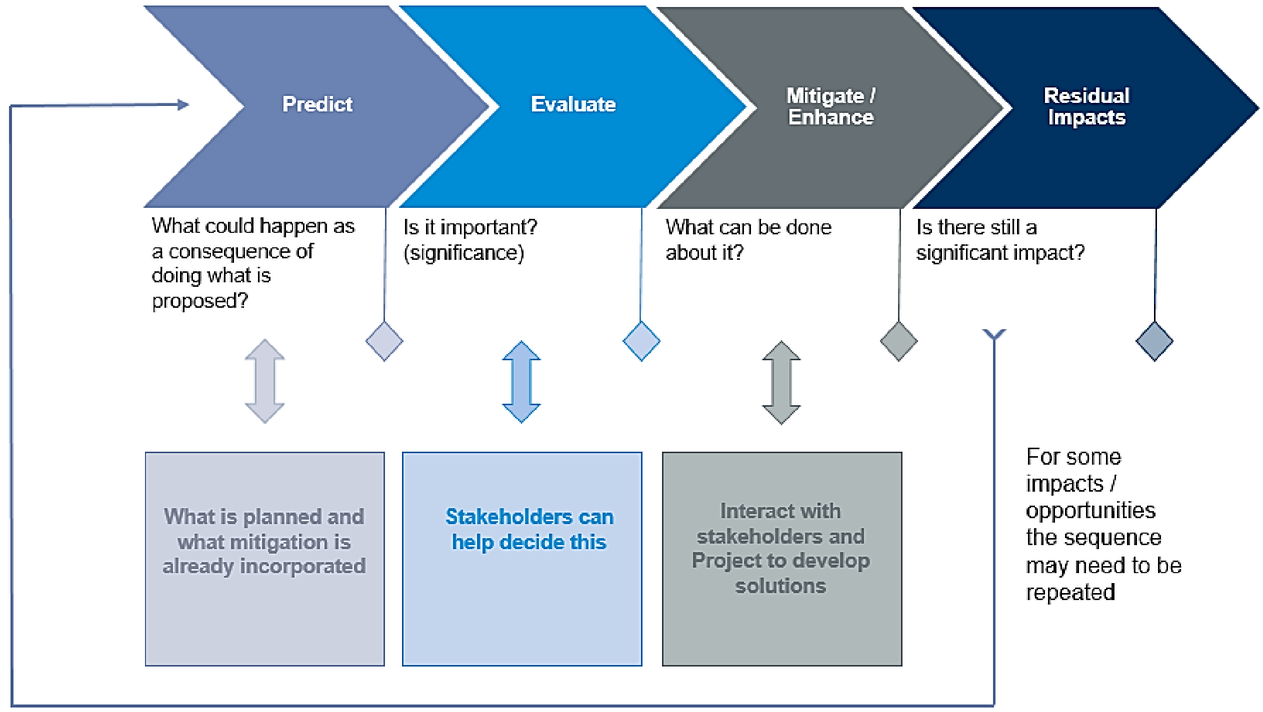
Source: Adapted from ERM, 2012

When categorising an potential impact, it is important to note that this process will consider any control measures that are already part of the project design. Additional mitigation measures aimed at further reducing the significance of potential impacts will also be proposed where necessary or appropriate.

POTENTIAL IMPACT PREDICTION

The assessment of potential impacts followed an iterative process considering four questions, as illustrated in Figure A1. For any potential impact rated as Minor or greater in significance, the project team performed an iterative process of reviewing the potential impacts using the mitigation hierarchy framework. Where significant residual impacts remained, additional mitigation measures were considered. Residual impacts were then re-assessed and refined until reduced to the lowest practicable level for the potential project.

FIGURE A1 POTENTIAL IMPACT PREDICTION AND EVALUATION PROCESS



Source: ERM, 2012

DETERMINING RECEPTOR SENSITIVITY

The specific scale of sensitivity/vulnerability/importance for a receptor depends on the receptor assessed, but in general, it may be defined in terms of its quality, value, rarity, or importance. The ability of a receptor to adapt to change, tolerate, and/or recover from potential impacts is key in adding expert judgment and assessing its overall sensitivity to the impact under consideration.

The value of a resource is assessed by considering its quality and its importance as represented, e.g., by its local, regional, national or international designation, its importance to the local or wider community or its economic value.

The assessment of receptors' sensitivity (e.g., a faunal community or an industry such as fishing or shipping) considers their expected response to the change and their capacity to adapt to and manage the effects of the potential impact.

The scale of sensitivity/vulnerability/importance of the environmental and social receptors that will be impacted by a planned event will be classed as 'low', 'medium', or 'high', as described in Table A2 The severity of the potential impact on environmental and social receptors that will be impacted by an unplanned planned event will be classed as 'low', 'medium', or 'high', as described in Table A2.

TABLE A2 RECEPTOR-SENSITIVITY/ VULNERABILITY DEFINITIONS

Receptor Type	Low Sensitivity Some tolerance to accommodate the effect or can recover/adapt. Low risk of irreplaceable loss of resources.	Medium Sensitivity Low capacity to accommodate the effect and limited ability to recover/adapt. Moderate risk of irreplaceable loss of resources.	High Sensitivity Very low capacity to accommodate the effect and low ability to recover/adapt. High risk of irreplaceable loss of unique or sensitive resources.
Communities	Cohesive, resilient, strong infrastructure and governance	Moderate cohesion, some infrastructure/governance gaps	Fragmented, vulnerable, lacking infrastructure or governance
Ecosystems	Stable, diverse, resilient to environmental changes	Some stress or degradation, moderate resilience	Highly degraded, low biodiversity, sensitive to further disturbance

Source: Adapted from ERM, 2012

DETERMINING MAGNITUDE

This study describes what could happen by predicting the magnitude of the potential impacts and quantifying these to the extent practicable. The term 'magnitude' is used as shorthand to encompass all the dimensions of the predicted impact including:

- The nature of the change (what is affected and how).
- Its size, scale, or intensity.
- Its geographical extent and distribution.
- Its duration, frequency, reversibility; and
- Where relevant, the probability of the impact occurring as a result of accidental or unplanned events.

Magnitude therefore describes the actual change that is predicted to occur in the resource or receptor.

An overall grading of the magnitude of potential impacts is provided, considering all the various dimensions to determine whether a potential impacts is of Negligible, Small, Medium or Large Magnitude. Each potential impact is evaluated on a case-by-case basis and the rationale for each determination is described.

The magnitude designations themselves are universally consistent. However, this scale is defined according to the type of potential impact and is dependent on associated circumstances. For example, for readily quantifiable impacts, numerical values can be used whilst for other topics a more qualitative classification may be necessary. Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes are regarded as having no impact and characterised as having a negligible magnitude. In the case of a positive potential impact, no magnitude designation has been assigned as it is considered sufficient for the purpose of the impact assessment to indicate that the project is expected to result in a positive impact.

The following table summarizes magnitude designations across the different receptors:

TABLE A3 DEFINITION OF MAGNITUDE ACROSS DIFFERENT RECEPTORS

Magnitude	Biophysical	Socio-economic
Negligible	No measurable change; within natural variation. No observable alteration in ecosystem structure or function. Localized, short-term, fully reversible.	No perceptible effect on well-being or access to resources. No change in income, employment, or access. Localized, short-term, fully reversible.
Small	Localized, short-term, minor changes in ecosystem components. Small-scale, low intensity. Limited to project area. Reversible within months.	Local, rare, short-term effects on few individuals. Minor disruption in access or services. Reversible within months.
Medium	Regional, measurable, recoverable changes in ecosystem structure or function. Moderate scale and intensity. Reversible within 1–3 years.	Evident change affecting many people or areas. Medium duration and scale. Reversible with intervention.
Large	Widespread, long-term, potentially irreversible changes. High intensity and scale. Affects ecosystem integrity. May not be reversible.	Dominates baseline conditions. It affects majority of the population. Long-term or large-scale. Reversibility uncertain.
Positive	Not assigned; noted as beneficial where applicable.	Not assigned unless robust data is available to support benefit.

Source: Adapted from ERM, 2012

EVALUATION OF SIGNIFICANCE

The next step in the assessment is to take the information on the magnitude of impacts and explain what this means in terms of its importance to society and the environment. This is to enable decision makers and stakeholders to understand how much weight should be given to the issue in deciding on their view of a project. This is referred to as Evaluation of Significance.

For the purposes of this report, the following definition is used:

'An impact is significant if, in isolation or in combination with other impacts, it should, in the judgment of the team undertaking the assessment, be reported in the ESIA so that it can be taken into account in decision making on whether the project should proceed and if so under what conditions.' (ERM, 2013).

This recognises that evaluation requires an exercise of judgment and that judgments may vary between parties in the process. The evaluation of impacts that is presented in this study is based on the professional judgment and experience of the team undertaking the assessment. The team undertaking the assessment is informed by reference to the national legal standards, international regulations, government policies, CNEL policies/ standards/ guidelines and applicable industry practices.

Where standards are not available or provide insufficient information on their own to allow a grading of significance, the significance has been evaluated considering the magnitude of the impact and the value or sensitivity of the affected resource or receptor. Magnitude is defined across the various dimensions described in the previous sub-section. The value of a resource is judged considering its quality and its importance as represented, for example, by its local, regional, national, or international designations; its importance to the local or wider community; or its economic value. The assessment of receptor sensitivity, for example a faunal community or an industry (e.g. fishing, shipping), takes into account their anticipated response to the change and their ability to adapt to and manage the effects of the impact.

PLANNED AND UNPLANNNED EVENTS

For both planned and unplanned events, magnitude and sensitivity/vulnerability/importance are considered in combination to evaluate whether an potential impact is significant, and if so, to determine its degree of significance.

For planned events, magnitude considers the nature, size, geographical extent, duration, frequency, and reversibility of the potential impact occurring.

For unplanned events, magnitude (often referred to as consequence) considers the probability, extent, duration, intensity, and the severity of the potential impact on environmental and social receptors, particularly in the context of accidental or unforeseen events. The principle is illustrated in Figure A2.

FIGURE A2 EVALUATION OF SIGNIFICANCE (PLANNED AND UNPLANNED EVENTS)

Evaluation of Significance		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	Medium	High
Magnitude of Impact	Negligible	Incidental	Incidental	Incidental
	Small	Minor	Minor	Moderate
	Medium	Moderate	Major	Severe
	Large	Major	Severe	Catastrophic

Source: Adapted from ERM, 2012

The matrix applies universally to all resources/receptors, and all potential impacts to these resources/receptors, as the resource/receptor-specific considerations are factored into the assignment of magnitude and sensitivity/vulnerability/importance designations. Table A4 provides context for the various impact significance ratings.

TABLE A4 DEFINITIONS OF ENVIRONMENTAL AND SOCIAL SIGNIFICANCE (CONSEQUENCE) CRITERIA AND ASSOCIATED POTENTIAL IMPACT SIGNIFICANCE RATING

Impact Significance	Potential Environmental Impact Definition	Potential Social Impact Definition
Incidental	Negligible disturbance or impact, and/or the impact is reversible within a very short period of time (e.g. days to months).	Incidental impact that is indistinguishable from existing and/or pre-project conditions.

Impact Significance	Potential Environmental Impact Definition	Potential Social Impact Definition
Minor	Impact occurs at a local scale (e.g. within, or in the vicinity of a disturbance footprint or operational area) or affects a minor part of a species habitat or population but the impact is recoverable in the short term (e.g. 3 months to 2 years).	Minor, inconvenient social impacts that lasts less than one year and/or are reversible.
Moderate	Impact occurs at a local scale or affects a minor part of a species habitat or population but the impact is recoverable in the long-term (e.g. two to ten years), or impact affects a wide area (e.g. significantly greater than disturbance footprint), or affects a significant proportion of a habitat or population (e.g. >10%) but the impact is recoverable in the short-term (e.g. 3 months to 2 years).	Moderate, localised or short-term (e.g. 1 to 3 years), recoverable social impact. Community stakeholders are likely able to adapt with relative ease.
Major	Impact occurs at a local scale or affects a minor part of a species habitat or population and the impact is persistent (e.g. >10 years for recovery or never expected to fully recover), or impact affects a wide area (e.g. significantly greater than disturbance footprint), or affects a significant proportion of a habitat or population (e.g. >10%) but where the impact is recoverable in the long-term (e.g. 2 to 10 years).	Major, local-to-regional (sub-national) or medium-term (e.g. 3 to 6 years) recoverable social impact. Community stakeholders may be able to adapt with some targeted support or assistance.
Severe	Impact affects a wide area (e.g. significantly greater than disturbance footprint), or affects a significant proportion of a species habitat or population (e.g. >10%) and the impact is persistent (e.g. >10 years or never expected to fully recover), or impact affects a very large area (e.g. an entire region and/or the majority or all of a habitat type or population and/or results in loss of ecosystem function), and lasts long-term (e.g. 2 to 10 years).	Severe, local-to-national or long-term (up to 10 years) non-recoverable social impacts. Community stakeholders, social services or infrastructure may not be able to adapt without sustained targeted support or assistance.
Catastrophic	Impact affects a very large area (e.g., an entire region and/or the majority or all of a species habitat type or population and/or results in loss of ecosystem function) and is persistent (e.g., >10 years for recovery or never expected to fully recover).	Nonrecoverable social impacts lasting longer than 10 years, and community stakeholders may not be able to adapt without significant intervention. Total loss of (substantial or significant) community property, cultural asset or natural resources (e.g., ecosystems services) without the ability to replace.

Source: Chevron, 2024

MITIGATION

The impact assessment process make sures that project decisions are informed by their potential effects on the environment and society. A critical step in this process is the identification and integration of mitigation measures into the design and planning of the potential project.

Mitigation efforts focus on identifying where potential impacts of Minor or greater significance may occur and working with the project team to apply the Protective by Design approach using the mitigation hierarchy framework. This make sures that potential impacts are avoided or reduced as far as reasonably practicable.

When a significant potential impact is identified, mitigation measures are defined following a structured hierarchy, as outlined in Box A1. The priority is to first avoid or reduce the impact at its source. If residual effects remain, additional measures such as abatement, restoration, or compensation are considered to further reduce the significance of the impact.

BOX A1 MITIGATION HIERARCHY

Avoid at Source; Reduce at Source: avoiding or reducing at source through the design of the project i.e. avoiding by siting or re-routing activity away from sensitive areas or reducing by restricting the working area or changing the time of the activity.
Abate on Site: add something to the design to abate the impact i.e. pollution control equipment.
Abate at Receptor: if an impact cannot be abated on-site then control measures can be implemented off-site i.e. traffic measures.
Repair or Remedy*:* some impacts involve unavoidable damage to a resource (i.e. material storage areas) and these impacts require repair, restoration, and reinstatement measures.
Compensate in Kind; Compensate through Other Means where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate i.e. financial compensation for degrading agricultural land and impacting crop yields.

Source: ERM, 2012

POTENTIAL RESIDUAL IMPACTS

In some cases, it may only be possible to reduce the potential impact to a certain degree through mitigation (i.e., there is an impact remaining even after mitigation). These potential impacts are therefore residual in the sense that they remain after mitigation measures have been applied to the intended activity.

Where an impact could not be completely avoided, the potential residual impact has been reassessed and the possibility for further mitigation considered. All residual significant impacts are described in this study with commentary on why further mitigation is not feasible. Additional mitigation measures do not need to be declared for impacts rated as Incidental and Minor significance.

POTENTIAL CUMULATIVE IMPACTS

Potential cumulative impact arise a result of an potential impact from the project interacting with an impact from another activity to create an additional impact.

How the potential impacts and effects are assessed is strongly influenced by the status of the other activities (e.g. already in existence, approved or proposed) and how much data is available to characterise the magnitude of their impacts.

The approach to assessing cumulative impacts is to screen potential interactions with other projects on the basis of:

- Projects that are already in existence and are operating or in progress;

- Projects that are approved but not yet operating or in progress; and
- Projects that are a realistic proposition but are not yet installed or under construction.

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MARINE BIODIVERSITY STUDY

ENVIRONMENTAL IMPACT ASSESSMENT FOR PROPOSED EXPLORATION WELL DRILLING IN PEL 82 IN THE WALVIS BASIN OFF THE COAST OF CENTRAL NAMIBIA

Marine Biodiversity Assessment

PREPARED FOR

Chevron Namibia Exploration Limited

DATE
30 September 2025

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ENVIRONMENTAL IMPACT ASSESSMENT FOR PROPOSED EXPLORATION WELL DRILLING IN PEL 82 IN THE WALVIS BASIN OFF THE COAST OF CENTRAL NAMIBIA
Marine Biodiversity Assessment
0775081

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ACRONYMS AND ABBREVIATIONS

Acronyms	Description
ALARP	As Low As Reasonably Practicable
AUD INJ	auditory injury
BAT	Best Available Techniques
bbl	barrels
BCC-SBA	Benguela Current Commission Spatial Biodiversity Assessment
BCLME	Benguela Current Large Marine Ecosystem
BOD	Biological Oxygen Demand
BOP	Blow-out Preventor
BOCP	Blow Out Contingency Plan
CBD	Convention of Biological Diversity
Cd	Cadmium
CFSR	Climate Forecast System Reanalysis
cm	centimetres
cm/s	centimetres per second
CITES	Convention on International Trade in Endangered Species
CMS	Convention on Migratory Species
CNEL	Chevron Namibia Exploration Limited II
CO_2	Carbon dioxide
CSIR	Council for Scientific and Industrial Research
dB	decibels
DNA	deoxyribonucleic acid
DPS	Dynamic Positioning System
DST	Drill String Test
DWH	Deepwater Horizon
EBSA	Ecologically or Biologically Significant Area
EEZ	Exclusive Economic Zone
EMPr	Environmental Management Programme report
ENSO	El Niño Southern Oscillation
EPA	Environmental Protection Agency
EPLs	Exclusive Prospecting Licenses
ERP	Emergency Response Plan
ESA	Ecological Support Area
ESIA	Environmental and Social Impact Assessment
FAO	Food and Agricultural Organisation
g	grams

Acronyms	Description
g/m^2	grams per square metre
$g\ C/m^2$	grams Carbon per square metre
g/L	grams per litre
h	hour
HAB	Harmful Algal Bloom
HF	High Frequency
Hg	Mercury
H_2S	hydrogen sulphide
Hz	Herz
IBAs	Important Bird Areas
IFC	International Finance Corporation
IPIECA	International Petroleum Industry Environmental Conservation Association
IMMA	Important Marine Mammal Area
IMO	International Maritime Organisation
IOGP	International Association of Oil & Gas Producers
ISPPC	International Sewage Pollution Prevention Certificate
ITOPF	International Tanker Owners Pollution Federation
IUCN	International Union for the Conservation of Nature
IWC	International Whaling Commission
JNCC	Joint Nature Conservation Committee
KBA	Key Biodiversity Area
kHz	kiloHerz
km	kilometre
km^2	square kilometre
km/h	kilometres per hour
kts	knots
KZN	KwaZulu Natal
LF	Low Frequency
LOC	Loss of containment
MCM	Marine & Coastal Management (RSA)
MET	Ministry of Environment and Tourism
MFMR	Ministry of Fisheries and Marine Resources
ML	Mining License
MMNET	Marine Mammal Noise Exposure Tool
MMO	Marine Mammal Observer
MODU	Mobile Offshore Drilling Unit

Acronyms	Description
MPA	Marine Protected Area
MSP	Marine Spatial Planning
m	metres
m^2	square metres
mm	millimetres
m^3	cubic metre
m^3/s	cubic metre per second
m/sec	metres per second
MFO	Mixed-function oxygenase
mg $C/m^2/hr$	milligrams Carbon per square metre per hour
mg/kg	Milligrams per kilogram
mg/L	milligrams per litre
mg/m^3	milligrams per cubic metre
ml/L	millilitres per litre
MSP	Marine Spatial Planning
MT	Metric tonne
NABF	Non-Aqueous Base Fluid
NADF	Non-aqueous drilling fluid
NEMBA	National Environmental Management: Biodiversity Act
NDP	Namibian Dolphin Project
NIMPA	Namibian Islands Marine Protected Area
nm	Nautical mile
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NSF	National Science Foundation
NSO	nitrogen-sulfur-oxyge
OMZs	Oxygen Minimum Zones
OOC	Oil on Cuttings
OSCP	Oil Spill Contingency Plan
OSPAR	Oslo/Paris convention *(for the Protection of the Marine Environment of the North-East Atlantic)*
OSRP	Oil Spill Response Plan
OSPL	Oil Spill Response Limited
OWCP	Oiled Wildlife Contingency Plan
PAH	Polycyclic aromatic hydrocarbons
PAM	Passive Acoustic Monitoring

Acronyms	Description
PCAD	population consequences of acoustic disturbance
PCoD	Population Consequences of Disturbance
PEL	Petroleum Exploration License
PIM	Particulate Inorganic Matter
PNEC	Predicted no-effect concentration
POM	Particulate Organic Matter
ppm	parts per million
psi	pound-force per square inch
PTS	permanent threshold shifts
RMS	root mean squared
RMU	Regional Management Unit
ROVs	Remote Operated Vehicles
SACW	South Atlantic Central Water
SAR	Synthetic Aperture Radar
SD	standard deviation
SEL	sound exposure level
SLR	SLR Consulting (Pty) Ltd
SOPEP	Shipboard Oil Pollution Emergency Plan
SPL	sound pressure level
SPRFMO	South Pacific Regional Fisheries Management Organisation
SSDI	Subsea Dispersion Injection
SWIO	South Western Indian Ocean
TAC	Total Allowable Catch
TEEPNA	Total Exploration and Production Namibia B.V.
TFCA	Transfrontier Conservation Area
THC	Total hydrocarbon concentration
TOPS	Threatened or Protected Species
TSPM	Total Suspended Particulate Matter
TSS	Total Suspended Solids
TTS	temporary threshold shifts
UK	United Kingdom
US	United States of America
VHF	Very High Frequency
VMEs	Vulnerable Marine Ecosystems
VOCs	volatile organic compounds
VOS	Voluntary Observing Ships

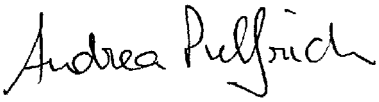
Acronyms	Description
VSP	Vertical Seismic Profiling
WBM	Water-based mud
WWF	World Wildlife Fund
µg	micrograms
µm	micrometre
µg/L	micrograms per litre
µM	micro Mols
µPa	micro Pascal
°C	degrees Centigrade
%	percent
~	approximately
<	less than
>	greater than

Expertise and Declaration of INDEPENDENCE

This report was prepared by Dr Andrea Pulfrich of Pisces Environmental Services (Pty) Ltd. Andrea has a PhD in Fisheries Biology from the Institute for Marine Science at the Christian-Albrechts University, Kiel, Germany.

As Director of Pisces since 1998, Andrea has considerable experience in undertaking specialist environmental impact assessments, baseline and monitoring studies, and Environmental Management Programmes relating to marine diamond mining and dredging, hydrocarbon exploration and thermal/hypersaline effluents. She is a registered Environmental Assessment Practitioner and member of the South African Council for Natural Scientific Professions, South African Institute of Ecologists and Environmental Scientists, and International Association of Impact Assessment (South Africa).

This specialist report was compiled for ERM on behalf of Chevron Namibia Exploration Limited for their use in preparing an Environmental & Social Impact Assessment for proposed exploration well drilling in PEL 82 off the coast of Central Namibia. I do hereby declare that Pisces Environmental Services (Pty) Ltd is financially and otherwise independent of the Applicant and ERM.



Dr Andrea Pulfrich

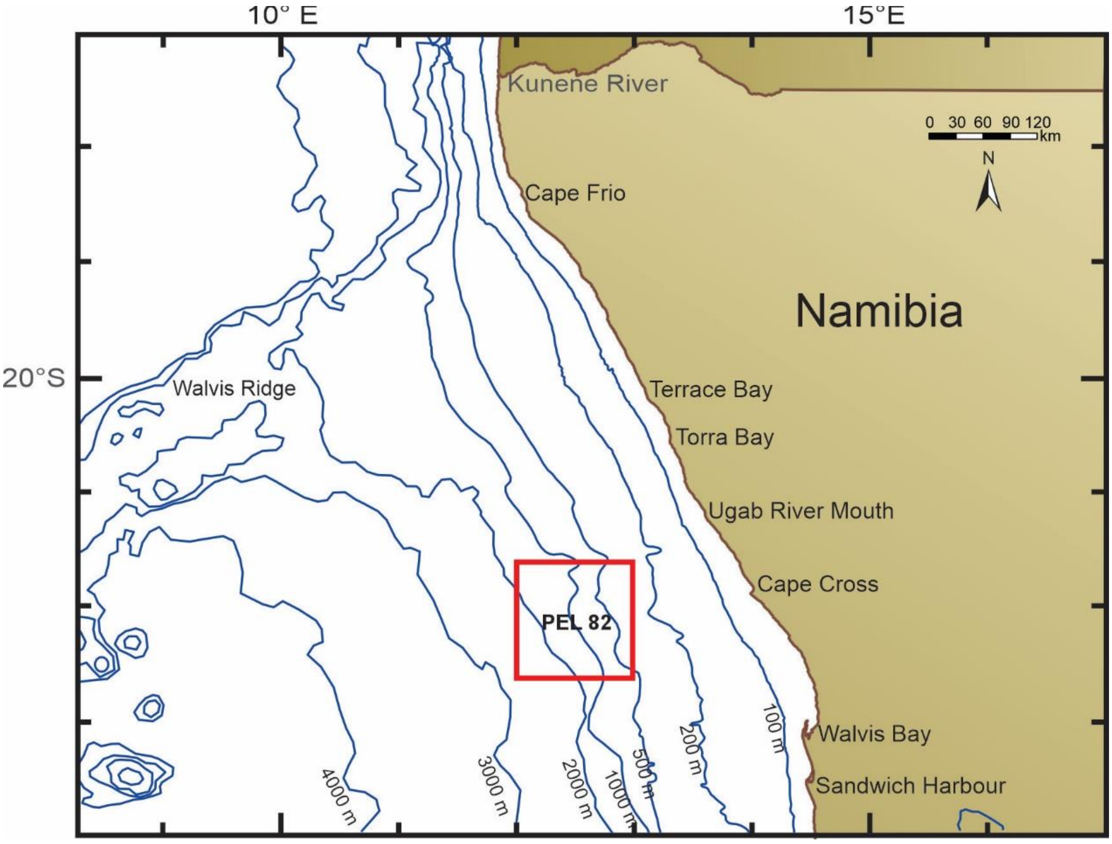
1. GENERAL INTRODUCTION

1.1 BACKGROUND

Chevron Namibia Exploration Limited II (CNEL) entered agreements to acquire 80% working interest and operatorship for Namibian Blocks 2112B and 2212A under Petroleum Exploration License (PEL) 82 on April 28, 2024. PEL 82 is located in the Walvis Basin off the coast of Namibia. The license covers an area of approximately 11,400 km^2 located between 72 and 300 km from the Namibian coastline with water depths ranging from 200 – 2,500 m (Figure 1-1).

Under Namibia's Environmental Management Act of 2007, exploration well drilling is a listed activity (Government Notice No. 29) requiring an Environmental Impact Assessment (EIA) process to obtain an Environmental Clearance Certificate from the Ministry of Environment, Forestry and Tourism (MEFT).

FIGURE 1-1 THE LOCATION OF PEL 82 (BLOCKS 2112B AND 2212A) IN RELATION TO BATHYMETRIC FEATURES AND PLACES MENTIONED IN THE TEXT.



ERM has been appointed by CNEL to undertake the necessary application processes in terms of the Petroleum (Exploration and Production) Act, 1991 (No. 2 of 1991) and Environmental Management Act, 2007 (No. 7 of 2007). ERM in turn approached CapMarine Environmental and Pisces Environmental Services (Pty) Ltd to provide a specialist report on potential impacts of the proposed exploration well-drilling operations on fisheries and marine biodiversity, respectively, in the area.

1.2 SCOPE OF WORK

The following general terms of reference, as specified by ERM, for specialist studies are:

- Describe the receiving environment and baseline conditions that exist in the study area and identify any sensitive areas that will need special consideration.
- Review the Scoping Comments and Responses Report to ensure that all relevant issues and concerns relevant to fields of expertise are addressed.
- Identify and assess potential impacts of the proposed project activities and infrastructure, including any associated cumulative impacts.
- Describe the legal, permit, policy and planning requirements.
- Identify areas where issues could combine or interact with issues likely to be covered by other specialists, resulting in aggravated or enhanced impacts.
- Indicate the reliability of information utilised in the assessment of impacts as well as any constraints to which the assessment is subject (e.g. any areas of insufficient information or uncertainty).
- Where necessary consider the precautionary principle in the assessment of impacts.
- • Identify management and mitigation actions using the Mitigation Hierarchy by recommending actions in order of sequential priority. Avoid first, then reduce/minimise, then rectify and then lastly offset.
- Identify alternatives that could avoid or minimise impacts.
- Determine significance thresholds for limits of acceptable change.

The terms of reference specifically for the marine faunal assessment are:

- Provide a general description of the benthic environment in the Benguela System along the central and southern Namibian coast, based on current available literature.
- Describe the coastal and offshore habitats that are likely to be affected by exploration drilling activities.
- Identify sensitive habitats and species that may be potentially affected by the proposed exploration activities.
- Describe seasonal and migratory occurrences of key marine fauna.
- Identify, describe and assess the significance of potential impacts of the proposed exploration drilling programme on the local marine fauna, focusing particularly on the benthic environment, but including generic effects on cetaceans, turtles, seals, fish and pelagic invertebrates. The assessment is to consider both planned (normal operation) and unplanned (emergency event) activities, including any related transboundary impacts.
- Identify practicable mitigation measures to reduce the significance of any negative impacts and indicate how these can be implemented during the execution of

exploration well drilling. Mitigation for unplanned emergency events must also take cognisance of Namibia's National Marine Pollution Contingency Plan and highlight any aspects relevant to marine fauna.

1.3 APPROACH TO THE STUDY

All identified potential marine impacts are summarised, categorised and ranked in appropriate impact assessment tables, to be incorporated in the overall ESIA Report.

NOTE: This report covers the drilling of up to ten exploration and appraisal wells by CNEL only. The possible range of future exploration and production activities that may arise cannot at this stage be reasonably defined as these may vary significantly in scope, location, extent, and duration depending on whether a resource(s) is discovered, its size, properties and location, etc. It is possible that the proposed exploration fails to identify an economic hydrocarbon resource, in which case the potential impacts associated with the production phase would not be realised. It is thus not possible to include an assessment of the potential environmental impacts associated with the production phase. Should the project proceed to the production phase, a new ESIA process would need to be undertaken.

1.3.1 ASSUMPTIONS, LIMITATIONS AND INFORMATION GAPS

As determined by the terms of reference, this study has adopted a 'desktop' approach. Consequently, the description of the natural baseline environment in the study area is based on a review and collation of existing information and data from the scientific literature, internal reports and various Marine Mammal Observer (MMO) Reports for the general project area. Information had been updated where appropriate.

The information for the identification of potential impacts of the proposed exploration activities on the benthic marine environment was drawn from various scientific publications, the Generic EMPr (CCA and CMS 2001) and Benguela Current Large Marine Ecosystem (BCLME) Thematic Report (CSIR 1999), previous specialist reports (Atkinson 2010; Atkinson & Shipton 2010), various MMO Reports for the general project area, and information sourced from the Internet. The sources consulted are listed in the Reference chapter.

The assumptions made in this specialist assessment are that:

- The study is based on the project description made available to the specialist at commencement of the study.
- Some important conclusions regarding the extent of the zones of impact of underwater sound, drilling discharges, and oil spill caused by an unplanned loss of containment event, and associated assessments on marine ecology, are based on the results of the various modelling studies conducted as part of the ESIA. The specialist assumes that the results provided in these reports are correct and true.

Information gaps include:

- abundance, distribution and diversity of the benthic macrofaunal communities and potentially vulnerable species beyond the shelf break and in continental slope and abyssal habitats;
- abundance, distribution, diversity and seasonality of demersal fish communities beyond the shelf break and in continental slope and abyssal habitats;
- information specific to the marine communities of seamounts and submarine canyons; and
- current information on the distribution, population sizes and seasonal trends of pelagic seabird, turtle and cetacean species occurring in southern African waters and the project area in particular.

Keeping these information gaps in mind, the assessment of impacts has adopted a strongly precautionary approach and information gaps are thus not considered to have any negative implications in terms of the credibility of the results of the assessment.

1.4 IMPACT ASSESSMENT METHODOLOGY

During scoping, a preliminary analysis was undertaken of the ways in which the project may potentially interact (positively and negatively) with environmental and socioeconomic resources or receptors. The potential impacts that were identified as potentially significant during the scoping process provided focus for the specialist studies for the detailed ESIA Report. Each of the potential impacts identified is assessed using the following methodology.

1.4.1 IMPACT IDENTIFICATION AND CHARACTERISATION

An ‘impact’ is any change to a resource or receptor caused by the presence of a project component or by a project-related activity. Impacts can be negative or positive. Impacts are described in terms of their characteristics, including the impact type, and their spatial and temporal features (namely extent, duration, reversibility and scale). Terms used in the characterisation of potential impacts within this study are described in Table 1-1.

TABLE 1-1 POTENTIAL IMPACT CHARACTERISTICS

Characteristic	Definition	Term
Type	A descriptor indicating the relationship of the impact to the project (in terms of cause and effect).	Direct - Impacts that result from a direct interaction between the project and a resource/receptor (e.g. between occupation of the seabed and the habitats which are affected). Indirect - Impacts that follow on from the direct interactions between the project and its environment as a result of subsequent interactions within the environment (e.g. viability of a species population resulting from loss of part of a habitat as a result of the project occupying the seabed). Induced - Impacts that result from other activities (which are not part of the project) that happen as a consequence of the project. Cumulative - Impacts that arise as a result of an impact and effect from the project interacting with those from another activity (including those from concurrent or planned future third-party activities) to create an additional impact and effect.
Duration and Reversibility	Duration - The time period over which a resource / receptor is affected. Reversibility - The degree to which an impact can be undone or recovered from. This includes consideration of the natural resilience of the affected resource or receptor, the availability of restoration measures and the timeframe required for recovery.	Temporary - impacts are of short duration and intermittent or occasional. Localized and fully reversible within a short timeframe. Short term - impacts last for 6 months or less. Localized, low intensity and fully reversible. Medium term - impacts last more than 6 months and up to 3years. Regional in extent, moderate intensity and reversible with intervention. Long term -Impacts last more than three years and less than ten years. May affect ecosystem or community function. Reversible but may require significant effort. Permanent - impacts cause a lasting change beyond 10 years. High intensity and scale. Irreversible or only partially reversible.
Probability/ Likelihood	The chance or frequency with which an impact may occur.	Rare - The impact is rare or unheard of. Remote - The impact has occurred once or twice in the industry. Unlikely - Reasonable to expect the impact will not occur . Seldom - Exceptional conditions may allow impact to occur. Occasional - Conditions may allow the impact to occur. Likely - The impact is expected to occur.

Characteristic	Definition	Term
Extent	The reach of the impact (i.e. physical distance an impact will extend to)	On-site - impacts that are limited to the project site. Local - impacts that are limited to the project site and adjacent areas. Regional - impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries, habitat type/ecosystems, i.e., extend to areas outside the project site. National - impacts that affect nationally important environmental resources or affect an area that is nationally important/ or have macro-economic consequences. Trans-boundary/International - impacts that affect internationally important resources such as areas protected by international conventions or impact areas beyond the national boundary of the country in which the project is based.
Scale	Quantitative measure of the impact	The size of the impact (e.g., area damaged or impacted, the fraction of a resource that is lost or affected, etc.). This characteristic has no fixed designations as it is intended to be a numerical value.
Irreplaceable loss of resources	The degree to which the impact may cause permanent loss of unique or sensitive resources.	Evaluate the uniqueness and sensitivity of affected resources. Identify if the impact could lead to permanent loss of critical habitats, cultural heritage, or ecosystem services.

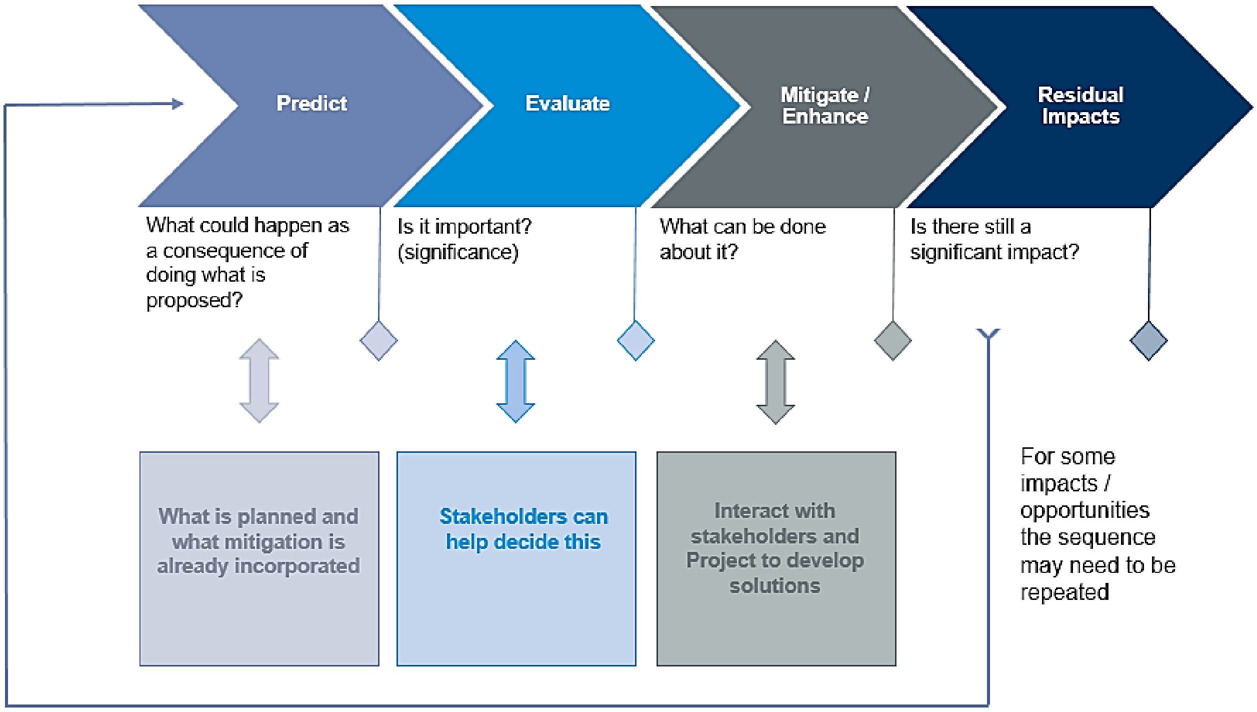
Source: Adapted from ERM, 2012

When categorising an impact, it is important to note that this process will consider any control measures that are already part of the project design. Additional mitigation measures aimed at further reducing the significance of impacts will also be proposed where necessary or appropriate.

1.4.2 POTENTIAL IMPACT PREDICTION

The assessment of potential impacts followed an iterative process considering four questions, as illustrated in Figure 1-2. For any potential impact rated as Minor or greater in significance, the project team performed an iterative process of reviewing the potential impacts using the mitigation hierarchy framework. Where potential significant residual impacts remained, additional mitigation measures were considered. Potential residual impacts were then re-assessed and refined until reduced to the lowest practicable level for the project being considered.

FIGURE 1-2 POTENTIAL IMPACT PREDICTION AND EVALUATION PROCESS



Source: ERM, 2012

1.4.3 DETERMINING MAGNITUDE

This study describes what could happen by predicting the magnitude of the potential impacts and quantifying these to the extent practicable. The term ‘magnitude’ is used as shorthand to encompass all the dimensions of the predicted impact including:

The nature of the change (what is affected and how).

- Its size, scale, or intensity.
- Its geographical extent and distribution.
- Its duration, frequency, reversibility; and
- Where relevant, the probability of the impact occurring as a result of accidental or unplanned events.

Magnitude therefore describes the actual change that is predicted to occur in the resource or receptor.

An overall grading of the magnitude of potential impacts is provided, considering all the various dimensions to determine whether a potential impact is of Negligible, Small, Medium or Large Magnitude. Each potential impact is evaluated on a case-by-case basis and the rationale for each determination is described.

The magnitude designations themselves are universally consistent. However, this scale is defined according to the type of potential impact and is dependent on associated circumstances. For example, for readily quantifiable impacts, numerical values can be used whilst for other topics a more qualitative classification may be necessary. Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes are regarded as having no impact and characterised as having a negligible magnitude. In the case of a positive potential impact, no magnitude designation has been assigned as it is considered sufficient for the purpose of the impact assessment to indicate that the project is expected to result in a positive impact.

The following table summarizes magnitude designations across the different receptors:

TABLE 1-2 DEFINITION OF MAGNITUDE ACROSS DIFFERENT RECEPTORS

Magnitude	Biophysical	Socio-economic
Negligible	No measurable change; within natural variation. No observable alteration in ecosystem structure or function. Localized, short-term, fully reversible.	No perceptible effect on well-being or access to resources. No change in income, employment, or access. Localized, short-term, fully reversible.
Small	Localized, short-term, minor changes in ecosystem components. Small-scale, low intensity. Limited to project area. Reversible within months.	Local, rare, short-term effects on few individuals. Minor disruption in access or services. Reversible within months.
Medium	Regional, measurable, recoverable changes in ecosystem structure or function. Moderate scale and intensity. Reversible within 1–3 years.	Evident change affecting many people or areas. Medium duration and scale. Reversible with intervention.
Large	Widespread, long-term, potentially irreversible changes. High intensity and scale. Affects ecosystem integrity. May not be reversible.	Dominates baseline conditions. It affects majority of the population. Long-term or large-scale. Reversibility uncertain.
Positive	Not assigned; noted as beneficial where applicable.	Not assigned unless robust data is available to support benefit.

Source: Adapted from ERM, 2012

1.4.4 DETERMINING RECEPTOR SENSITIVITY

The specific scale of sensitivity/vulnerability/importance for a receptor depends on the receptor assessed, but in general, it may be defined in terms of its quality, value, rarity, or importance. The ability of a receptor to adapt to change, tolerate, and/or recover from potential impacts is key in adding expert judgment and assessing its overall sensitivity to the impact under consideration.

The value of a resource is assessed by considering its quality and its importance as represented, e.g., by its local, regional, national or international designation, its importance to the local or wider community or its economic value.

The assessment of receptors' sensitivity (e.g., a faunal community or an industry such as fishing or shipping) considers their expected response to the change and their capacity to adapt to and manage the effects of the impact.

The scale of sensitivity/vulnerability/importance of the environmental and social receptors that will be impacted by a planned event will be classed as 'low', 'medium', or 'high', as described in Table 1-3. The severity of the potential impact on environmental and social receptors that will be impacted by an unplanned planned event will be classed as 'low', 'medium', or 'high', as described in Table 1-3.

TABLE 1-3 RECEPTOR-SENSITIVITY/ VULNERABILITY DEFINITIONS

Receptor Type	Low Sensitivity Some tolerance to accommodate the effect or can recover/adapt. Low risk of irreplaceable loss of resources.	Medium Sensitivity Low capacity to accommodate the effect and limited ability to recover/adapt. Moderate risk of irreplaceable loss of resources.	High Sensitivity Very low capacity to accommodate the effect and low ability to recover/adapt. High risk of irreplaceable loss of unique or sensitive resources.
Communities	Cohesive, resilient, strong infrastructure and governance	Moderate cohesion, some infrastructure/governance gaps	Fragmented, vulnerable, lacking infrastructure or governance
Ecosystems	Stable, diverse, resilient to environmental changes	Some stress or degradation, moderate resilience	Highly degraded, low biodiversity, sensitive to further disturbance

Source: Adapted from ERM, 2012

1.4.5 EVALUATION OF SIGNIFICANCE

The next step in the assessment is to take the information on the magnitude of impacts and explain what this means in terms of its importance to society and the environment. This is to enable decision makers and stakeholders to understand how much weight should be given to the issue in deciding on their view of a project. This is referred to as Evaluation of Significance.

For the purposes of this report, the following definition is used:

'An impact is significant if, in isolation or in combination with other impacts, it should, in the judgment of the team undertaking the assessment, be reported in the ESIA so that it can be taken into account in decision making on whether the project should proceed and if so under what conditions.' (ERM 2013).

This recognises that evaluation requires an exercise of judgment and that judgments may vary between parties in the process. The evaluation of impacts that is presented in this study is based on the professional judgment and experience of the team undertaking the assessment. The team undertaking the assessment is informed by reference to the national legal standards, international regulations, government policies, CNEL policies/ standards/ guidelines and applicable industry practices.

Where standards are not available or provide insufficient information on their own to allow a grading of significance, the significance has been evaluated considering the magnitude of the impact and the value or sensitivity of the affected resource or receptor. Magnitude is defined across the various dimensions described in the previous sub-section (refer to Section 1.4.3). The value of a resource is judged considering its quality and its importance as represented, for example, by its local, regional, national, or international designations; its importance to the local or wider community; or its economic value. The assessment of receptor sensitivity, for example a faunal community or an industry (e.g. fishing, shipping), takes into account their anticipated response to the change and their ability to adapt to and manage the effects of the impact (refer to Section 1.4.4).

1.4.5.1 PLANNED AND UNPLANNNED EVENTS

For both planned and unplanned events, magnitude and sensitivity/vulnerability/importance are considered in combination to evaluate whether a potential impact is significant, and if so, to determine its degree of significance.

For planned events, magnitude considers the nature, size, geographical extent, duration, frequency, and reversibility of the potential impact occurring.

For unplanned events, magnitude (often referred to as consequence) considers the probability, extent, duration, intensity, and the severity of the impact on environmental and social receptors, particularly in the context of accidental or unforeseen events. The principle is illustrated in Figure 1-3.

FIGURE 1-3 EVALUATION OF SIGNIFICANCE (PLANNED AND UNPLANNED EVENTS)

Evaluation of Significance		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	Medium	High
Magnitude of Impact	Negligible	Incidental	Incidental	Incidental
	Small	Minor	Minor	Moderate
	Medium	Moderate	Major	Severe
	Large	Major	Severe	Catastrophic

Source: Adapted from ERM, 2012

The matrix applies universally to all resources/receptors, and all impacts to these resources/receptors, as the resource/receptor-specific considerations are factored into the assignment of magnitude and sensitivity/vulnerability/importance designations. TABLE 1-4 provides context for the various impact significance ratings.

TABLE 1-4 DEFINITIONS OF ENVIRONMENTAL AND SOCIAL SIGNIFICANCE (CONSEQUENCE) CRITERIA AND ASSOCIATED IMPACT SIGNIFICANCE RATING

Impact Significance	Potential Environmental Impact Definition	Potential Social Impact Definition
Incidental	Negligible disturbance or impact, and/or the impact is reversible within a very short period of time (e.g. days to months).	Incidental impact that is indistinguishable from existing and/or pre-project conditions.
Minor	Impact occurs at a local scale (e.g. within, or in the vicinity of a disturbance footprint or operational area) or affects a minor part of a species habitat or population but the impact is recoverable in the short term (e.g. 3 months to 2 years).	Minor, inconvenient social impacts that lasts less than one year and/or are reversible.
Moderate	Impact occurs at a local scale or affects a minor part of a species habitat or population but the impact is recoverable in the long-term (e.g. two to ten years), or impact affects a wide area (e.g. significantly greater than disturbance footprint), or affects a significant proportion of a habitat or population (e.g. >10%) but the impact is recoverable in the short-term (e.g. 3 months to 2 years).	Moderate, localised or short-term (e.g. 1 to 3 years), recoverable social impact. Community stakeholders are likely able to adapt with relative ease.
Major	Impact occurs at a local scale or affects a minor part of a species habitat or population and the impact is persistent (e.g. >10 years for recovery or never expected to fully recover), or impact affects a wide area (e.g. significantly greater than disturbance footprint), or affects a significant proportion of a habitat or population (e.g. >10%) but where the impact is recoverable in the long-term (e.g. 2 to 10 years).	Major, local-to-regional (sub-national) or medium-term (e.g. 3 to 6 years) recoverable social impact. Community stakeholders may be able to adapt with some targeted support or assistance.
Severe	Impact affects a wide area (e.g. significantly greater than disturbance footprint), or affects a significant proportion of a species habitat or population (e.g. >10%) and the impact is persistent (e.g. >10 years or never expected to fully recover), or impact affects a very large area (e.g. an entire region and/or the majority or all of a habitat type or population and/or results in loss of ecosystem function), and lasts long-term (e.g. 2 to 10 years).	Severe, local-to-national or long-term (up to 10 years) non-recoverable social impacts. Community stakeholders, social services or infrastructure may not be able to adapt without sustained targeted support or assistance.
Catastrophic	Impact affects a very large area (e.g., an entire region and/or the majority or all of a species habitat type or	Nonrecoverable social impacts lasting longer than 10 years, and community stakeholders may not be able to

Impact Significance	Potential Environmental Impact Definition	Potential Social Impact Definition
	population and/or results in loss of ecosystem function) and is persistent (e.g., >10 years for recovery or never expected to fully recover).	adapt without significant intervention. Total loss of (substantial or significant) community property, cultural asset or natural resources (e.g., ecosystems services) without the ability to replace.

Source: Chevron, 2024

1.4.5.2 MITIGATION

The impact assessment process makes sure that project decisions are informed by their potential effects on the environment and society. A critical step in this process is the identification and integration of mitigation measures into the design and planning of the proposed project.

Mitigation efforts focus on identifying where potential impacts of Minor or greater significance may occur and working with the project team to apply the Protective by Design approach using the mitigation hierarchy framework. This makes sure that impacts are avoided or reduced as far as reasonably practicable.

When a potentially significant impact is identified, mitigation measures are defined following a structured hierarchy, as outlined in Box 1.1. The priority is to first avoid or reduce the impact at its source. If residual effects remain, additional measures such as abatement, restoration, or compensation are considered to further reduce the significance of the impact.

BOX 1.1 MITIGATION HIERARCHY

Avoid at Source; Reduce at Source: avoiding or reducing at source through the design of the project i.e. avoiding by siting or re-routing activity away from sensitive areas or reducing by restricting the working area or changing the time of the activity.
Abate on Site: add something to the design to abate the impact i.e. pollution control equipment.
Abate at Receptor: if an impact cannot be abated on-site then control measures can be implemented off-site i.e. traffic measures.
Repair or Remedy: some impacts involve unavoidable damage to a resource (i.e. material storage areas) and these impacts require repair, restoration, and reinstatement measures.
Compensate in Kind; Compensate through Other Means where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate i.e. financial compensation for degrading agricultural land and impacting crop yields.

Source: ERM, 2012

1.4.5.3 POTENTIAL RESIDUAL IMPACTS

In some cases, it may only be possible to reduce the potential impact to a certain degree through mitigation (i.e., there is an impact remaining even after mitigation). These potential impacts are therefore residual in the sense that they remain after mitigation measures have been applied to the intended activity.

Where an impact could not be completely avoided, the potential residual impact has been reassessed and the possibility for further mitigation considered. All residual significant impacts are described in this study with commentary on why further mitigation is not feasible. Additional mitigation measures do not need to be declared for impacts rated as Incidental and Minor significance.

1.4.5.4 CUMULATIVE IMPACTS

A cumulative impact is one that arises from a result of an impact from the project interacting with an impact from another activity to create an additional impact.

How the impacts and effects are assessed is strongly influenced by the status of the other activities (e.g. already in existence, approved or proposed) and how much data is available to characterise the magnitude of their impacts.

The approach to assessing cumulative impacts is to screen potential interactions with other projects on the basis of:

- Projects that are already in existence and are operating or in progress;
- Projects that are approved but not yet operating or in progress; and
- Projects that are a realistic proposition but are not yet installed or under construction.

2. DESCRIPTION OF THE PROPOSED PROJECT

CNEL is considering initiating an offshore exploration program within Blocks 2112B and 2212A (Figure 1-1), situated within the Walvis Basin, Namibia. The license area spans approximately 11,400 km², located between 72 km and 300 km offshore, with water depths ranging from 200 m to 2,500 m. The plan is to initially conduct up to two-wells in the first campaign at the Gemsbok prospect, located within Block 2112B (coordinates: LAT: 21° 44’ 48.15” S, LONG: 12° 27’ 13.74” E), in water depths ranging from 900 m to 1,500 m. Subject to the results of this initial campaign, additional drilling campaigns of up to 3 to 4 wells per year could potentially start from late 2027 to 2028 over a 3 to 5 year period for a total of up to 10 wells (exploration or appraisal) across blocks 2112B and 2212A.

The summary of the project description below is drawn from the Final Scoping Report. The reader is referred to the Scoping Report for further details.

2.1 DRILLING UNIT

Various types of drilling vessels are used worldwide in offshore drilling operations, with the type of unit typically dependent on water depths in which it needs to operate and marine operating conditions experienced at the well site. The potential drilling unit is a drillship or semi-submersible drill rig using Dynamic Positioning System (DPS). The DPS allows for minimal subsea disturbance due to its ability to operate without moorings. A significant benefit to using a drillship is the ease of mobility as it is a self-propelled vessel with the flexibility to move from location to location without the need of transport vessels.

The use of a semi-submersible drilling unit may also be considered based on the availability of vessels. This type of drilling unit consists of a rig mounted on a floating structure supported by pontoons. When positioned at the well site, the pontoons are partially filled with seawater (ballasted) to submerge them to a specific depth below the sea surface, where wave motion is reduced. This submersion provides stability to the drilling vessel, thereby enhancing the efficiency of drilling operations.

2.1.1 SUPPORT VESSELS

The drilling unit will be serviced by up to four support vessels. These vessels are expected to operate two to three rotations per week. They will be in proximity of the drilling site. They will also facilitate the transportation of equipment and materials between the drilling unit and the onshore base. The support vessels can also be utilized for medical evacuations or crew transfers if necessary and provide assistance in firefighting, oil containment and recovery, rescue operations in case of emergencies, and supply any additional equipment that may be needed.

2.1.2 HELICOPTERS

Transportation of personnel to and from the drillship would most likely be provided by helicopter operations from Walvis Bay area. It is estimated that there could be up to four trips per week between the drilling unit and the helicopter support base in the Walvis Bay area (primary) or Windhoek (secondary). If required, helicopters can also be used for medical evacuations from the drilling unit to shore, both during the day and at night.

2.1.3 EXCLUSION ZONE

During the drilling operations, there will be a temporary 500 m exclusion/safety zone around the drillship, which will be enforced by a standby vessel. The exclusion zone would be described in a Notice to Mariners as a navigational warning.

The purpose of the exclusion zone is to prevent a vessel collision with the drillship during operations. Under the Marine Traffic Act, 1981 (No. 2 of 1981), as amended by the Namibia Ports Authority Act No. 2 of 1994, an “exploration platform” or “exploration vessel” used in prospecting for or mining of any substance falls under the definition of an “offshore installation” and as such it is protected by a 500 m exclusion zone.

According to the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS 1972, Part B, Section II, Rule 18), a drillship involved in underwater operations is classified as a "vessel restricted in its ability to manoeuvre." This classification mandates that power-driven and sailing vessels must yield to such a vessel. Additionally, fishing vessels are required to avoid interfering with the well drilling operations as much as possible.

2.2 SHORE BASE

An onshore logistics base will be located in Walvis Bay. The shore base within the port authority boundaries and control will provide for the storage of various materials and equipment, including pipes, subsea equipment, drilling fluid, cement, chemicals, marine fuels, and water. It will also house a mud plant for mixing drilling fluids, which will be transported to and from the drilling vessel by sea. Additionally, the shore base will serve as office space equipped with communication systems, first response emergency facilities, and will provide accommodation as well as waste management services, vessel refuelling, and customs clearance services.

This base will include a yard area and a warehouse to store drilling materials such as hardware (tubular, wellhead), bulk materials (barite, bentonite, cement), and other minor equipment. A third-party service provider—yet to be selected—will be responsible for supplying additional resources, including a mud plant, essential materials, equipment, and logistical support. Supply vessels providing fuel, food supplies, water, and other necessities to the drillship will also utilize the shore base.

Supply vessels are expected to occupy the quay for approximately 12 hours per trip, depending on the volume of materials to be loaded or unloaded and the time required for customs and sailing clearance. The shore base will feature a mooring area, a temporary office, and bunkering services for vessels.

The existing service infrastructure at the port is sufficient to provide the necessary onshore support for the project, and no additional permanent onshore infrastructure is anticipated to be required.

2.3 PROJECT ACTIVITIES

The following description outlines the typical phases associated with offshore exploration well drilling. While the general approach remains consistent, specific details such as water depth, geological conditions and seafloor characteristics may vary slightly between wells.

Project activities include:

- Mobilisation of the supply vessels, operation of the shore-based facilities for handling support services needed by the Mobile Offshore Drilling Unit (MODU);
- Drilling of a well;
- Well execution (side track, logging, completion) options;
- Optional well testing;
- Well abandonment; and
- Demobilisation of the drillship, vessel and local logistics base.

All activities will be carried out in accordance with internationally recognised industry best practice to make sure safety, environmental protection and operational integrity.

2.4 MOBILISATION PHASE

The mobilisation phase will involve issuing necessary notifications, setting up the onshore base, hiring local service providers, sourcing and transporting equipment and materials from different ports and airports, arranging accommodation, and moving the drilling unit and support vessels to the drilling site.

1.4.1 2.4.1 VESSEL MOBILISATION AND SITE PREPARATION

The drilling unit and supply vessels may either sail directly to the well site from outside Namibian waters or from a Namibian port, depending on the selected drilling unit and its last location. The drillship will be equipped with navigation equipment for accurate station keeping above the well location (dynamic positioning – using thrusters). Both the drilling unit and support and supply vessels will need to undergo customs clearance.

Once in position, the drillship will carry out its pre-drilling activities comprising seabed survey; Remote Operated Vehicle (ROV) dive; positioning; beacon placement and dynamic positioning trials. These activities will be followed up with safety checks, drills, communication tests and drilling of the pilot hole.

Drilling materials, including casings, mud components, cement, and other equipment, will be transported into the country either on the drilling unit itself or via a container vessel directly to the onshore logistics base. From there, supply vessels will transfer these materials to the drilling unit.

2.5 DRILLING PHASE

Drilling is essentially undertaken in two stages, namely the riserless and risered drilling stages.

2.5.1 DRILLING PROCESS

Riserless (Initial) Drilling Stage

The first, 36 inch ("), and second 26" sections of the potential well will be drilled riserless. During this section drilling mud returns are not flowed back to the drilling unit. The drilling of a well generally involves drilling a large diameter hole first and running a large diameter conductor casing which serves as structural pipe to support the load of the well control equipment and subsequent casing strings.

Closed-Loop Drilling Stage

Closed-loop drilling occurs for all sections below the 26" hole section. For deepwater well construction, after the riserless drilling stage, a drilling riser (i.e. a hollow tube known as the 'marine riser') is run between the drilling unit and the seabed so that weighted drilling fluid can be pumped through the drill pipe and out through the drill bit. It circulates all the way around up through the marine riser back to the drilling unit. Drilling fluid helps prevent the well from caving in and clears the rock bits or "cuttings" that are constantly being chipped away as the drill bit drills deeper into the ground to prevent them from building up on the bottom of the well.

2.5.2 WELL DRILLING

The well is planning to be drilled to a total depth range of 1,500 to 4,000 m below mud line.

Once in position at the designated well location, drilling will commence. The well is drilled using a bit that chips off pieces of rock. The drill bit is connected to the surface by segments of hollow pipe, which together are called the drill string. The first and second drilling stages (riserless stage) are made by lowering the drill string from the drill deck to the seafloor and drilling into the seabed. All cuttings are set down directly onto the seafloor. Following these first two stages, a marine riser pipe connects the drilling floor of the drilling unit to the wellhead on the seafloor to collect drilling mud. Drilling is undertaken by lowering the drill string through the closed loop riser to the seafloor and rotating the drill string, causing the drill bit to crush the rock. Cuttings are removed from the bottom of the hole thanks to a drilling fluid containing clays, polymers, weighting agents and/or other materials suspended in a fluid medium. Drilling is stopped at regular intervals to allow new sections of pipe to be added to the drill string or to replace the drill bit.

As the well is drilled, metal casing is placed inside the well to line it and stabilize the hole to prevent it from caving in. The casing also isolates aquifers and hydrocarbon-bearing zones through which the well passes, thus preventing liquids or gases from entering the well prematurely. After each casing string is installed, it is cemented in place. The casing string also provides a firm point for the attachment of the blowout preventor (BOP) stack, which is where it will be located. The conductor casing serves as a support during drilling operations, to flowback returns during drilling and cementing of the surface casing, and to prevent collapse of the loose soil near the surface. The lengths and diameters of each casing section of the well are established prior to drilling. The exact details are determined by the geological conditions through which the well is drilled and will be driven by the final desired hole diameter to drill the reservoir section.

The well will be drilled initially with water-based mud for the riserless sections and then Non-Aqueous Drilling Fluid (NADF) for the subsequent sections. Following installation of the wellhead, BOP, and marine riser, forming a closed, circulating system between the well and drilling unit. The spent NADF will be recycled onboard the drilling unit through a dedicated mechanism where the NADF cuttings will be separated from NADF. Spent NADF will be collected in a fully enclosed skip and shipped to shore for disposal in an environmentally responsible manner, at a licensed waste management facility. NADF cuttings will be treated on the drilling unit to reduce oil content to <6.9% Oil On Cutting (OOC) and discharge the treated cuttings overboard.

2.5.3 DRILLING FLUIDS AND MATERIAL

Drilling Mud

Seawater with high viscous pills, sweeps, and water-based muds (WBM) are used for drilling the tophole sections of the well, which are drilled riserless (that is without the marine riser installed) while NADF are used for the subsequent sections (with riser installed on top of wellhead and BOP).

Mud Management

Unused WBMs will be disposed of at sea after their use. During NADF drilling, drilling muds are circulated in a closed loop system which recycles the drilling muds and removes the drill cuttings. The returns from downhole (muds and cuttings) are routed to the shakers, which will physically separate the drill cuttings from the drilling muds that are then recycled.

Cuttings

During the riserless drilling stage (tophole section drilling) WBM and associated drill cuttings are discharged directly on the seabed in immediate proximity of the well. Cuttings with associated NADF are returned to the drilling unit and processed onboard as stated above (i.e. treated on the drilling unit to reduce oil content to <6.9% OOC and discharged overboard).

Cement

During drilling, the required cement volume will be pumped into the annular space between the casing and the borehole wall. The tophole sections however are cemented to seabed. An excess of cement, necessary to guarantee sufficient presence of cement through the overall annulus, will emerge out of the top of the well. In doing this, the conductor pipe and surface casing are cemented all the way to the seafloor.

After the riser has been installed, for the next phases cement jobs, the excess cement will be returned via the riser to the drilling vessel and treated using the solids control system. Unused cement slurry that has already been mixed is discharged overboard to avoid plugging the lines and tanks.

2.6 WELL LOGGING AND TESTING

Wireline logging is currently planned only in the success case. Data from Logging While Drilling will be gathered during the drilling sections.

Well logging will be standard electric wireline logging. Logging instruments are attached to the bottom of a 'wireline' and lowered to the bottom of the well. The wireline containing a pre-determined array of monitoring instruments is then slowly brought back up, the devices reading different data as they pass each formation and recording it on graphs, which can be interpreted by the geologist, geophysicist, and drilling engineer. The evaluation programme will include sidewall rotary coring; the cores will be recovered to the surface. There are no emissions to the environment associated with standard wireline logging operations. Recovery of fluid samples to surface using a Modular Formation Dynamics Tester, a type of wireline tester which allows samples of reservoir hydrocarbon to be brought to the surface in small, contained volumes.

Vertical Seismic Profiling (VSP) may be undertaken in any of the wells pending data needs for understanding the subsurface.

Well testing is conducted to assess the economic viability of a discovery. If conducted, typically, one test is performed per appraisal well if a resource is found, with up to two tests possible. Each test and associated flaring, can last up to seven days, including five days of build-up and two days of flowing and flaring. During testing, any water from the reservoir may be separated from oily components and treated onboard to minimize hydrocarbons. Any treated water is then either discharged overboard or sent to an onshore facility for further treatment and disposal.

2.7 WELL PLUGGING AND ABANDONMENT

Once drilling is completed, and after well logging activities have been undertaken, the exploration well will be plugged and abandoned; irrespective of whether any hydrocarbons have been discovered in the reservoir sections.

Abandonment involves inserting cement plugs across all reservoir sections that were identified and an abandonment cap on top of the well following standard procedures. The well will be abandoned in accordance with the Chevron global technical standards and will meet or exceed any local regulations. A minimum of two permanent barriers will be placed in the well between any reservoir sands and the seabed.

2.8 DEMOBILISATION

With the exception of the wellhead and potential cuttings depositions, there will be no further physical evidence of drilling on the seafloor. A final clearance survey check will be undertaken using a ROV. On completion of drilling activities, the drilling unit and support vessel will go off hire and will either leave the area or be contracted to other oil and gas exploration operators to continue similar operations.

Wireless monitoring gauges, operating at frequencies between 12.75 and 21.25 kHz, may be installed on wells that CNEL plans to revisit for future appraisal or production activities. These gauges will be positioned on the wellhead and remain there. However, monitoring gauges will not be installed on exploration wells designated for abandonment.

2.9 PROJECT SCHEDULE

The first well on the Gemsbok Prospect, located within Block 2112B, may be drilled in the 2026/2027 timeframe. The plan would be to initially drill an exploration well and subject to the results of this initial well, a second well may be drilled for appraisal (appraisal well). The potential for additional drilling campaigns of up to 3 to 4 wells may be considered in late 2027 to 2028 over a 3 to 5 year period for a total of up to 10 wells (exploration or appraisal) across Blocks 2112B and 2212A.

The drilling of an exploration or appraisal well is expected to require a maximum of 90 days to complete, including mobilisation, drilling operations, well testing if conducted, and demobilisation. This report therefore assesses the impact of drilling either an exploration or appraisal well. The preliminary project schedule for the first well is provided in Table 2-1 below.

TABLE 2-1 PRELIMINARY PROJECT SCHEDULE FOR THE DRILLING OF AN EXPLORATION AND APPRAISAL WELL

Project Phase / Activity	Anticipated Timeframe
Mobilisation	Up to 15 days
Drilling (Exploration Well)	Up to 60 days (including abandonment)
Drilling (Appraisal Well)	Up to 60 days (including abandonment)
Demobilisation	Up to 15 days
Total Estimated Duration	Conservative estimate of up to 90 days for one exploration or an appraisal well based on the timing of when the wells are drilled. If the appraisal well is drilled sequentially, there will not be a separate mobilization and demobilization activity.

2.10 DISCHARGES TO SEA

2.10.1 DRILL CUTTINGS AND MUD DISPOSAL

Drilling operations for the Gemsbok Exploration Well (Block 2112B) and a potential second exploration well location (Block 2112A) will generate drill cuttings as the drill bit penetrates subsurface rock. These cuttings, along with drilling muds, will be discharged according to a defined schedule and composition, as presented in Table 2-2 below.

Although both wells follow the same drilling and discharge procedures, they differ in ocean depth, ranging from 900 to 1,500 m.

TABLE 2-2 WELL PROFILE, DRILLING SCHEDULE AND DISCHARGE PROPERTIES

Section No. and Bore Diameter (ft)	Section Length (m)	Discharge Duration (hours)	Cuttings Mass (MT)	Discharged Mineral Mass of Mud / Attached NABF Mass (MT)	Cuttings Bulk Density (kg/m³)	Density of Mineral Mass of Mud / Density of NABF (kg/m³)
Section 1 36"	85	24	165.49	468.43 / NA	2,588	1,031 (of WBM)
Section 2 26"	938	48	1321.11	9,962.98 / NA	2,588	1,234 (of WBM)
Section 3 17.5"	2,041	120	867.00	101.5 / 101.5	2,108 (Cuttings with adhered NADF Base Oil)	1,984 / 810
Section 4 12.25"	1,417	192	296.75	37.5 / 37.5	2,078 (Cuttings with adhered NADF Base Oil)	2,817 / 810

Source: CNEL, 2025

The drilling process will consist of four sections:

- Sections 1 and 2 will use Water-Based Muds (WBMs), with cuttings discharged near the seabed at approximately 5 m above the seafloor.
- Sections 3 and 4 will use Non-Aqueous Drilling Fluids (NADFs), with treated cuttings containing adhered Non-Aqueous Base Fluid (NABF) discharged at 10 m below the water surface.

Top-hole sections are drilled without a marine riser, using seawater, viscous pills, sweeps and WBM. Fluids and cuttings are discharged directly onto the seabed. Once the riser is installed, excess seawater stored in tanks is discharged. NADF systems operate in a closed-loop configuration, recycling drilling muds and separating cuttings using onboard shakers and dryers. Unused WBMs are discharged to sea, while NADF that cannot be reused is returned to shore. Non-Aqueous Base Fluid (NABF) adhered to cuttings is treated onboard to reduce base fluid retention.

Cuttings containing NADF are treated to minimise NABF retention. NABF, composed of hydrocarbons, may degrade over time once settled on the seabed. Depending on the hydrocarbon properties, they may enter sediment pore water or dissolve into the water column. Although the NABF to be used is considered low toxicity due to the very low percentage of aromatics within the hydrocarbon mixture (Group III as defined by the International Association of Oil and Gas Producers, OGP 2003), degradation may consume dissolved oxygen in sediments, potentially resulting in ecological effects.

The expected fall and spatial extent of the deposition of discharged cuttings is investigated in the Drill Cuttings Deposition Modelling Study conducted by ERM (refer to Appendix D).

2.10.2 CEMENT

Generally during drilling cement and its additives are generally not released. However, in the initial cementing process, i.e. surface casing, surplus cement can flow out of the well's top and onto the seafloor to fully cement the conductor pipe to the seafloor. This process may involve pumping up to 150-200% of the necessary cement volume into the annulus (the space between the casing and the borehole wall). In the worst-case scenario, around 100 m^3 of cement might be discharged onto the seafloor.

2.10.3 PRODUCED WATER

The volume of hydrocarbons (to be burned) and possible associated produced water from the reservoir which could be generated during well testing cannot be reliably predicted due to variations in gas composition, flow rates and water content. Burners are manufactured to make sure emissions are kept to a minimum. The estimated volume of hydrocarbons to be burned cannot be with much accuracy because the actual test requirements can only be established after the penetration of a hydrocarbon-bearing reservoir. However, an estimated 20 million standard cubic feet of gas per day and 20,400 bbl of oil could be flared per test.

If produced water is generated during well testing, it will be separated from the hydrocarbons and discharged to the sea.

2.10.4 BOP HYDRAULIC FLUID

During routine operations involving the opening and closing of the subsea BOP stack, small volumes of hydraulic fluid are released into the marine environment at the seafloor. It is estimated that approximately 500 to 1,000 litres of oil-based hydraulic emulsion fluid may be discharged discharged over 30 days (up to 60 days per well for drilling) during the drilling of a single well. These fluids are designed to be environmentally benign and are biodegradable in seawater within 28 days.

2.10.5 LIQUID DISCHARGES

Table 2-3 shows types and disposal methods of liquid waste anticipated to be generated during the potential project activities. The disposal methods shall comply with Namibian regulations and MARPOL requirements.

TABLE 2-3 TYPES OF LIQUID WASTE AND THEIR DISPOSAL METHODS

Type	Potential disposal method
Wastewater	Wastewater will include brine (which is produced in the reverse osmosis process to produce freshwater on the drillship). Typically, in well drilling operations, the production of freshwater is approximately 40 m^3 per day, leading to an estimated salt output of about 35 g for every litre of water generated (equating to roughly 1,400 kg of salt/brine daily). The wastewater will be treated onboard via a dedicated and approved system prior to discharge in accordance with the requirements the International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78.
Bilge water	Bilge water will be collected and piped into a bilge holding tank on board the project vessels in accordance with MARPOL 1973/78 Annex 1. The fluid will be monitored and any oily water would be processed through a suitable separation and treatment system. Detergents used for washing exposed marine deck spaces will be managed as bilge water. The toxicity of detergents varies greatly depending on their composition. Water-based or biodegradable detergents are preferred for use due to their low toxicity. In certain cases of specific area cleaning, e.g., marine deck with no contamination of pollutants, using no toxic detergent, direct overboard discharge may be considered.
Galley waste	The disposal of galley waste into the sea is permitted under MARPOL 73/78 Annex V, only when the vessel is located more than three nautical miles (approximately 5.5 km) from land and the food waste has been ground or comminuted to particle sizes smaller than 25 mm.
Ballast water	Ballast water is crucial for maintaining safe operating conditions on a ship. It helps reduce hull stress, provides stability, enhances propulsion and manoeuvrability, and compensates for weight changes due to fuel and water consumption. However, discharging ballast water can introduce foreign marine species, such as bacteria and larvae, into new environments, posing ecological risks. This is particularly relevant when moving a drilling unit to Namibia. To mitigate these risks, the 2004 International Convention for the Control and Management of Ships' Ballast Water and Sediments mandates that all ships must have a Ballast Water Management Plan. Ships using ballast water exchange must do so at least 200 nautical miles (approximately 370 km) from the nearest land in waters at least 200 meters deep when arriving from a different marine region. If this is not feasible, the exchange should occur as far from the nearest land as possible, with a minimum distance of 50 nautical miles (about 93 km) and preferably in waters at least 200 meters deep. Project vessels are required to adhere to these regulations.
Sewage and grey water	Sewage discharge from the project vessels and the drilling unit will meet the requirements of MARPOL 73/78 Annex IV. The drilling unit and all project vessels will have a valid International Sewage Pollution Prevention (ISPP) Certificate. The sewage discharged from vessels will be disinfected, comminuted and any effluent will not produce visible floating solids in, nor cause discoloration of the surrounding water. The treatment system will provide primary settling, chlorination, and de-chlorination. The treated effluent will then be discharged into the sea.

2.11 LAND DISPOSAL

A number of other types of wastes generated during the drilling activities would not be discharged at sea but would be transported to shore for disposal. These wastes would be recycled or re-used if possible or disposed at an appropriate licensed municipal landfill facility (Walvis Bay has general and hazardous landfill sites) or at an alternative approved site. The services of a Licensed waste contractor will be used to collect all operational waste for treatment, disposal or recycling.

Typical waste types generated by a drillship that are disposed of onshore include:

- Garbage (e.g. paper, plastic, wood and glass) including wastes from accommodation and workshops etc;
- Scrap metal and other material;
- Drums and containers containing residues (e.g. lubricating oil) that may have environmental effects;
- Used oil, including lubricating and gear oil; solvents; hydro-carbon based detergents, possible drilling fluids and machine oil;
- Chemicals and hazardous wastes (e.g. radioactive materials, neon tubes and batteries);
- Medical waste from treatment of personal onboard the vessel;
- Filters and filter media from machinery;
- Drilling fluid, spent NADF, brine from drilling and completion activities.

Additionally, Naturally Occurring Radioactive Materials (NORM) can be found in subsurface rocks and fluids in oil and gas fields. While an exploration well can contain low levels of NORM, especially in the produced water, exploration wells are not subject to the long-term, high-volume flow conditions that cause significant build-up and therefore, considered as a low risk during exploration.

2.12 NOISE EMISSIONS

Underwater noise generated by the proposed drilling operations will arise from several key sources, including vessel propellers and positioning thrusters, drag on the riser, supply vessels, and drilling activities. These sources are expected to produce highly variable sound levels, depending on the operational mode and configuration of each vessel. Additionally, if a VSP survey is undertaken during well logging, it will contribute to short-term noise emissions over a period of approximately 8 to 12 hours.

The principal sources of noise are categorised as follows:

> Drilling Noise: Drilling units typically emit underwater noise across a frequency range of 10 Hz to 100 kHz, with dominant components below 100 Hz (OSPAR Commission 2009). Source levels can reach up to 196.2 dB re 1 μPa @ 1 m RMS, particularly when bow thrusters are in use. For this project, the estimated source level for the MODU is approximately 196.2 dB re 1 μPa @ 1 m RMS, based on the Brown (1977) empirical formula.
>
> Propeller and Positioning Thrusters: Noise from propellers and thrusters is primarily caused by cavitation around the blades, especially during high-speed transit or when operating under load to maintain vessel position. This noise is typically broadband, with low tonal peaks, and can be audible over several

kilometres. Supply vessels also contribute to overall propeller noise. For this project, the estimated source level from a single support vessel is approximately 195.4 dB re 1 µPa @ 1 m RMS, with the combined noise from four support vessels reaching approximately 202 dB re 1 µPa @ 1 m RMS.

Machinery Noise: When vessels are stationary or moving slowly, low-frequency machinery noise becomes dominant. This originates from large onboard systems such as power generators, compressors and fluid pumps and is transmitted via both structural paths (machine → hull → water) and airborne paths (machine → air → hull → water). Machinery noise is typically tonal. A ROV will be deployed to sweep the drilling site for debris, but it is not expected to be a significant noise source.

Well Logging Noise (VSP): Although unlikely, a VSP survey may be conducted to acquire high-resolution geological data near the well. This involves a dual airgun array with a total volume of 1,200 cubic inches of compressed nitrogen at 2,000 psi. The airguns discharge approximately five times at 20-second intervals, repeated across different well sections, totalling around 250 shots. VSP operations typically last 8 to 12 hours per well, generating intermittent short-term noise. An alternative scenario considered in the underwater noise modelling assumes 50 VSP pulses over approximately 2 hours, representing a shorter-duration operation. For this project, the estimated source level for the VSP G-Gun array show the Peak level to be 242 dB re 1 µPa at 1 m, the RMS 230 dB re 1 µPa at 1 m, and the SEL 221 dB re $\mu Pa^2 \cdot s$ at 1 m. These values were used in the underwater noise modelling to evaluate transmission loss and potential impacts on marine fauna.

Well Testing Noise: Flaring during well testing produces airborne noise above sea level, which may affect nearby fauna.

Subsea Equipment Noise: Equipment such as the drill string generates relatively low levels of underwater noise compared to drilling and dynamic positioning systems.

Helicopter Noise: Helicopter operations contribute to both airborne and underwater noise, potentially affecting marine fauna.

The extent of project-related noise above ambient levels will vary depending on the types of vessels used, the number of support vessels operating, weather conditions and proximity to other vessel traffic.

An Underwater Noise Modelling Study has been undertaken by ERM to evaluate transmission loss with distance from the well site and to compare results against threshold values for marine fauna, thereby identifying zones of potential impact.

2.13 LIGHT EMISSIONS

For safe operations and navigation during nighttime, the drilling unit and supply vessels will use operational lighting. Efforts will be made to shield these lights to reduce their spill into the surrounding sea where possible.

2.14 UNPLANNED HYDROCARBONS AND CHEMICAL SPILLS (ONSHORE AND OFFSHORE)

Two of the main types of accidental events could result in a discharge of hydrocarbons or chemicals to the marine environment are:

- Loss of well containment; and
- Single-event/batch spills.

A loss of well containment typically involves a continuous release, which could last for a measurable period of time, while a single-event spill is an instantaneous or limited duration occurrence. CNEL is committed to minimising the release of hydrocarbons and hazardous chemical discharge into the marine and onshore environments and avoiding unplanned spills.

In the case of an accidental event, CNEL will aim to minimise any adverse effects to the environment through the following measures:

- Incorporating oil and chemical spill prevention into the well design and drilling plans.
- Confirming that the necessary contingency planning has taken place to respond effectively in the event of an incident.

Prior to the commencement of drilling, CNEL will develop and implement an Oil and Chemical Spill Response Plan (OSRP) to address any accidental release of oil or chemicals offshore. In addition, precautionary measures will be taken to make sure that all chemicals and petroleum products stored and transferred both onshore and offshore are managed in a manner that minimises the risk of spills and environmental harm in the event of an accidental release.

Additionally, CNEL, is a member of Oil Spill Response Limited (OSRL) which provides advanced capping stacks to shut-in uncontrolled subsea wells in the event of a blow-out. The primary capping stack, a 10K unit, is housed at OSRL's Saldanha Bay Base in South Africa and is available for global mobilisation. Additional stacks are located in Brazil, Norway, and Singapore.

In the event of a sub-sea loss of containment event, a number of critical resources would be mobilized to the location. These include debris removal, stabilization and monitoring equipment and the capping stack. The capping stack allows for the safe capture and/or closure of the oil flow. Before its arrival, a ROV inspects the seabed, removes debris and prepares the wellhead.

An Oil Spill Modelling Study has been undertaken by RPS Ocean Science to evaluate potential spill scenarios (refer to Appendix E). Chevron Namibia Exploration Limited II (CNEL) contracted RPS Ocean Science, a Tetra Tech company, ("ROS") to assess the trajectory and fate of hypothetical hydrocarbon spill events from three locations, Gemsbok, Potential Second Well, and a Shallow Well, within the PEL 82 exploration license area, Block 2112B and Block 2212A, offshore Namibia

3. DESCRIPTION OF THE BASELINE ENVIRONMENT

The descriptions of the physical and biological environments along the northern and central Namibian coast primarily cover the offshore area from the Kunene River in the north to the Lüderitz in the south, although where appropriate reference is made to the entire Namibian coastline. The purpose of this environmental description is to provide the marine baseline environmental context within which the proposed exploration drilling activities will take place. The summaries presented below are based on information gleaned from Lane and Carter (1999), Morant (2006), Penney *et al.* (2007) and the Marine Mammal Observer (MMO) Reports.

3.1 GEOPHYSICAL CHARACTERISTICS

3.1.1 BATHYMETRY

The continental shelf off Namibia is variable in width. Off the Orange River the shelf is wide (230 km) and characterised by well-defined shelf breaks, a shallow outer shelf and the aerofoil-shaped submarine Recent River Delta on the inner shelf. It narrows to the north reaching its narrowest point (90 km) off Chameis Bay, before widening again to 130 km off Lüderitz (Rogers 1977). Off Walvis Bay there is a double shelf break, with the inner and outer breaks beginning at depths of around 140 m and 400 m, respectively (Shannon and O'Toole 1998).

Off Terrace Bay the shelf gives rise to the Walvis Ridge, an underwater plateau extending obliquely (NE-SW) south-westwards far into the south Atlantic from the northern Namibian shelf (18°S) to the Tristan da Cunha island group at the Mid-Atlantic Ridge (38°S). Beyond the Walvis Ridge, the shelf narrows again towards Cape Frio (see Figure 1-1). The Walvis Ridge is a chain of seamounts and guyots that individually and collectively constitute an ecologically and biologically significant deep-sea feature. It also includes steep canyons, embayments formed by massive submarine slides, trough-like structures, a graben, abyssal plains, and a fossilized cold-water coral reef mound community (GEOMAR 2014).

The salient topographic features of the shelf include the relatively steep descent to about 100 m, the gentle decline to about 180 m, and the undulating depths to about 200 m. The most prominent topographic feature in the study area is the Walvis Ridge, which extends from the African coast at around 18°S more than 3,000 km south-westwards to Tristan da Cunha, the Gough Islands and the Mid-Atlantic Ridge. This plateau effectively splits the abyssal plain of the Southeast Atlantic into the Angola Basin to the north and the Cape Basin to the south. The variable topography of the shelf is of significance for near shore circulation and for fisheries (Shannon and O'Toole 1998).

Banks on the continental shelf in the broader project area include the Orange Bank (Shelf or Cone), a shallow (160 - 190 m) zone that reaches maximal widths (180 km) offshore of the Orange River. Tripp Seamount is a geological feature situated ~300 km offshore at about 29°S, which rises from the seabed at ~1,000 m to a depth of 150 m. These features are located over 800 km to the south of PEL 82.

3.1.2 COASTAL AND INNER-SHELF GEOLOGY AND SEABED GEOMORPHOLOGY

As part of the recent Marine Spatial Planning (MSP) process in Namibia, the marine geology of the Namibian continental shelf and geomorphic seafloor features within the Exclusive Economic Zone (EEZ) were mapped (MFMR 2021) (Figure 3-1 and Figure 3-2).

FIGURE 3-1 PEL 82 (RED POLYGON) IN RELATION TO THE MARINE GEOLOGY OF THE SOUTHERN NAMIBIAN CONTINENTAL SHELF (ADAPTED FROM MFMR 2021).

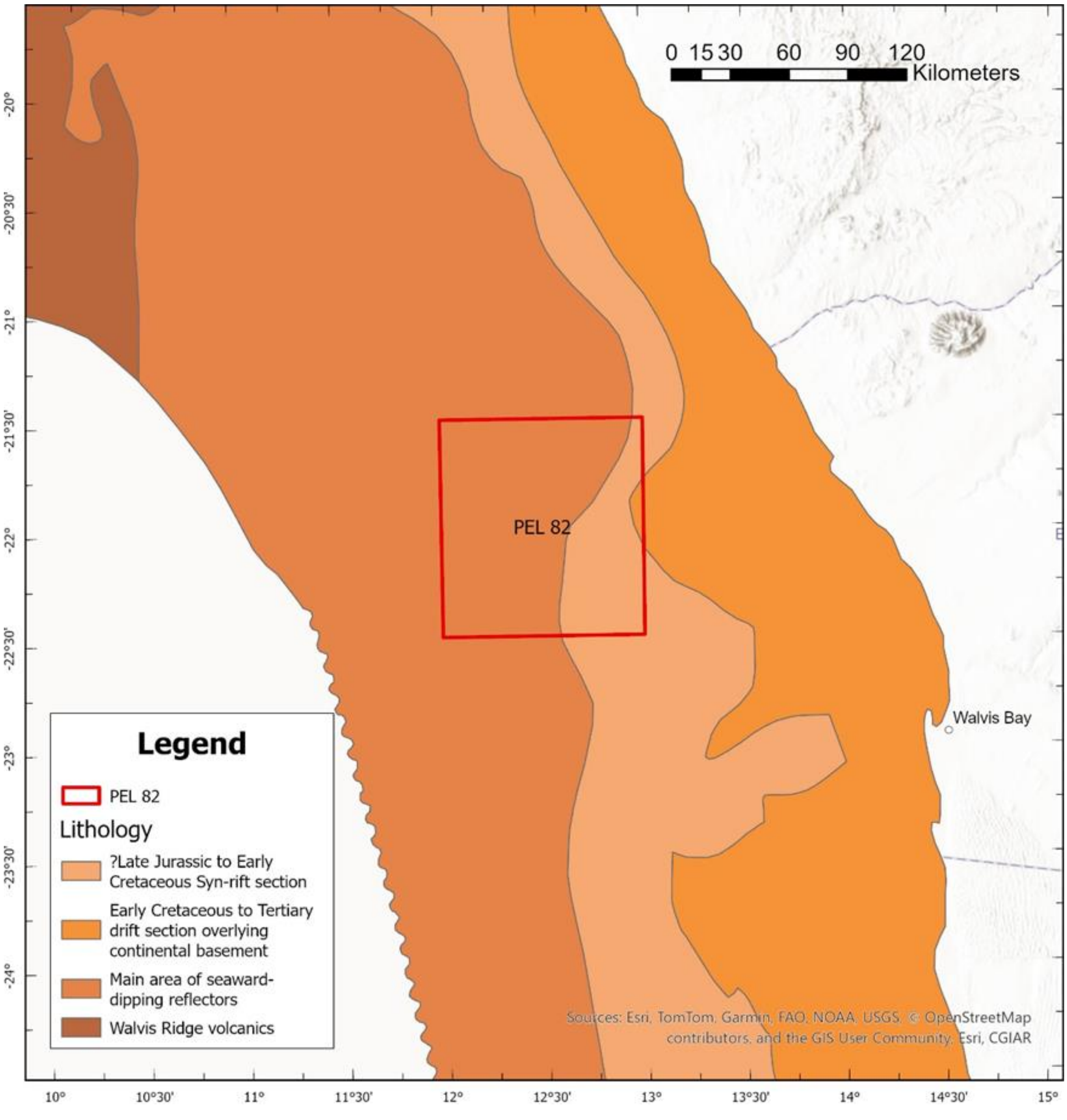


FIGURE 3-2 PEL 82 (RED POLYGON) IN RELATION TO SEABED GEOMORPHIC FEATURES OFF CENTRAL NAMIBIA (ADAPTED FROM MFMR 2021).

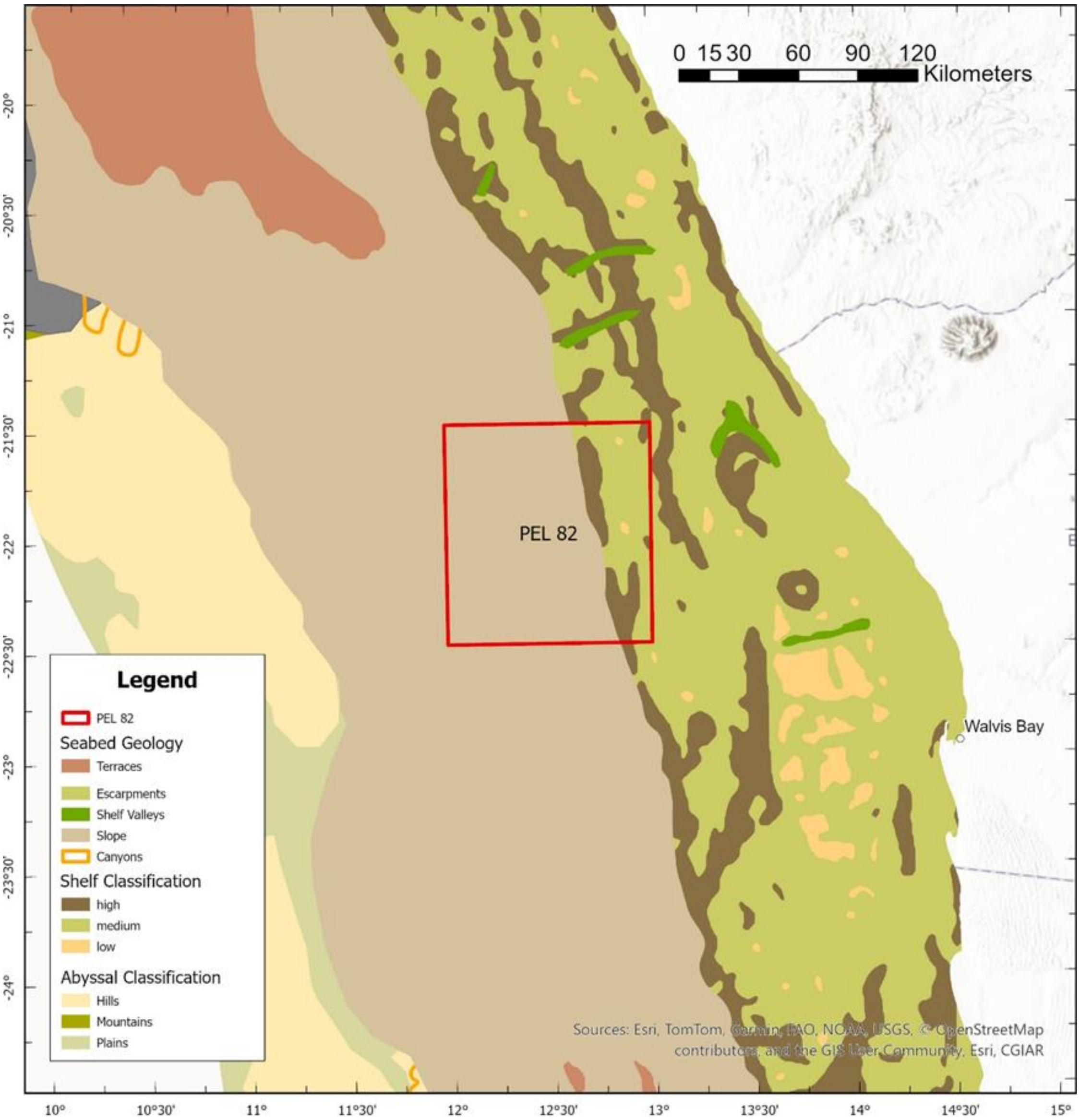
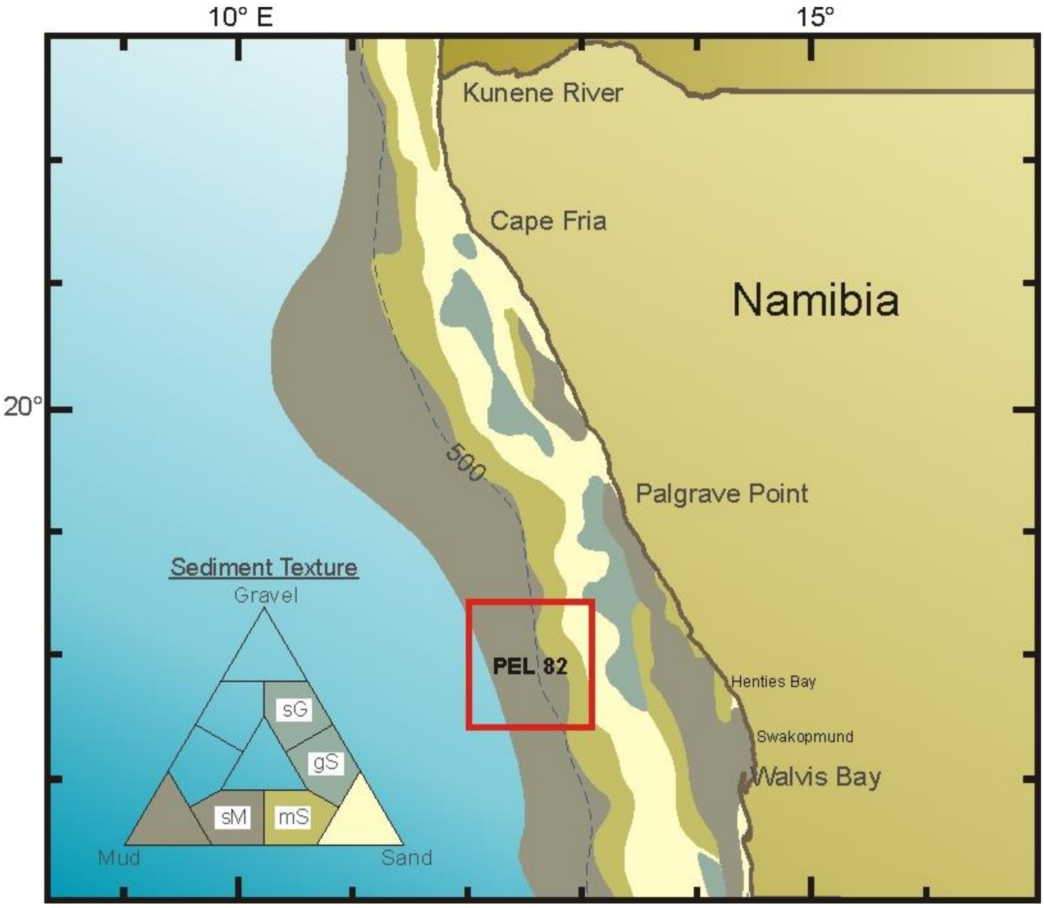


Figure 3-3 illustrates the distribution of seabed surface sediment types off the central and northern Namibian coast. The inner shelf is underlain by Precambrian bedrock (also referred to as Pre-Mesozoic basement), whilst the middle and outer shelf areas are composed of Cretaceous and Tertiary sediments (Dingle 1973; Birch *et al*. 1976; Rogers 1977; Rogers and Bremner 1991). As a result of erosion on the continental shelf, the unconsolidated sediment cover is generally thin, often less than 1 m. Sediments are finer seawards, changing from sand on the inner and outer shelves to muddy sand and sandy mud in deeper water. However, this general pattern has been modified considerably by biological deposition (large areas of shelf sediments contain high levels of calcium carbonate) and localised river input. Off central Namibia, the muddy sand in the near shore area off Henties Bay gives way to a tongue of organic-rich sandy mud, which extends from south of Sandwich Harbour to ~ 20°40'S northwards to Pelgrave Point (Figure 3-3). These biogenic muds are the main determinants of the formation of low-oxygen waters and sulphur eruptions off central Namibia (see Sections 3.2.9 & 3.2.10). Further offshore these give way to muddy sands, sands and gravels before changing again into mud-dominated seabed beyond the 500-m contour. The continental slope, seaward of the shelf break, has a smooth seafloor, underlain by calcareous ooze.

FIGURE 3-3 PEL 82 IN RELATION TO THE SEDIMENT DISTRIBUTION ON THE CONTINENTAL SHELF OFF CENTRAL AND NORTHERN NAMIBIA (ADAPTED FROM ROGERS 1977).



3.1.3 SEDIMENTARY PHOSPHATES

Phosphorite, or phosphate-rich rock, is defined as sedimentary rock typically containing between 5%-20% phosphate. In the marine environment, it occurs either as a nodular hard ground capping of a few metres thick or as layers of consolidated or unconsolidated sediments on continental shelves and in the upper part of continental slopes (Morant 2013). Such deposits provide a record of paleoceanographic changes in upwelling systems linked to climate. Being one of the most productive upwelling systems in the world, the Benguela Upwelling System is associated with major phosphorite deposits (of various type and grade) exposed over an area of 24 700 km^2 on the Namibian shelf (Compton & Bergh 2016).

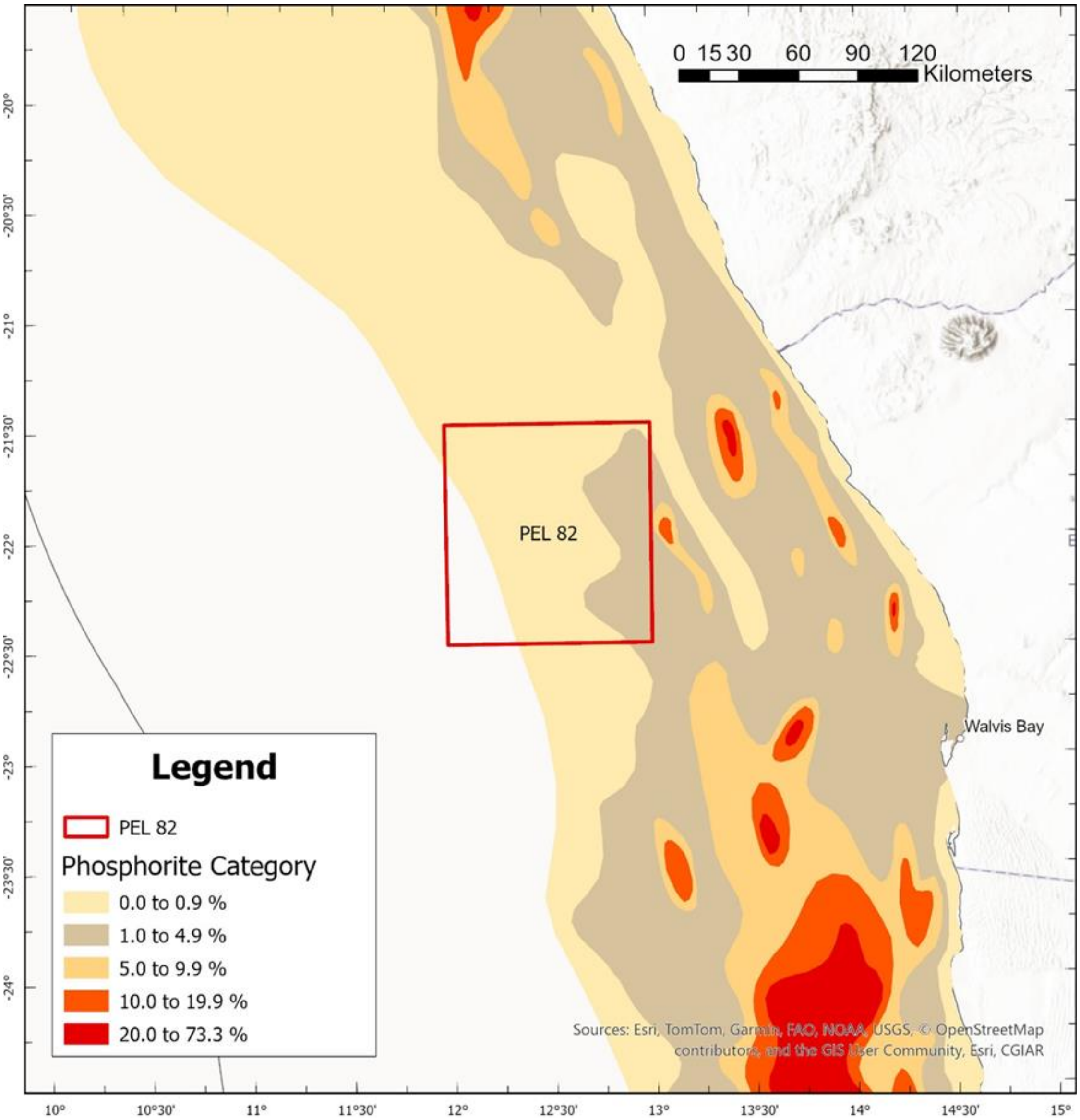
The “open shelf” phosphorite deposits, originated from the precipitation of phosphate in the form of calcium phosphate. Intense upwelling resulted in a change in temperature and pressure of the phosphate-laden oceanic waters, thus lowering the solubility of the phosphate salts they contained, and consequently precipitating the phosphates (in the form of apatite) over the continental shelf to form phosphatic packstones and colitic pellets at the sediment-water interface. The precipitation is facilitated by the decay of siliceous phytoplankton. The precipitated phosphates subsequently combined with calcium, derived from the disaggregation of calcareous foraminiferal and coccolithophorid debris on the outer continental shelf, to form phosphatised lime-rich muds. These muds subsequently lithified or consolidated through their replacement by secondary calcium phosphate (francolite), to form a near-continuous hard capping of phosphate rock over the seafloor sediments (Birch 1990; Morant 2013).

Off Namibia, marine phosphates were first discovered and regionally mapped in the late 1960s and 1970s, with subsequent exploratory work undertaken in the 1990s and 2000s. Various types of phosphorite are known to exist on the Namibian continental shelf these being concretionary phosphorite, as well as pelletal and glauconitized pelletal phosphorite on the middle shelf to the south and north of Walvis Bay, respectively. ‘Rock phosphate’ occurs on the middle and inner shelves, predominantly north of Walvis Bay (Bremner 1980). On the middle to outer shelf (190 m and 350 m water depth) offshore of Lüderitz and Walvis Bay the deposit consists of coarsening-upward muddy to gravelly pelletal phosphorite sand, up to several meters thick (Baturin 2002; Compton & Bergh 2016). These deposits are characterized by their spatial continuity (especially in a SSW - NNE direction) and general uniformity in grade. The variations in thickness are generally the product of thicker accumulation of sediment in very shallow palaeo-topographic depressions in the underlying clay surface, which is locally burrowed, with these borings being filled with phosphate-rich sediment (NMP 2012). Less extensive and less continuous deposits occur offshore of Walvis Bay as far north as the Kunene River mouth on the inner to middle shelf (50 and 250 m water depth). Pelletal phosphorite sand and concretionary phosphorite pebbles are the dominant grain types consisting of up to 90 wt.% carbonate fluorapatite (francolite) cement and inclusions of organic matter, pyrite and terrigenous mud.

Phosphogenesis is predicted to have been initiated in the latest Miocene, with most phosphorite formed in the Plio/Pleistocene but ranging through to the Holocene. The early diagenetic phosphorite was extensively reworked by glacial to interglacial sea-level fluctuations, which correspond to Benguela coastal upwelling intensity and continental aridification. Repeated phosphorite formation and reworking over Pleistocene glacial to interglacial cycles resulted in the economic concentration of phosphorite on the Namibian shelf, with an estimated total resource of 7,800 million tons of phosphate rock at an average grade of 19 wt.% P_2O_5 (Compton & Bergh 2016).

PEL 82 overlaps primarily with low percentage occurrence of the known phosphate deposits (Figure 3-4).

FIGURE 3-4 PEL 82 (RED POLYGON) IN RELATION TO THE KNOWN LOCATION OF PHOSPHATE DEPOSITS ON THE SOUTHERN NAMIBIAN CONTINENTAL SHELF (ADAPTED FROM MFMR 2021).



3.2 BIOPHYSICAL CHARACTERISTICS

3.2.1 CLIMATE

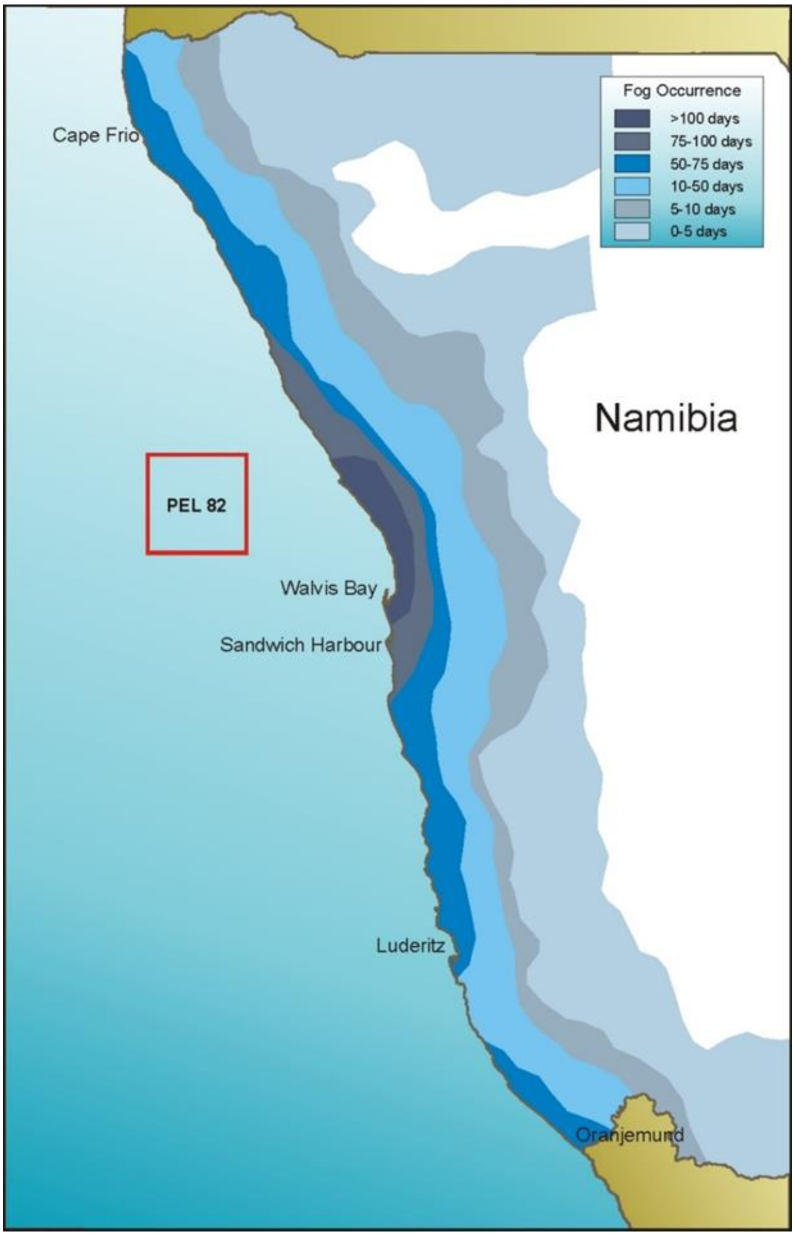
The climate of the Namibian coastline is classified as hyper-arid with typically low, unpredictable winter rains and strong predominantly southerly or south-westerly winds. Further out to sea, a south-easterly component is more prominent. Winds reach a peak in the late afternoon and subside between midnight and sunrise.

The Namibian coastline is characterised by the frequent occurrence of fog, which occurs on average between 50-75 days per year, being most frequent during the months of

February through May (Figure 3-5). The fog lies close to the coast extending about 20 nautical miles (~35 km) seawards (Olivier 1992, 1995). This fog is usually quite dense, appears as a thick bank hugging the shore and visibility may be reduced to <300 m.

Average precipitation per annum along the coastal region between Walvis Bay and the Kunene River is <15 mm. Due to the combination of wind and cool ocean water, temperatures are mild throughout the year. Coastal temperatures average around 16°C, gradually increasing inland (Barnard 1998). In winter, maximum diurnal shifts in temperature can occur caused by the hot easterly 'Berg' winds which blow off the desert. During such occasions temperatures up to 30°C are not uncommon.

FIGURE 3-5 FOG DAY FREQUENCY FOR 1984 USING METEOSAT IMAGES (ADAPTED FROM OLIVIER 1992, 1995).



3.2.2 WIND PATTERNS

Winds are one of the main physical drivers of the near shore Benguela region, both on an oceanic scale, generating the heavy and consistent south-westerly swells that impact this coast, and locally, contributing to the northward-flowing longshore currents, and being the prime mover of sediments in the terrestrial environment. Consequently, physical processes are characterised by the average seasonal wind patterns, and substantial episodic changes in these wind patterns have strong effects on the entire Benguela region.

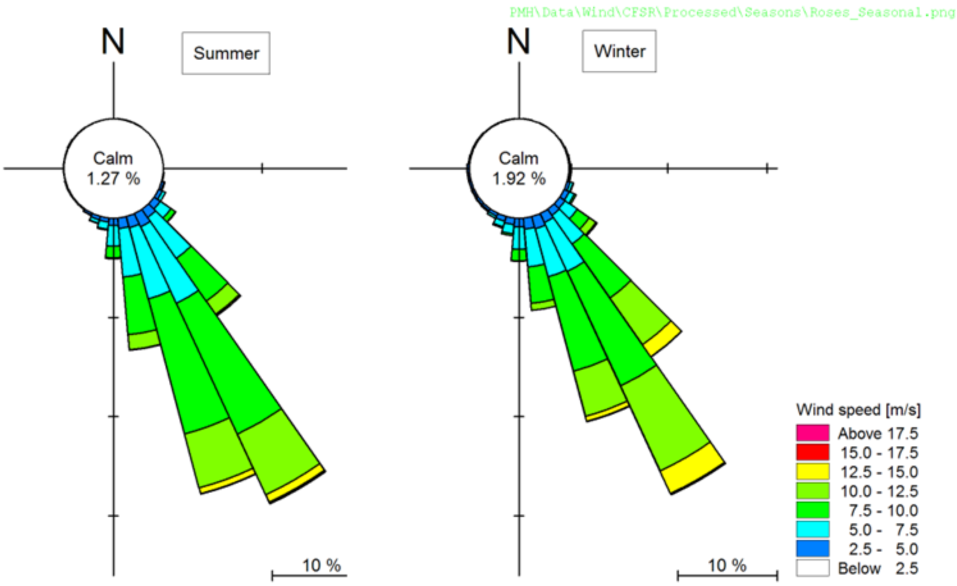
The prevailing winds in the Benguela region are controlled by the South Atlantic subtropical anticyclone, the eastward moving mid-latitude cyclones south of southern Africa, and the seasonal atmospheric pressure field over the subcontinent. The south Atlantic anticyclone is a perennial feature that forms part of a discontinuous belt of high-pressure systems that encircle the subtropical southern hemisphere. This undergoes seasonal variations, being strongest in the austral summer, when it also attains its southernmost extension, lying south west and south of the subcontinent. In winter, the south Atlantic anticyclone weakens and migrates north-westwards.

These seasonal changes result in substantial differences between the typical summer and winter wind patterns in the region, as the southern hemisphere anti-cyclonic high-pressure system, and the associated series of cold fronts, move northwards in winter, and southwards in summer. The strongest winds occur in summer, when winds blow 99% of the time. Virtually all winds in summer are strongly dominated by southerlies, which occur over 40% of the time, averaging 20 - 30 kts and reaching speeds in excess of 60 kts. In northern Namibia long-shore south-easterly winds dominate in summer, whereas off Walvis Bay south-south-westerlies dominate and wind speeds are generally lower on average and display less seasonality than in the south of the country (Shannon and O'Toole 1998). These southerly winds bring cool, moist air into the coastal region and drive the massive offshore movements of surface water, and the resultant strong upwelling of nutrient-rich bottom waters, which characterise this region in summer. The winds also play an important role in the loss of sediment from beaches. These strong equatorwards winds are interrupted by the passing of coastal lows with which are associated periods of calm or north or northwest wind conditions. These northerlies occur throughout the year, but are more frequent in spring and summer.

Winter remains dominated by southerly winds, but the closer proximity of the winter cold-front systems results in a significant south-westerly to north-westerly component. This 'reversal' from the summer condition results in cessation of upwelling, movement of warmer mid-Atlantic water shorewards and breakdown of the strong thermoclines which typically develop in summer.

The PEL 82 license area is located in an area of strong south-easterly winds, which blow approximately parallel to the coastline. There is minimal seasonality in the wind pattern, with a slightly more easterly direction in winter. Seasonal wind roses for the CFSR wind hindcast data at 10°E, 22°S in the vicinity of PEL 82 are illustrated in Figure 3-6 (PRDW 2019).

FIGURE 3-6 SEASONAL WIND ROSES AT 10°E, 22°S IN THE VICINITY OF PEL 82 (SOURCE PRDW 2019).



During autumn and winter, catabatic, or easterly 'berg' winds can also occur. These powerful offshore winds can exceed 50 km/h, producing sandstorms that considerably reduce visibility at sea and on land. Although they occur intermittently for about a week at a time, they have a strong effect on the coastal temperatures, which often exceed 30°C during 'berg' wind periods (Shannon and O'Toole 1998). The winds also play a significant role in sediment input into the coastal marine environment with transport of the sediments up to 150 km offshore (Figure 3-7).

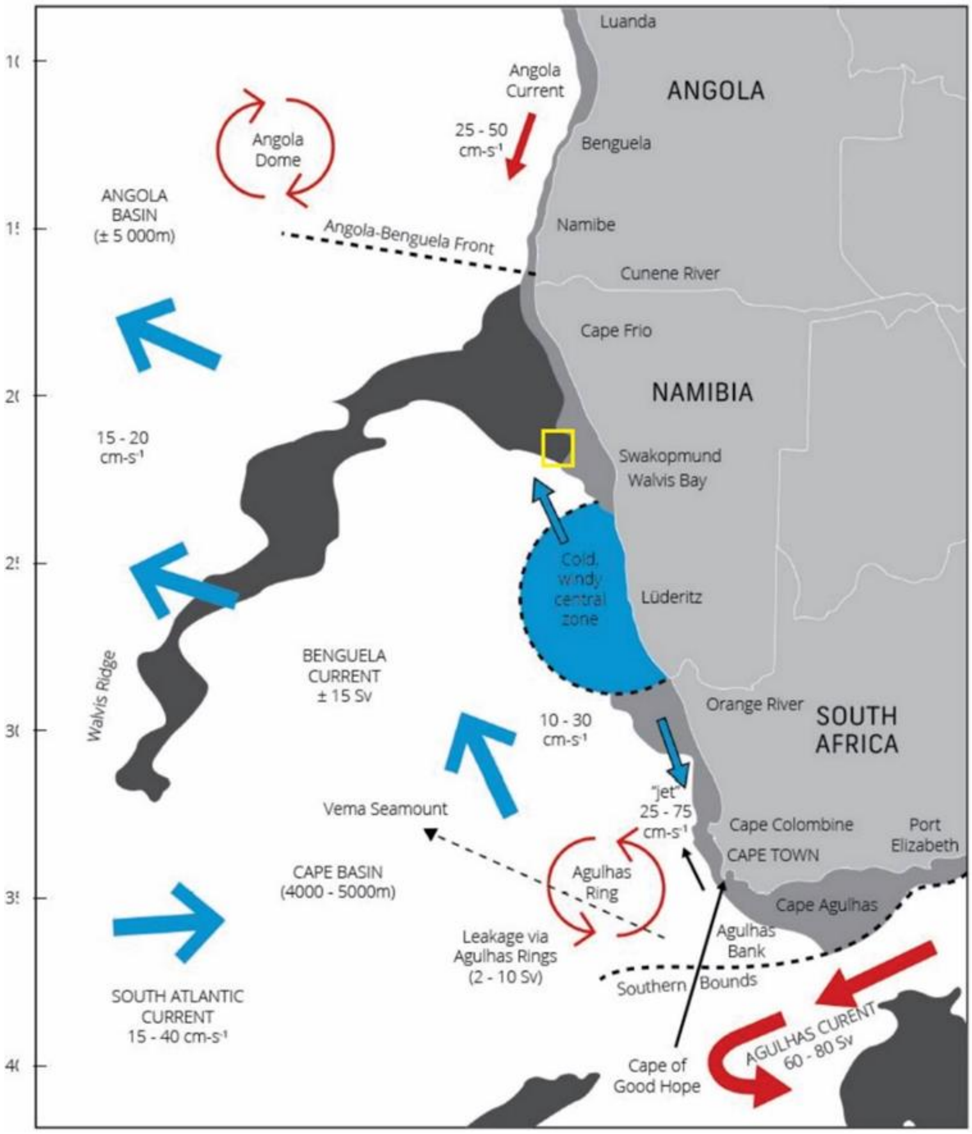
FIGURE 3-7 SATELLITE IMAGE SHOWING AEROSOL PLUMES OF SAND AND DUST BEING BLOWN OUT TO SEA DURING A NORTHEAST 'BERG' WIND EVENT

ALONG THE CENTRAL NAMIBIAN COAST (IMAGE SOURCE: WWW.INTUTE.AC.UK).

3.2.3 LARGE-SCALE CIRCULATION AND COASTAL CURRENTS

The Namibian coastline is strongly influenced by the Benguela Current. Current velocities in continental shelf areas generally range between 10–30 cm/s (Boyd and Oberholster 1994). In the south the Benguela current has a width of 200 km, widening rapidly northwards to 750 km. The flows are predominantly wind-forced, barotropic and fluctuate between poleward and equatorward flow (Shillington et al. 1990; Nelson and Hutchings 1983) (Figure 3-8). Fluctuation periods of these flows are 3 - 10 days, although the long-term mean current residual is in an approximate northwest (alongshore) direction. Near bottom shelf flow is mainly poleward (Nelson 1989) with low velocities of typically 5 cm/s.

FIGURE 3-8 PEL 82 (YELLOW POLYGON) IN RELATION TO MAJOR FEATURES OF THE PREDOMINANT CIRCULATION PATTERNS AND VOLUME FLOWS IN THE BENGUELA SYSTEM (ADAPTED FROM SHANNON AND NELSON 1996).



The Angola Dome lies to the north of the license area and is characterised by cyclonic circulation, with periodic intrusion of tropical waters into the northern Benguela from the north and northwest. Off the coast of Angola, the most prominent circulation feature is the southward flowing Angola current, which turns westwards between 16°S and 17°S just north of the Angola-Benguela Front. The Angola-Benguela Front is a permanent feature at the surface and to a depth of at least 200 m between latitudes 14°S and 17°S. The front is maintained by a combination of factors including coastal orientation, wind stress, bathymetry and opposing flows of the Angola and Benguela Currents. To what extent the Angola Current contributes to the Benguela system at the surface and subsurface off northern Namibia is uncertain. At greater depths (400 m), however, the poleward flow of the Angola Current is more continuous. The episodic southward movement of this front during late summer introduces warm tropical water southwards and eastwards along the Namibian coast. Known as Beguela Niños, these events occur on average every ten years (Shannon and O'Toole 1998).

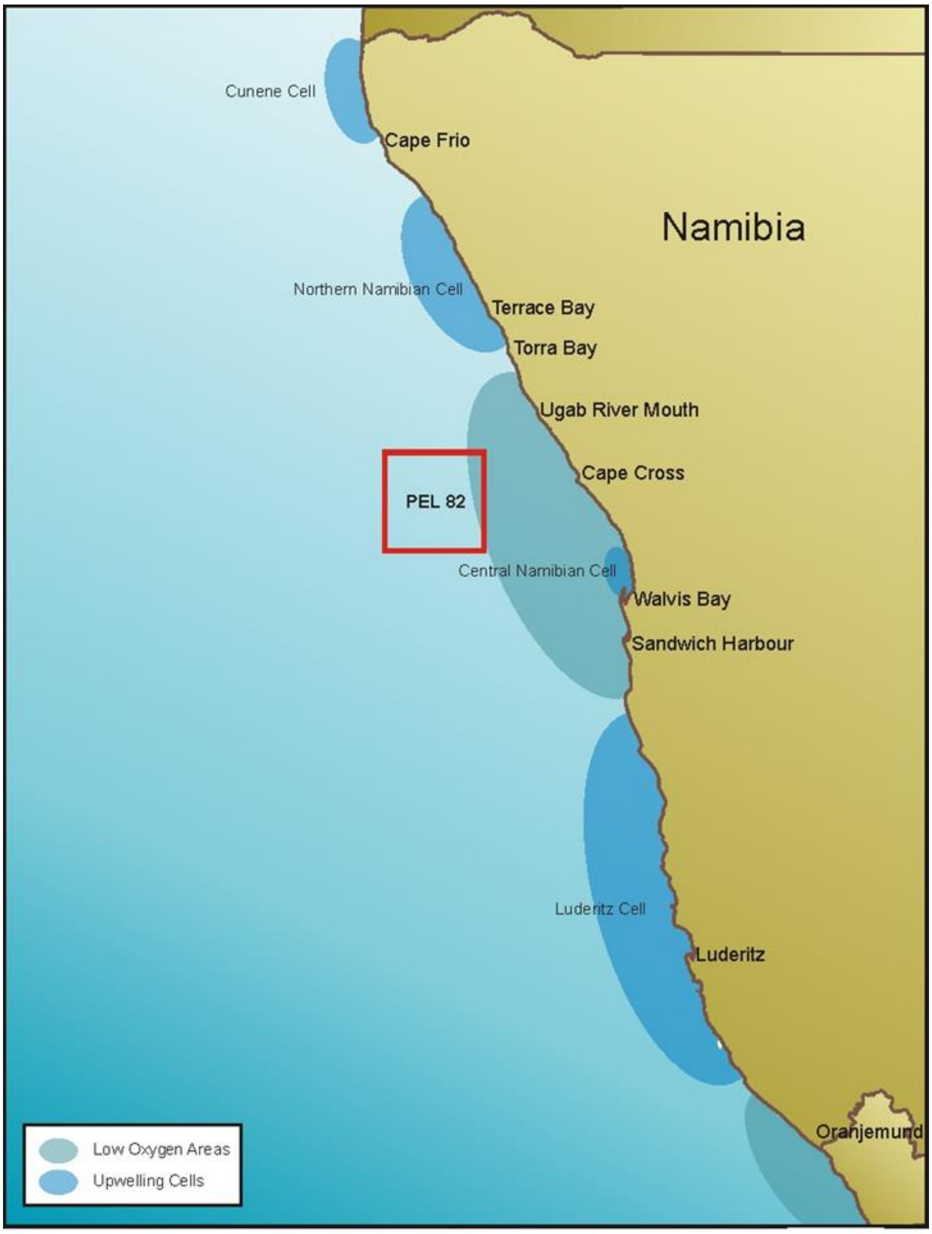
3.2.4 WAVES AND TIDES

The Namibian Coast is classified as exposed, experiencing strong wave action rating between 13-17 on the 20-point exposure scale (McLachlan 1980). The coastline is influenced by major swells generated in the roaring forties, as well as significant sea waves generated locally by the persistent southerly winds.

Typical seasonal swell-height rose-plots, compiled from Voluntary Observing Ship (VOS) data off Walvis Bay are shown in

Figure 3-10 (supplied by CSIR). The wave regime along the southern African west coast shows only moderate seasonal variation in direction, with virtually all swells throughout the year coming from the SW - S direction. In winter there is a slight increases in swell from SW direction. The median significant wave height is 2.4 m with a dominant peak energy period of ~12 seconds. Longer period swells (11 to 15 seconds), generated by mid-latitude cyclones occur about 25-30 times a year. These originate from the S-SW sectors, with the largest waves recorded along the southern African West Coast attaining 4-7 m. With wind speeds capable of reaching 100 km/h during heavy winter south-westerly storms, winter swell heights can exceed 10 m. Generally, wave heights decrease with water depth and distance longshore.

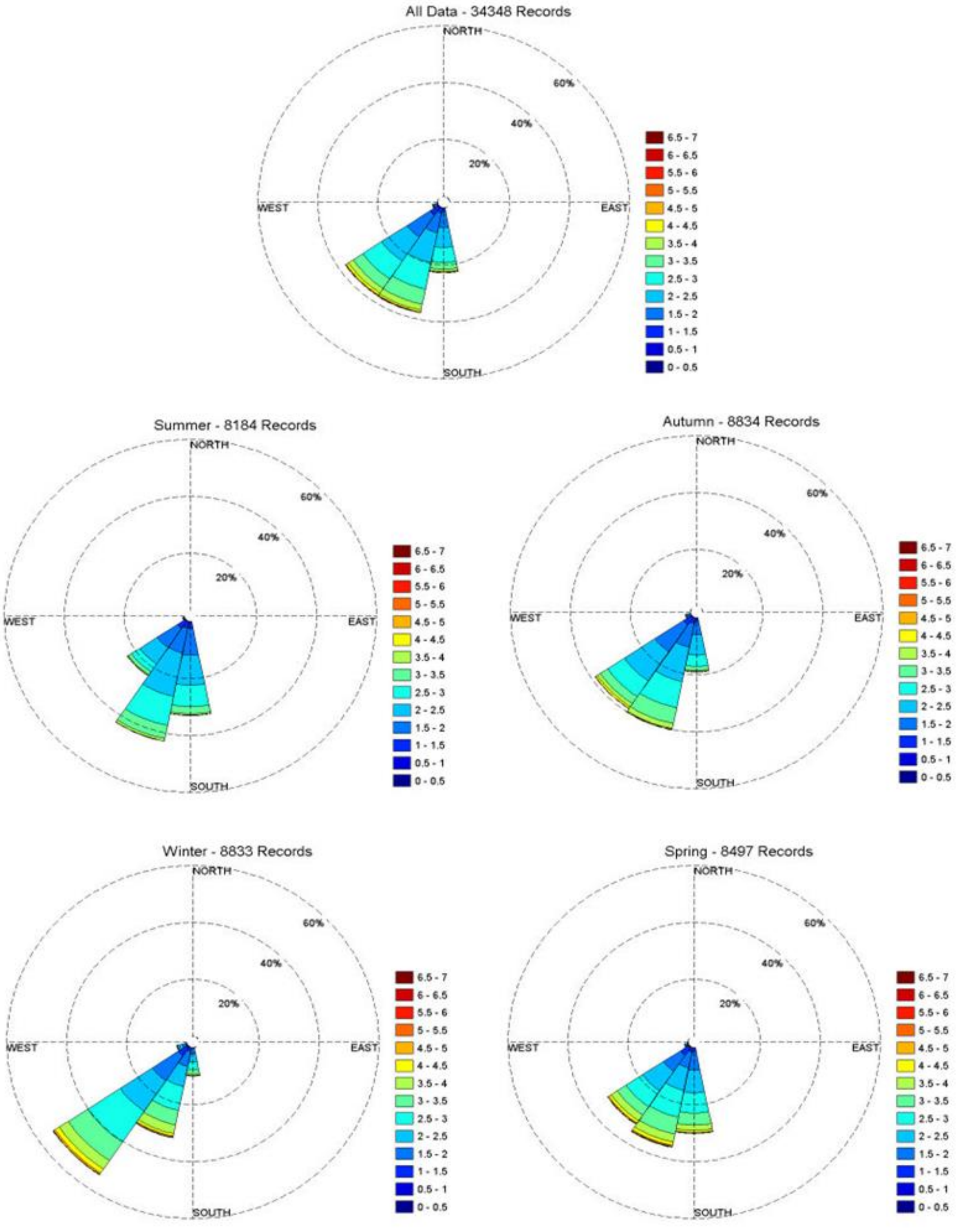
FIGURE 3-9 PEL 82 IN RELATION TO THE UPWELLING CENTRES AND LOW OXYGEN AREAS ON THE WEST COAST OF NAMIBIA (ADAPTED FROM SHANNON 1985).



In comparison, spring and summer swells tend to be smaller on average, typically around 2 m, not reaching the maximum swell heights of winter. There is also a more pronounced southerly swell component in summer. These southerly swells tend to be wind-induced, with shorter wave periods (~8 seconds), and are generally steeper than swell waves (CSIR 1996). These wind-induced southerly waves are relatively local and, although less powerful, tend to work together with the strong southerly winds of summer to cause the northward-flowing nearshore surface currents, and result in substantial nearshore sediment mobilisation, and northwards transport, by the combined action of currents, wind and waves.

In common with the rest of the southern African coast, tides are semi-diurnal, with a total range of some 1.5 m at spring tide, but only 0.6 m during neap tide periods.

FIGURE 3-10 SEASONAL OFFSHORE WAVE CONDITIONS FOR A DATA POINT LOCATED AT 23° S, 13.75°E (SOURCE: CSIR 2009).



3.2.5 WATER

South Atlantic Central Water (SACW) comprises the bulk of the seawater in the study area, either in its pure form in the deeper regions, or mixed with previously upwelled water of the same origin on the continental shelf (Nelson and Hutchings 1983). Salinities range between 34.5 ‰ and 35.5 ‰ (Shannon 1985).

Data recorded over a ten year period at Swakopmund (1988 – 1998) showed that seawater temperatures vary between 10°C and 23°C, averaging 14.9°C. Well-developed thermal fronts exist, demarcating the seaward boundary of the upwelled water. Upwelling filaments are characteristic of these offshore thermal fronts, occurring as surface streamers of cold water, typically 50 km wide and extending beyond the normal offshore extent of the upwelling cell. Such fronts typically have a lifespan of a few days to a few weeks, with the filamentous mixing area extending up to 625 km offshore.

The continental shelf waters of the Benguela system are characterised by low oxygen concentrations, especially near the seabed. SACW itself has depressed oxygen concentrations (~80% saturation value), but lower oxygen concentrations (<40% saturation) frequently occur (Bailey et al. 1985; Chapman and Shannon 1985). Nutrient concentrations of upwelled water of the Benguela system attain 20 µm nitrate-nitrogen, 1.5 µM phosphate and 15-20 µM silicate, indicating nutrient enrichment (Chapman and Shannon 1985). This is mediated by nutrient regeneration from biogenic material in the sediments (Bailey et al. 1985). Modification of these peak concentrations depends upon phytoplankton uptake which varies according to phytoplankton biomass and production rate. The range of nutrient concentrations can thus be large but, in general, concentrations are high. As PEL 82 is located well offshore of the upwelling cells, nutrient concentrations are expected to be low.

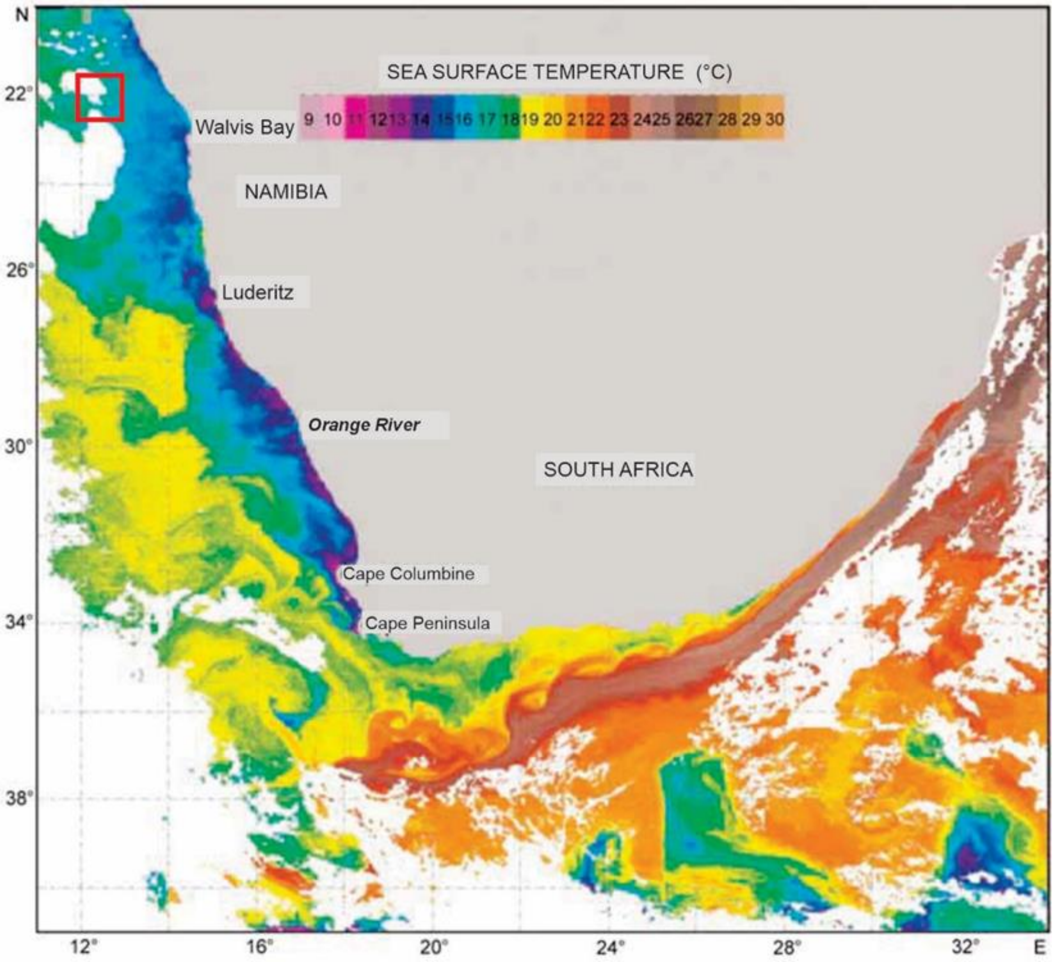
3.2.6 UPWELLING AND PLANKTON PRODUCTION

The major feature of the Benguela Current Coastal is upwelling and the consequent high nutrient supply to surface waters leads to high biological production and large fish stocks. The prevailing longshore, equatorward winds move nearshore surface water northwards and offshore. To balance the displaced water, cold, deeper water wells up inshore supporting substantial seasonal primary phytoplankton production. Although the rate and intensity of upwelling fluctuates with seasonal variations in wind patterns, the most intense upwelling tends to occur where the shelf is narrowest and the wind strongest. Consequently, it is a semi-permanent feature at Lüderitz and upwelling can occur there throughout the year and areas to the north due to perennial southerly winds (

Figure 3-9; Shannon 1985). The Lüderitz upwelling cell is the most intense upwelling cell in the system (

Figure 3-11), with the seaward extent reaching nearly 300 km, and the upwelling water is derived from 300-400 m depth (Longhurst 2006). A detailed analysis of water mass characteristics revealed a discontinuity in the central and intermediate water layers along the shelf north and south of Lüderitz (Duncombe Rae 2005). The Lüderitz / Orange River region thus forms a major environmental barrier between the northern and southern Benguela sub-systems (Ekau & Verheye 2005). Off northern and central Namibia, several secondary upwelling cells occur. Upwelling in these cells is perennial, with a late winter maximum (Shannon 1985).

FIGURE 3-11 SEA SURFACE TEMPERATURE IMAGE FOR 15 MAY 2003 SHOWING PEL 82 (RED POLYGON) IN RELATION TO COASTAL UPWELLING EVENTS (ADAPTED FROM WEEKS ET AL. 2006).



The cold, upwelled water is rich in inorganic nutrients, the major contributors being various forms of nitrates, phosphates and silicates (Chapman and Shannon 1985). The seasonal primary production, in turn, serves as the basis for a rich food chain up through zooplankton, pelagic baitfish (anchovy, pilchard, round-herring and others), to predatory fish (hake and snoek), mammals (primarily seals and dolphins) and seabirds (jackass penguins, cormorants, pelicans, terns and others). High phytoplankton productivity in the upper layers again depletes the nutrients in these surface waters. This results in a wind-related cycle of plankton production, mortality, sinking of plankton detritus and eventual nutrient re-enrichment occurring below the thermocline as the phytoplankton decays.

3.2.7 TURBIDITY

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulate matter. Total Suspended Particulate Matter (TSPM) can be divided into Particulate Organic Matter (POM) and Particulate Inorganic Matter

(PIM), the ratios between them varying considerably. The POM usually consists of detritus, bacteria, phytoplankton and zooplankton, and serves as a source of food for filter-feeders. Seasonal microphyte production associated with upwelling events will play an important role in determining the concentrations of POM in coastal waters. PIM, on the other hand, is primarily of geological origin consisting of fine sands, silts and clays. Off the southern African West Coast, the PIM loading in nearshore waters is strongly related to natural riverine inputs. 'Berg' wind events can potentially contribute the same order of magnitude of sediment input as the annual estimated input of sediment by the Orange River (Shannon and Anderson 1982; Zoutendyk 1992, 1995; Shannon and O'Toole 1998; Lane and Carter 1999).

Concentrations of suspended particulate matter in shallow coastal waters can vary both spatially and temporally, typically ranging from a few mg/L to several tens of mg/L (Bricelj and Malouf 1984; Berg and Newell 1986; Fegley et al. 1992). Field measurements of TSPM and PIM concentrations in the Benguela current system have indicated that outside of major flood events, background concentrations of coastal and continental shelf suspended sediments are generally <12 mg/L, showing significant long-shore variation (Zoutendyk 1995). Considerably higher concentrations of PIM have, however, been reported from southern African West Coast waters under stronger wave conditions associated with high tides and storms, or under flood conditions.

The major source of turbidity in the swell-influenced nearshore areas off the West Coast is the redistribution of fine inner shelf sediments by long-period Southern Ocean swells. The current velocities typical of the Benguela (10-30 cm/s) are capable of resuspending and transporting considerable quantities of sediment equatorwards. Under relatively calm wind conditions, however, much of the suspended fraction (silt and clay) that remains in suspension for longer periods becomes entrained in the slow poleward undercurrent (Shillington et al. 1990; Rogers and Bremner 1991).

Superimposed on the suspended fine fraction, is the northward littoral drift of coarser bedload sediments, parallel to the coastline. This northward, nearshore transport is generated by the predominantly south-westerly swell and wind-induced waves. Longshore sediment transport varies considerably in the shore-perpendicular dimension, being substantially higher in the surf-zone than at depth, due to high turbulence and convective flows associated with breaking waves, which suspend and mobilise sediment (Smith and Mocke 2002).

On the inner and middle continental shelf, the ambient currents are insufficient to transport coarse sediments, and resuspension and shoreward movement of these by wave-induced currents occur primarily under storm conditions (see also Drake et al. 1985; Ward 1985).

The powerful easterly 'berg' winds occurring along the Namibian coastline in autumn and winter also play a significant role in sediment input into the coastal marine environment (see Figure 3-7), potentially contributing the same order of magnitude of sediment input as the annual estimated input of sediment by the Orange River (Zoutendyk 1992; Shannon & O'Toole 1998; Lane & Carter 1999). For example, for a single 'berg'-wind event it was estimated that 50 million tons of dust were blown into the sea by extensive sandstorms along much of the coast from Cape Frio, Namibia in the north to Kleinzee, South Africa in the south (Shannon & Anderson 1982) with transport of the sediments up to 150 km offshore.

3.2.8 ORGANIC INPUTS

The Benguela upwelling region is an area of particularly high natural productivity, with extremely high seasonal production of phytoplankton and zooplankton. These plankton blooms in turn serve as the basis for a rich food chain up through pelagic baitfish (anchovy, pilchard, round-herring and others), to predatory fish (snoek), mammals (primarily seals and dolphins) and seabirds (jackass penguins, cormorants, pelicans, terns and others). All of these species are subject to natural mortality, and a proportion of the annual production of all these trophic levels, particularly the plankton communities, die naturally and sink to the seabed.

Balanced multispecies ecosystem models have estimated that during the 1990s the Benguela region supported biomasses of 76.9 tons/km^2 of phytoplankton and 31.5 tons/km^2 of zooplankton alone (Shannon et al. 2003). Thirty six percent of the phytoplankton and 5% of the zooplankton are estimated to be lost to the seabed annually. This natural annual input of millions of tons of organic material onto the seabed off the southern African West Coast has a substantial effect on the ecosystems of the Benguela region. It provides most of the food requirements of the particulate and filter-feeding benthic communities that inhabit the sandy-muds of this area, and results in the high organic content of the muds in the region. As most of the organic detritus is not directly consumed, it enters the seabed decomposition cycle, resulting in subsequent depletion of oxygen in deeper waters.

An associated phenomenon ubiquitous to the Benguela system are red tides (dinoflagellate and/or ciliate blooms) (see Shannon and Pillar 1985; Pitcher 1998). Also referred to as Harmful Algal Blooms (HABs), these red tides can reach very large proportions. Toxic dinoflagellate species can cause extensive mortalities of fish and shellfish through direct poisoning, while degradation of organic-rich material derived from both toxic and non-toxic blooms results in oxygen depletion of subsurface water.

3.2.9 LOW OXYGEN EVENTS

The continental shelf waters of the Benguela system are characterised by low oxygen concentrations with <40% saturation occurring frequently (e.g. Visser 1969; Bailey et al. 1985). The low oxygen concentrations are attributed to nutrient remineralisation in the bottom waters of the system (Chapman and Shannon 1985). The absolute rate of this is dependent upon the net organic material build-up in the sediments, with the carbon rich mud deposits playing an important role. As the mud on the shelf is distributed in discrete patches (see Figure 3-3), there are corresponding preferential areas for the formation of oxygen-poor water (see

Figure 3-9). The two main areas of low-oxygen water formation in the central Benguela region are in the Orange River Bight and off Walvis Bay (Chapman and Shannon 1985; Bailey 1991; Shannon and O'Toole 1998; Bailey 1999; Fossing et al. 2000). The spatial distribution of oxygen-poor water in each of the areas is subject to short- and medium-term variability in the volume of hypoxic water that develops. De Decker (1970) showed that off Lambert's Bay in South Africa, the occurrence of low oxygen water is seasonal, with highest development in summer/autumn. Bailey and Chapman (1991), on the other hand, demonstrated that in the St Helena Bay area in South Africa, daily variability exists as a result of downward flux of oxygen through thermoclines and short-term variations in upwelling intensity. Subsequent upwelling processes can move this low-oxygen water up onto the inner shelf, and into nearshore waters, often with devastating effects on marine communities.

Oxygen deficient water can affect the marine biota at two levels. It can have sub-lethal effects, such as reduced growth and feeding, and increased intermoult period in the rock-lobster population (Beyers *et al.* 1994). The oxygen-depleted subsurface waters characteristic of the central and southern Namibian shelf are an important factor determining the distribution of rock lobster in the area. During the summer months of upwelling, lobsters show a seasonal inshore migration (Pollock & Shannon 1987), and during periods of low oxygen become concentrated in shallower, better-oxygenated nearshore waters.

On a larger scale, periodic low oxygen events in the nearshore region can have catastrophic effects on the marine communities. Low-oxygen events associated with massive algal blooms can lead to large-scale stranding of rock lobsters, and mass mortalities of other marine biota and fish (Newman & Pollock 1974; Matthews & Pitcher 1996; Pitcher 1998; Cockroft *et al.* 2000). In March 2008, a series of red tide or algal blooms dominated by the (non-toxic) dinoflagellate *Ceratium furca* occurred along the central Namibian coast (MFMR 2008). These bloom formations ended in disaster for many coastal marine species and resulted in what was possibly the largest rock lobster walkout in recent memory. Other fish mortalities included rock suckers, rock fish, sole, eels, shy sharks, and invertebrates such as octopuses and red bait, which were trapped in the low oxygen area below the surf zone (Louw 2008). The main cause for these mortalities and walkouts is oxygen starvation that results from the decomposition of huge amounts of organic matter. The blooms develop over a period of unusually calm wind conditions when sea surface temperatures where high. These anoxic conditions were further exacerbated by the release of hydrogen sulphide - which is highly toxic to most marine organisms. Algal blooms usually occur during summer-autumn (February to April) but can also develop in winter during the 'bergwind periods', when similar warm windless conditions occur for extended periods.

3.2.10 SULPHUR ERUPTIONS

Closely associated with seafloor hypoxia, particularly off central Namibia, is the generation of toxic hydrogen sulphide and methane within the organically-rich, anoxic muds following decay of expansive algal blooms. Under conditions of severe oxygen depletion, hydrogen sulphide (H_2S) gas is formed by anaerobic bacteria in anoxic seabed muds (Brüchert et al. 2003). This is periodically released from the muds as 'sulphur eruptions', causing upwelling of anoxic water and formation of surface slicks of sulphur discoloured water (Emeis et al. 2004), and even the temporary formation of floating mud islands (Waldron 1901). Such eruptions are accompanied by a characteristic pungent smell along the coast and the sea takes on a lime green colour (Figure 3-12). These eruptions strip dissolved oxygen from the surrounding water column, resulting in mass mortalities of marine life. Such complex chemical and biological processes are often associated with the occurrence of harmful algal blooms, causing large-scale mortalities to fish and crustaceans (see above).

FIGURE 3-12 SATELLITE IMAGE SHOWING DISCOLOURED WATER OFFSHORE THE CENTRAL NAMIBIAN COAST RESULTING FROM A NEARSHORE SULPHUR ERUPTION (SATELLITE IMAGE SOURCE: WWW.INTUTE.AC.UK).

Sulphur eruptions have been known to occur off the Namibian coast for centuries (Waldron 1901), and the biota in the area are likely to be naturally adapted to such pulsed events, and to subsequent hypoxia. However, satellite remote sensing has recently shown that eruptions occur more frequently, are more extensive and of longer duration than previously suspected, and that resultant hypoxic conditions last longer than thought (Weeks et al. 2002, 2004).

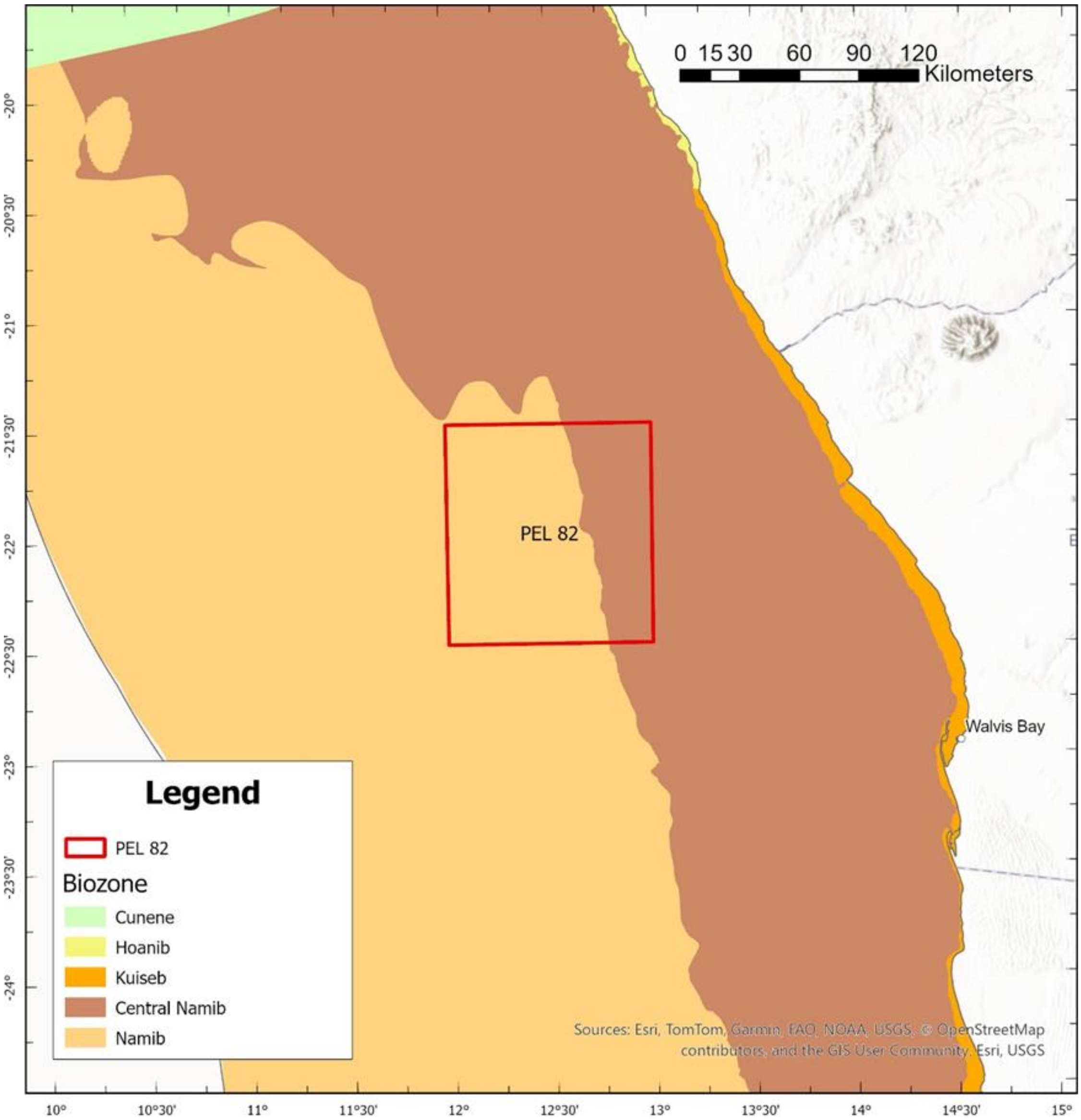
The role of micro-organisms in the detoxification of sulphidic water was investigated in 2004 during the occurrence of a sulphidic water mass covering 7,000 km^2 of seafloor off the coast of Namibia (http://www.mpi-bremen.de/Projekte_9.html; http://idw-online.de/pages/de/ news292832), when surface waters, however, remained well oxygenated. In the presence of oxygen, sulphide is oxidized and transformed into non-toxic forms of sulphur. An intermediate layer was discovered in the water column, which contained neither hydrogen sulphide nor oxygen. It was established that sulphide diffusing upwards from the anoxic bottom water is consumed by autotrophic denitrifying bacteria that inhabit the intermediate water layer. By using nitrate, the detoxifying microorganisms transform sulphide into finely dispersed particles of sulphur that are non-toxic, thereby creating a buffer zone between the toxic deep water and the oxygenated surface waters. These results, however, also suggest that benthic and demersal animals in coastal waters may be affected by sulphur eruptions more often than previously thought, and that many of these sulphidic events may go unnoticed on satellite imagery as the bacteria consume the hydrogen sulphide before it reaches the surface.

3.3 THE BIOLOGICAL ENVIRONMENT

Biogeographically the central Namibian coastline falls into the warm-temperate Namib Province, which extends northwards from Lüderitz into southern Angola (Emanuel *et al.* 1992). PEL 82 is located in the offshore Central Namib and Namib Biozones (De Cauwer 2007), which extend beyond the shelf break onto the continental slope and into abyssal depths (Figure 3-13). The coastal, wind-induced upwelling characterising the Namibian coastline, is the principle physical process which shapes the marine ecology of the central Benguela region. The Benguela system is characterised by the presence of cold surface water, high biological productivity, and highly variable physical, chemical and biological conditions (Barnard 1998). During periods of less intense winds off the northern Nambian coast (*Benguela Niños*), upwelling weakens and the warmer, more saline waters of the Angola Current intrude southwards along the coast introducing organisms normally associated with the subtropical conditions typical off Angola (Barnard 1998). As these events are typically temporary, the species of tropical west African origin associated with them will not be discussed here.

Communities within marine habitats are largely ubiquitous throughout the southern African West Coast region, being particular only to substrate type or depth zone. These biological communities consist of many hundreds of species, often displaying considerable temporal and spatial variability (even at small scales). PEL 82 is located beyond the 200 m depth contour, the closest points to shore being ~80 km off the coast near the Ugab River mouth. The near- and offshore marine ecosystems comprise a limited range of habitats, namely unconsolidated seabed sediments and the water column. The biological communities 'typical' of these habitats are described briefly below, focussing both on dominant, commercially important and conspicuous species, as well as potentially threatened or sensitive species, which may be affected by the exploration well-drilling.

FIGURE 3-13 PEL 82 IN RELATION TO THE NAMIBIAN BIOZONES (DE CAUWER 2007; MFMR 2021).



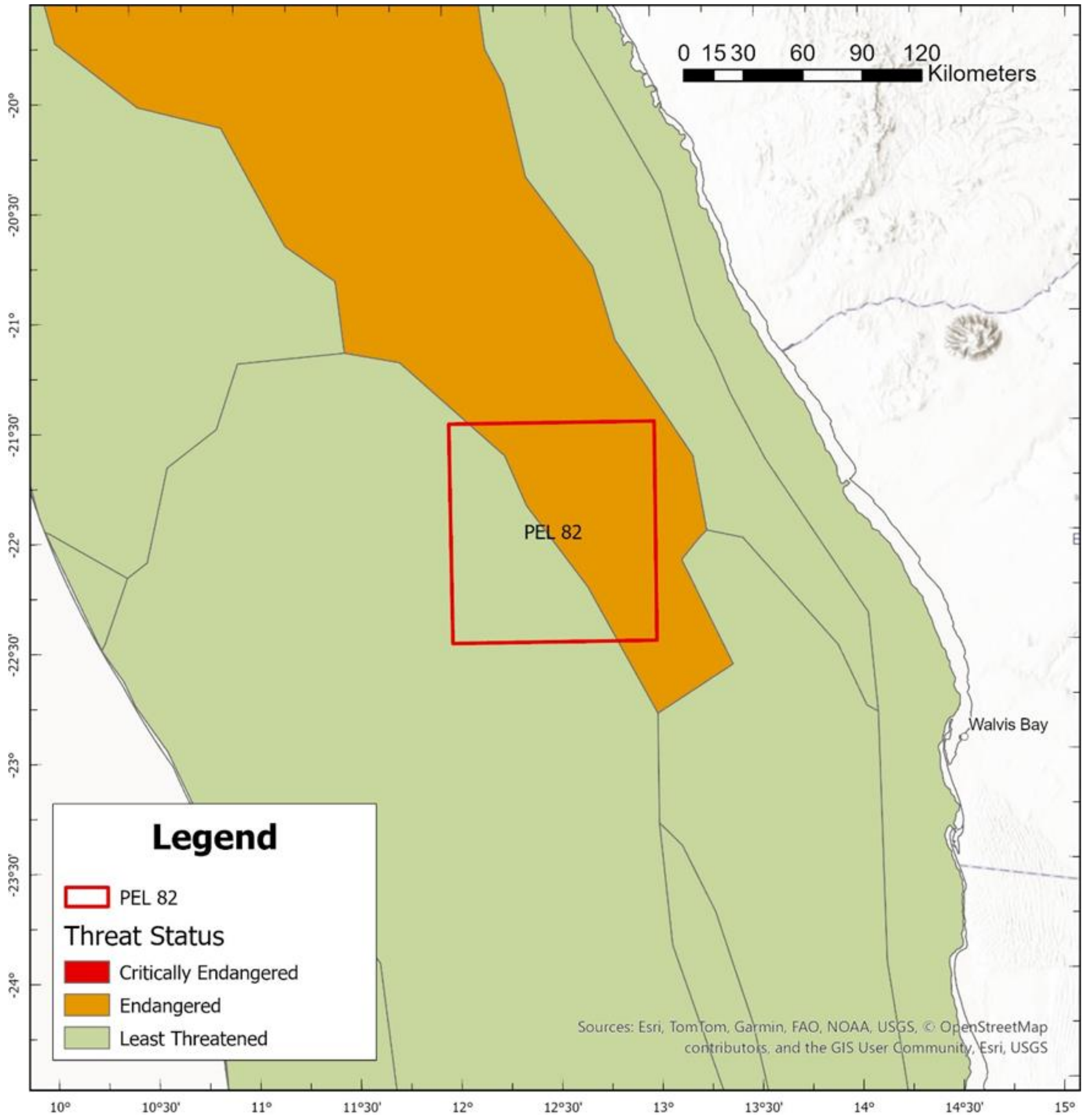
3.2.11 PELAGIC COMMUNITIES

The pelagic communities are typically divided into plankton, pelagic invertebrates and fish, and their main predators, marine mammals (seals, dolphins and whales), seabirds and turtles.

Pelagic habitat types within the broader project area have been defined as 'Least Threatened, 'Endangered' or 'Critically Endangered' depending on their level of protection (Sink et al. 2012; Holness et al. 2014) (Figure 3-14). The north-eastern half of PEL 82 falls within a pelagic habitat considered 'Endangered', with the remainder rated as 'Least Threatened'[1].

[1] Ecosystem Threat Status represents the degree to which ecosystems are still intact, or alternatively losing vital aspects of their structure, function or composition, on which their ability to provide ecosystem services ultimately depends. Unlike IUCN, the threat status here is at the ecosystem scale rather than the species level. Specific info on the species and features threatened are thus not provided but the threat status is based on the output of the MARXAN decision support tool, which utilises data on species, ecosystems and other biodiversity features; combined with data on planning unit costs to identify sets of areas that meet biodiversity targets while minimizing the total cost of the solution and hence ensuring a spatially optimal configuration of sites.

FIGURE 3-14 PEL 82 (RED POLYGON) IN RELATION TO ECOSYSTEM THREAT STATUS FOR OFFSHORE PELAGIC HABITAT TYPES ON THE CENTRAL NAMIBIAN COAST (ADAPTED FROM HOLNESS ET AL. 2014).



3.3.1.1 PLANKTON

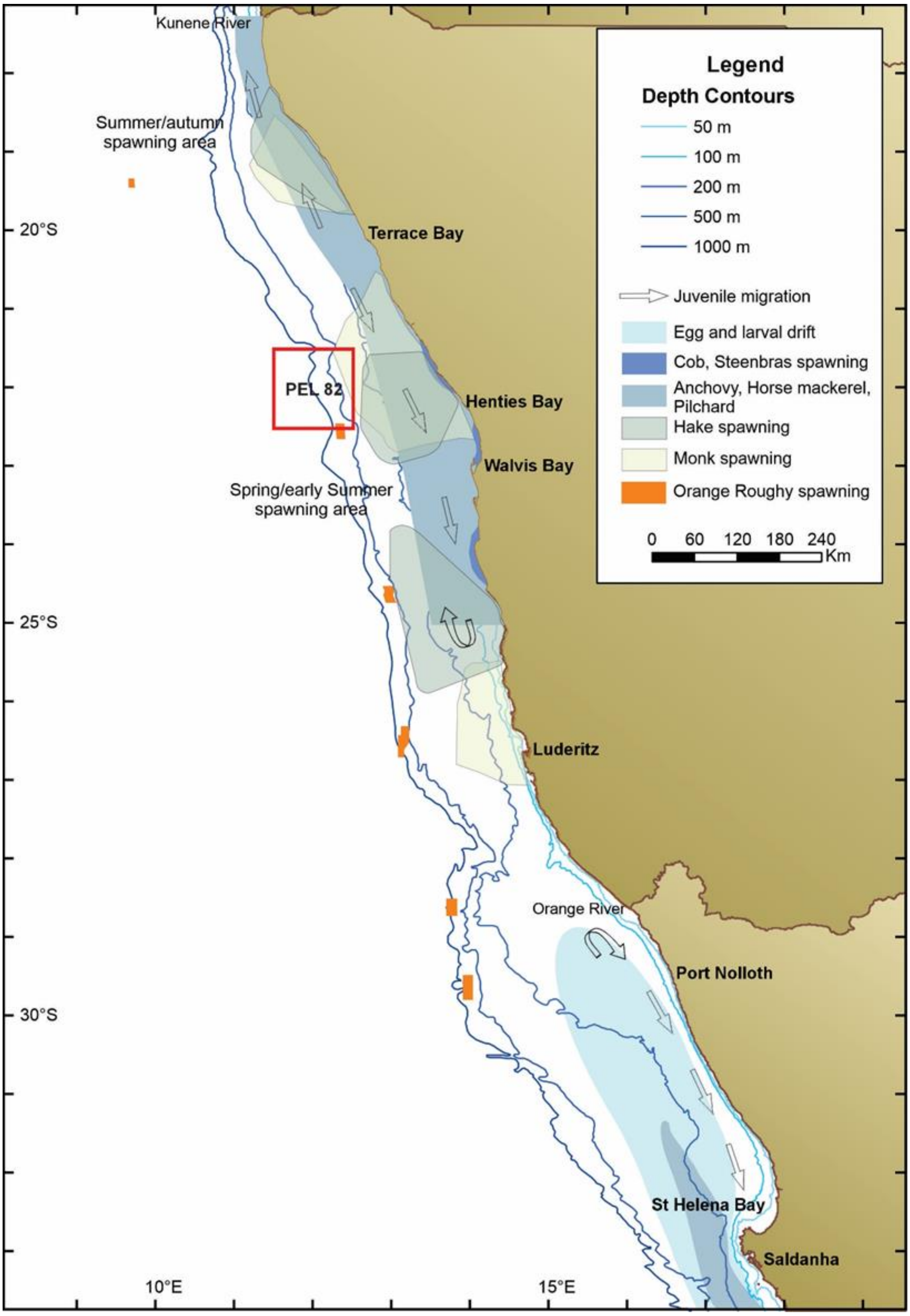
Plankton is particularly abundant in the shelf waters off Namibia, being associated with the upwelling characteristic of the area. Plankton range from single-celled bacteria to jellyfish of 2-m diameter, and include bacterio-plankton, phytoplankton, zooplankton, and ichthyoplankton.

Off the Namibian coastline, phytoplankton are the principle primary producers with mean annual productivity being comparatively high at 2 g C/m^2/day (Barnard 1998). The phytoplankton is dominated by diatoms, which are adapted to the turbulent sea conditions. Diatom blooms occur after upwelling events, whereas dinoflagellates are more common in blooms that occur during quiescent periods, since they can grow rapidly at low nutrient concentrations. In the surf zone, diatoms and dinoflagellates are nearly equally important members of the phytoplankton, and some silicoflagellates are also present.

Namibian zooplankton reaches maximum abundance in a belt parallel to the coastline and offshore of the maximum phytoplankton abundance. Samples collected over a full seasonal cycle (February to December) along a 10 to 90-nautical-miles transect offshore Walvis Bay showed that the mesozooplankton (<2 mm body width) community included egg, larval, juvenile and adult stages of copepods, cladocerans, euphausiids, decapods, chaetognaths, hydromedusae and salps, as well as protozoans and meroplankton larvae (Maartens 2003; Hansen et al. 2005). Copepods are the most dominant group making up 70–85% of the zooplankton. Seasonal patterns in copepod abundance, with low numbers during autumn (March–June) and increasing considerably during winter/early summer (July–December), appear to be linked to the period of strongest coastal upwelling in the northern Benguela (May–December), allowing a time lag of about 3–8 weeks, which is required for copepods to respond and build up large populations (Hansen et al. 2005). This suggests close coupling between hydrography, phytoplankton and zooplankton. Timonin et al. (1992) described three phases of the upwelling cycle (quiescent, active and relaxed upwelling) in the northern Benguela, each one characterised by specific patterns of zooplankton abundance, taxonomic composition and inshore-offshore distribution. It seems that zooplankton biomass closely follows the changes in upwelling intensity and phytoplankton standing crop. Consistently higher biomass of zooplankton occurs offshore to the west and northwest of Walvis Bay (Barnard 1998).

Ichthyoplankton constitutes the eggs and larvae of fish. As the preferred spawning grounds of numerous commercially exploited fish species are located off central and northern Namibia (Figure 3-15), their eggs and larvae form an important contribution to the ichthyoplankton in the region. Phytoplankton, zooplankton and ichthyoplankton abundances in the project area will be seasonally high, with diversity increasing in the in the vicinity of the confluence between the Angola and Benguela currents and west of the oceanic front and shelf-break.

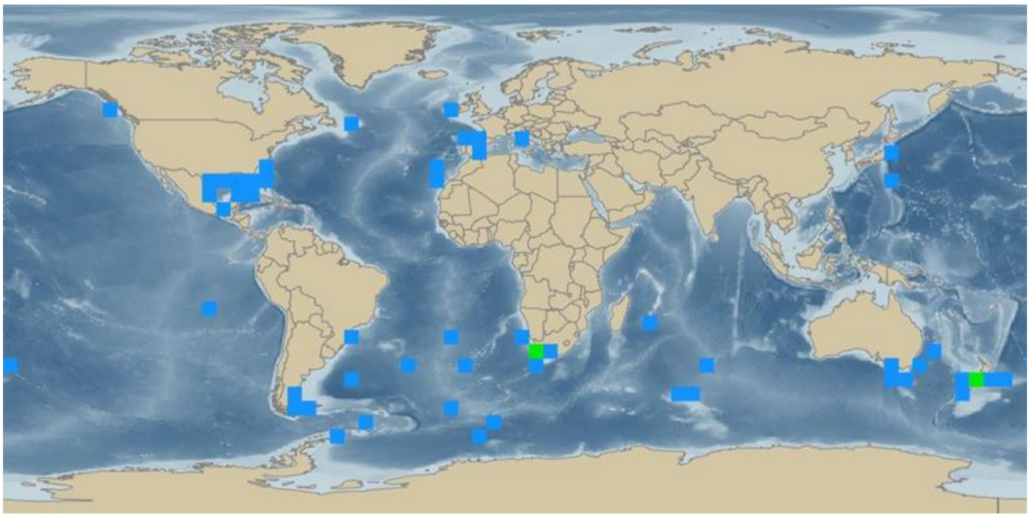
FIGURE 3-15 PEL 82 IN RELATION TO MAJOR SPAWNING AREAS IN THE CENTRAL AND NORTHERN BENGUELA REGION (ADAPTED FROM CRUIKSHANK 1990; HAMPTON 1992; HOLNESS ET AL. 2014).



3.3.1.2 PELAGIC INVERTEBRATES

Pelagic invertebrates that may be encountered in the project area are the giant squid *Architeuthis* sp. The giant squid is a deep dwelling species usually found near continental and island slopes all around the world's oceans (Figure 3-16) and could thus potentially occur in the pelagic habitats of the project area, although the likelihood of encounter is extremely low. Growing to in excess of 10 m in length, they are the principal prey of the sperm whale, and are also taken by beaked whaled, pilot whales, elephant seals and sleeper sharks. Nothing is known of their vertical distribution, but data from trawled specimens and sperm whale diving behaviour suggest they may span a depth range of 300 – 1,000 m. They lack gas-filled swim bladders and maintain neutral buoyancy through an ammonium chloride solution occurring throughout their bodies.

FIGURE 3-16 DISTRIBUTION OF THE GIANT SQUID. BLUE SQUARES <5 RECORDS, GREEN SQUARES 5-10 RECORDS (SOURCE: HTTP://IOBIS.ORG).



3.3.1.3 FISH

The surf zone and outer turbulent zone habitats of sandy beaches are considered to be important nursery habitats for marine fishes (Modde 1980; Lasiak 1981; Clark *et al.* 1994). However, the composition and abundance of the individual assemblages seems to be heavily dependent on wave exposure (Blaber & Blaber 1980; Potter *et al.* 1990; Clark 1997a, b). Surf zone fish communities off the coast of central Namibia have been studied at Langstrand (McLachlan 1986; Romer 1988), between Mile 9 and Wlotzkasbaken (Pulfrich 2015) and south of Langstrand to the Walvis Bay Naval Base (Laird *et al.* 2018). Species from the surf zone off Langstrand beach and further south included galjoen (*Dichistius capensis*), West Coast steenbras (*Lithognathus aureti*), flathead mullet (*Mugil cephalus*), southern mullet (*Chelon richardsonii*) and Cape silverside (*Atherina breviceps*) (McLachlan 1986; Romer 1988; Laird *et al.* 2018). The size composition of the catches confirmed that most of these species utilize the surf zone in the area as a nursery. North of Mile 9 the surf zone fish catches were more diverse with silver kob (*Argyrosomus inodorus*), Blacktail (*Diplodus capensis*), elf (*Pomatomus *saltatrix*), bluntnose guitarfish (*Rhinobatos blochii*) and maned blennie (*Scartella emarginata*) also being reported (Pulfrich 2015). Off Cape Cross only two species were recorded, these being sandsharks (*Rhinobatos annulatus*) and West Coast steenbras. Many of these species are important in the catches of recreational and/commercial net fisheries and linefisheries in Namibia (Kirchner *et al.* 2000; Holtzhausen et al 2001, Stage & Kirchner 2005).

The inshore waters of the central and northern Namibian coastline are also home to a number of bony fish and cartilagenous fish, many of which are popular angling species. Other than those mentioned above, these include the dusky kob *Argyrosomus coronus,* white steenbras *Lithognathus lithognathus,* west coast steenbras *Lithognathus aureti,* copper shark *Carcharhinus brachyurus*, the spotted gulley shark *Triakis megalopterus* and the smoothhound *Mustelus mustelus* (Kirchner *et al*. 2000; Zeybrandt and Barnes 2001). Warm water species that occur further north include garrick *Lichia amia*, shad *Pomatomus saltatrix* and spotted grunter *Pomadasys jubelini* (Barnard 1998).

A number of the nearshore teleost and chondrichthyan species are considered Endangered', 'Near Threatened' or 'Vulnerable' (Table 3-1).

TABLE 3-1 SOME OF THE MORE IMPORTANT LINEFISH SPECIES LIKELY TO OCCUR OFF CENTRAL NAMIBIA. THE GLOBAL IUCN CONSERVATION STATUS ARE ALSO PROVIDED.

Common Name	Species	IUCN Conservation Status
Teleosts		
Silver kob	*Argyrosomus inodorus*	Vulnerable
Elf	*Pomatomus saltatrix*	Vulnerable
West Coast steenbras	*Lithognathus aureti*	Near threatened
West coast dusky kob	*Argyrosomus coronus*	Data deficient
Chondrichthyans		
Bronze whaler	*Carcharhinus brachyurus*	Vulnerable
Six gill shark	*Hexanchus griseus*	Near threatened
Spotted gullyshark	*Triakis megalopterus*	Least Concern
Smooth houndshark	*Mustelus mustelus*	Endangered
Broadnose seven-gill cow shark	*Heptranchias perlo*	Near threatened

The biological, behavioural and life-history characteristics of the three most important linefish species in Namibian coastal waters are summarised below.

Silver kob *Argyrosomus inodorus* are distributed from northern Namibia to the warm temperate / subtropical transition zone on South Africa's east coast (Griffiths & Heemstra 1995). Four stocks have been identified, one in Namibia, with its core distribution from Cape Frio in the north to Meob Bay in the south (Kirchner 2001). Spawning occurs throughout the year but mostly in the warmer months from October to March when water temperatures are above 15°C and large adult fish occur in the nearshore, particularly in the identified spawning areas of Sandwich Harbour and Meob Bay. Adults are migratory whereas juveniles are resident in the surf zone. The stock is exploited by the commercial linefishery (deck and skiboats) and recreational shore angling and is regarded as overexploited and near collapse with less than 25% of pristine spawner biomass remaining (Kirchner 2001; Holtzhausen *et al.* 2001).

West coast dusky kob *Argyrosomus coronus* are distributed from northern Namibia to northern Angola (Griffiths & Heemstra 1995), but do occur as far south as St Helena Bay in South Africa (Lamberth *et al.* 2008). Early juveniles frequent muddy sediments in 50-100 m depth, moving inshore once they reach 300 mm total length. These juveniles and adolescents are resident in the nearshore, and are especially abundant in the turbid plume off the Cunene River Mouth and in selected surf zones of northern and central Namibia (Potts *et al.* 2010). The adults are migratory according to the movement of the Angola-Benguela frontal zone, moving northwards as far as Gabon in winter and returning to southern Angola in spring where spawning occurs in the offshore (Potts *et al.* 2010).

West coast steenbras *Lithognathus aureti* are endemic to the west coast of southern Africa, but rarely found outside Namibia's territorial waters (Holtzhausen 2000). Tagging studies have indicated that *L. aureti* comprise two separate closed populations; one in the vicinity of Meob Bay and one from central Namibia northwards (Holtzhauzen *et al.* 2001). Spawning localities are as yet unknown but tagging evidence suggests that males migrate considerable distances in search of gravid females (Holtzhausen 2000).

The spawning habitat of West coast steenbras is thought to also be limited. The bulk of the population exists in the nearshore at <10 m depth, with juveniles occurring in the intertidal surf zone (McLachlan 1986). By inference, spawning occurs in the surf zone and eggs and larvae from both populations drift northwards (Holtzhausen 2000). Whereas juveniles occur in the surf zone throughout its range, spawning habitat may be extremely limited and has yet to be clearly identified.

Small pelagic species include the sardine/pilchard (*Sadinops ocellatus*) (Figure 3-17, left), anchovy (*Engraulis capensis*), chub mackerel (*Scomber japonicus*), horse mackerel (*Trachurus capensis*) (Figure 3-17, right) and round herring (*Etrumeus whiteheadi*). These species typically occur in mixed shoals of various sizes (Crawford *et al*. 1987), and generally occur within the 200 m contour, although they may often be found very close inshore, just beyond the surf zone. They spawn downstream of major upwelling centres in spring and summer, and their eggs and larvae are subsequently carried up the coast in northward flowing waters. Historically, two seasonal spawning peaks for pilchard occurred; the first from October to December in an inshore area between Walvis Bay and Palgrave Point and the second from February to March near the 200 m isobath between Palgrave Point and Cape Frio. However, since the collapse of the pilchard stock, spawning in the south has decreased (Crawford *et al*. 1987). Recruitment success relies on the interaction of oceanographic events and is thus subject to spatial and temporal variability. Consequently, the abundance of adults and juveniles of these small pelagic fish is highly variable both within and between species. The Namibian pelagic stock is currently considered to be in a critical condition due to a combination of over-fishing and unfavourable environmental conditions as a result of *Benguela Niños* (Boyer et al. 2006).

Since the collapse of the pelagic fisheries, jellyfish biomass has increased and the structure of the Benguelan fish community has shifted, making the bearded goby (*Sufflogobius bibarbatus*) the new predominant prey species. Gobies have a high tolerance for low oxygen and high H_2S levels, which enables them to feed on benthic fauna within hypoxic waters during the day, and then move to oxygen-richer pelagic waters at night, when predation pressure is lower, to feed on live jellyfish (Utne-Palm *et al.* 2010; van der Bank *et al.* 2011).

FIGURE 3-17 CAPE FUR SEAL PREYING ON A SHOAL OF PILCHARDS (LEFT). SCHOOL OF HORSE MACKEREL (RIGHT) (PHOTOS: WWW.UNDERWATERVIDEO.CO.ZA; WWW.DELIVERY.SUPERSTOCK.COM).

Two species that migrate along the southern African West Coast following the shoals of anchovy and pilchards are snoek *Thyrsites atun* and chub mackerel *Scomber japonicus*. Both these species have been rated as ‘Least concern’ on the South African national assessment (Sink *et al.* 2019). Snoek has not been assessed by the International Union for the Conservation of Nature (IUCN), and chub mackerel is considered of ‘Least concern’. While the appearance of chub mackerel along the West coast is highly seasonal, adult snoek are found throughout their distribution range and longshore movement are random and without a seasonal basis (Griffiths 2002). Initially postulated to be a single stock that undergoes a seasonal longshore migration from southern Angola through Namibia to the South African West Coast (Crawford & De Villiers 1985; Crawford *et al.* 1987), Benguela snoek are now recognised as two separate sub-populations separated by the Lüderitz upwelling cell (Griffiths 2003). Snoek are voracious predators occurring throughout the water column, feeding on both demersal and pelagic invertebrates and fish. The abundance and seasonal migrations of chub mackerel are thought to be related to the availability of their shoaling prey species (Payne and Crawford 1989).

The fish most likely to be encountered on the shelf, beyond the shelf break and in the offshore waters of PEL 82 are the large migratory pelagic species, including various tunas, billfish and sharks, many of which are considered threatened by the International Union for the Conservation of Nature (IUCN), primarily due to overfishing (Table 3-2). Tuna and swordfish are targeted by high seas fishing fleets and illegal overfishing has severely damaged the stocks of many of these species. Similarly, pelagic sharks, are either caught as bycatch in the pelagic tuna longline fisheries, or are specifically targeted for their fins, where the fins are removed and the remainder of the body discarded.

Species occurring off Namibia include the albacore/longfin tuna *Thunnus alalunga* (Figure 3-18, right), yellowfin *T. albacares*, bigeye *T. obesus*, and skipjack *Katsuwonus pelamis* tunas, as well as the Atlantic blue marlin *Makaira nigricans* (Figure 3-18, left), the white marlin *Tetrapturus albidus* and the broadbill swordfish *Xiphias gladius* (Payne and Crawford 1989). Large pelagic species migrate throughout the southern oceans, between surface and deep waters (>300 m) and have a highly seasonal abundance in the Benguela. The distributions of these species are dependent on food availability in the mixed boundary layer between the Benguela and warm central Atlantic waters. Concentrations of large pelagic species are also known to occur associated with underwater feature such as canyons and seamounts as well as meteorologically induced oceanic fronts (Penney *et al.* 1992).

TABLE 3-2 SOME OF THE MORE IMPORTANT LARGE MIGRATORY PELAGIC FISH LIKELY TO OCCUR IN THE OFFSHORE REGIONS OF THE WEST COAST AND THEIR GLOBAL IUCN CONSERVATION STATUS.

Common Name	Species	IUCN Conservation Status
Tunas		
Southern Bluefin Tuna	*Thunnus maccoyii*	Endangered
Bigeye Tuna	*Thunnus obesus*	Vulnerable
Longfin Tuna/Albacore	*Thunnus alalunga*	Least concern
Yellowfin Tuna	*Thunnus albacares*	Least concern
Frigate Tuna	*Auxis thazard*	Least concern
Eastern Little Tuna	*Euthynnus affinis*	Least concern
Skipjack Tuna	*Katsuwonus pelamis*	Least concern
Billfish		
Black Marlin	*Istiompax indica*	Data deficient
Blue Marlin	*Makaira nigricans*	Vulnerable
Striped Marlin	*Kajikia audax*	Least Concern
Sailfish	*Istiophorus platypterus*	Vulnerable
Swordfish	*Xiphias gladius*	Near Threatened

Common Name	Species	IUCN Conservation Status
Pelagic Sharks		
Oceanic Whitetip Shark	*Carcharhinus longimanus*	Critically Endangered
Dusky Shark	*Carcharhinus obscurus*	Endangered
Great White Shark	*Carcharodon carcharias*	Vulnerable
Shortfin Mako	*Isurus oxyrinchus*	Endangered
Longfin Mako	*Isurus paucus*	Endangered
Whale Shark	*Rhincodon typus*	Endangered
Blue Shark	*Prionace glauca*	Near Threatened

*Until recently Southern Bluefin Tuna was globally assessed as 'Critically Endangered' by the IUCN. Although globally the stock remains at a low state, it is not considered overfished as there have been improvements since previous stock assessments. Consequently, the list of species changing IUCN Red List Status for 2020-2021 now list Southern Bluefin Tuna is globally 'Endangered'. In South Africa the stock is considered collapsed (Sink *et al.* 2019).

FIGURE 3-18 LARGE MIGRATORY PELAGIC FISH SUCH AS BLUE MARLIN (LEFT) AND LONGFIN TUNA (RIGHT) OCCUR IN OFFSHORE WATERS (PHOTOS: WWW.SAMATHATOURS.COM; www.osfimages.com).

A number of species of pelagic sharks are also known to occur off the southern African West Coast, including blue *Prionace glauca*, short-fin mako *Isurus oxyrinchus* and oceanic whitetip sharks *Carcharhinus longimanus*. Occurring throughout the world in warm temperate waters, these species are usually found further offshore. Great whites *Carcharodon carcharias* and whale sharks *Rhincodon typus* may also be encountered in coastal and offshore areas, although the latter occurs more frequently along the South and East coasts of southern Africa. The recapture of a juvenile blue shark off Uruguay, which had been tagged off the Cape of Good Hope, supports the hypothesis of a single blue shark stock in the South Atlantic (Hazin 2000; Montealegre-Quijano & Vooren 2010) and Indian Oceans (da Silva *et al*. 2010). Using the Benguela drift in a north-westerly direction, it is likely that juveniles from the parturition off the south-western Cape would migrate through the project area *en route* to South America (da Silva *et al.* 2010).

The shortfin mako inhabits offshore temperate and tropical seas worldwide. It can be found from the surface to depths of 500 m, and as one of the few endothermic sharks is seldom found in waters <16°C (Compagno 2001; Loefer *et al.* 2005). As the fastest species of shark, shortfin makos have been recorded to reach speeds of 40 km/h with burst of up to 74 km/h, and can jump to a height of 9 m (http://www.elasmo-research.org/education/shark_profiles/ i_oxyrinchus.htm). Most makos caught by longliners off South Africa are immature, with reports of juveniles and sub-adults sharks occurring near the edge of the Agulhas Bank and off the South Coast between June and November (Groeneveld *et al.* 2014), whereas larger and reproductively mature sharks were more common in the inshore environment along the East Coast (Foulis 2013).

Until recently, the Southern Bluefin Tuna was globally assessed as 'Critically Endangered' by the IUCN, and in South Africa the stock is considered collapsed (Sink *et al.* 2019). Although globally the stock remains at a low state, it is not considered overfished as there have been improvements since previous stock assessments. Consequently, the list of species changing IUCN Red List Status for 2020-2021 now list Southern Bluefin Tuna as globally 'Endangered'.

Whale sharks are regarded as a broad ranging species typically occurring in offshore epipelagic areas with sea surface temperatures of 18–32°C (Eckert & Stewart 2001). Adult whale sharks reach an average size of 9.7 m and 9 tonnes, making them the largest non-cetacean animal in the world. They are slow-moving filter-feeders and therefore particularly vulnerable to ship strikes (Rowat 2007). Although primarily solitary animals, seasonal feeding aggregations occur at several coastal sites all over the world, those closest to the project area being off Sodwana Bay in KwaZulu Natal (KZN) (Cliff *et al.* 2007). Satellite tagging has revealed that individuals may travel distances of tens of 1,000s of kms (Eckert & Stewart 2001; Rowat & Gore 2007; Brunnschweiler *et al.* 2009). On the southern African West Coast their summer and winter distributions are centred around the Orange River mouth and further south between Cape Columbine and Cape Point (Harris *et al*. 2022). The likelihood of an encounter in the offshore waters of PEL 82 is relatively low.

Of the species listed above, the Oceanic Whitetip is listed as 'Critically Endangered', blue shark is listed as 'Near threatened', and the short-fin and long-fin mako, Dusky and whale shark as 'Endangered' on the IUCN database. The whale shark and shortfin mako are listed in Appendix II (species in which trade must be controlled in order to avoid utilization incompatible with their survival) of CITES (Convention on International Trade in Endangered Species) and Appendix I and/or II of the Bonn Convention for the Conservation of Migratory Species (CMS).

3.3.1.4 TURTLES

Five of the eight species of turtle worldwide occur off Namibia (Bianchi *et al.* 1999). The Leatherback (*Dermochelys coriacea*) turtle (Figure 3-19, left) is occasionally encountered in the offshore waters off Namibia. Observations of Green (*Chelonia mydas*), Loggerhead (*Caretta caretta*) (Figure 3-19, right), Hawksbill (*Eretmochelys imbricata*) and Olive

Ridley (*Lepidochelys olivacea*) turtles in the area are rare. Loggerhead turtles have been reported by MMOs during seismic operations in PEL 82. The leatherback turtle may also be encountered, although abundance in the study area is expected to be low.

FIGURE 3-19 LEATHERBACK (LEFT) AND LOGGERHEAD TURTLES (RIGHT) OCCUR ALONG THE COAST OF CENTRAL NAMIBIA (PHOTOS: KETOS ECOLOGY 2009; WWW.AQUAWORLD-CRETE.COM).

The Benguela ecosystem is increasingly being recognized as a potentially important feeding area for leatherback turtles from several globally significant nesting populations in the south Atlantic (Gabon, Brazil) and south-east Indian Ocean (South Africa) (Lambardi *et al.* 2008, Elwen & Leeney 2011). Leatherback turtles from the east South Africa population have been satellite tracked swimming around the west coast of South Africa and remaining in the warmer waters west of the Benguela ecosystem (Lambardi *et al.* 2008, Elwen & Leeney 2011; SASTN 2011[2]).

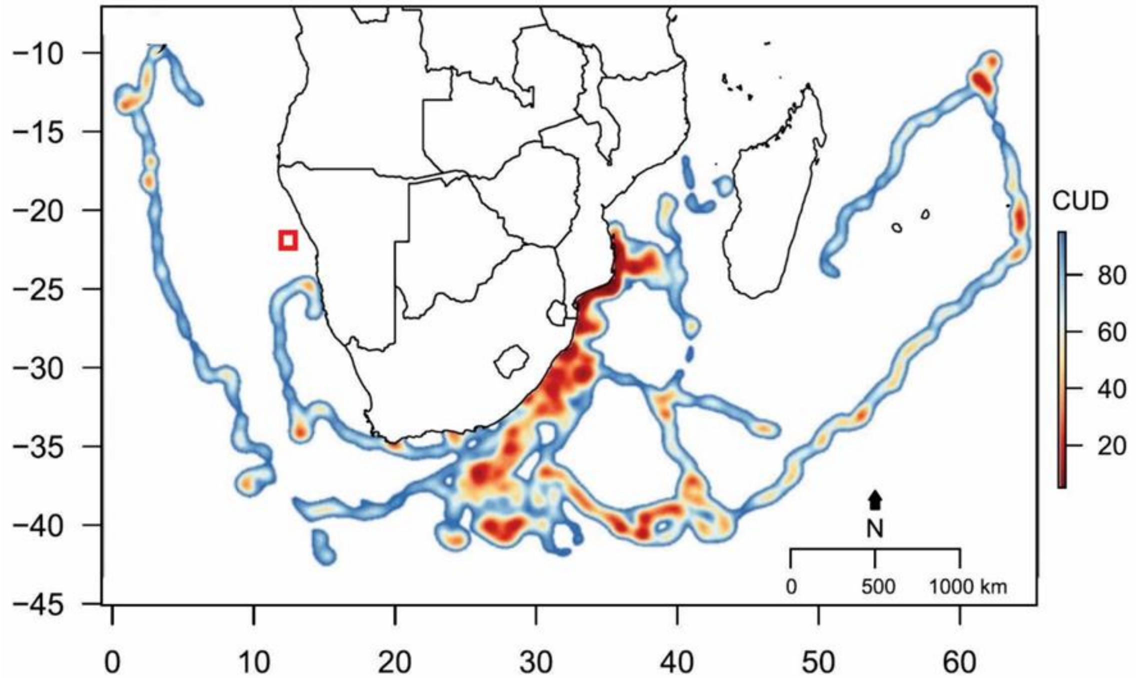
Leatherback turtles inhabit deeper waters and are considered a pelagic species, travelling the ocean currents in search of their prey. While hunting they may dive to over 600 m and remain submerged for up to 54 minutes (Hays *et al.* 2004). Their abundance in the study area is unknown but expected to be low. Although they tend to avoid nearshore areas, they may be encountered in Walvis Bay and off Swakopmund between October and April when prevailing north wind conditions result in elevated seawater temperatures (Figure 3-20).

After completion of the nesting season (October to January) both Leatherbacks and Loggerheads undertake long-distance migrations to foraging areas. Loggerhead turtles are coastal specialists keeping inshore, hunting around reefs, bays and rocky estuaries along the African South and East Coast, where they feed on a variety of benthic fauna including crabs, shrimp, sponges, and fish. In the open sea their diet includes jellyfish, flying fish, and squid (www.oceansafrica.com/turtles.htm). Satellite tagging of loggerheads suggests that they seldom occur west of Cape Agulhas (Harris *et al.* 2018; Robinson *et al.* 2019). A green turtle and loggerhead turtle recently released on the

[2] *SASTN Meeting – Second meeting of the South Atlantic Sea Turtle Network, Swakopmund, Namibia, 24-30 July 2011.*

Cape Peninsula by the Two Oceans Aquarium has, however stayed in the West Coast waters, spending time in St Helena Bay and travelling up the Namaqualand coast before heading northwards into Namibian waters to north of Walvis Bay, suggesting that occurrence in West Coast waters does arise (https://www.aquarium.co.za/foundation/news /tracking-our-turtles-the-first-update-of-2024).

FIGURE 3-20 PEL 82 (RED POLYGON) IN RELATION TO THE MIGRATION CORRIDORS OF LEATHERBACK TURTLES IN THE SOUTH-WESTERN INDIAN OCEAN. RELATIVE USE (CUD, CUMULATIVE UTILIZATION DISTRIBUTION) OF CORRIDORS IS SHOWN THROUGH INTENSITY OF SHADING: LIGHT, LOW USE; DARK, HIGH USE (ADAPTED FROM HARRIS ET AL. 2018).



Loggerheads and leatherbacks nest along the sandy beaches of the northeast coast of KZN, as well as southern Mozambique during summer months. Loggerhead and leatherback females come ashore to nest from October to March, with peak nesting for both species occurring in December – January (Le Gouvello *et al.* 2020). Hatchlings emerge from their nests from mid-January to mid-March. Those hatchlings that successfully escape predation *en route* to the sea, enter the surf and are carried ~10 km offshore by coastal rip currents or swim actively offshore for 24-48 hours (frenzy period) to reach the Agulhas Current (Hughes 1974). Although they can actively swim to influence their dispersal trajectories (Scott *et al.* 2014; Putman & Mansfield 2015), hatchlings are not powerful swimmers and will primarily drift south-westwards in the current. The Agulhas Current migration corridor will therefore be very active with migrating sea turtles between January and April (Harris *et al.* 2018), some of which may be distributed along the West Coast through mass transport of Agulhas Current water into the southeast Atlantic by warm core rings. Despite their extensive distributions and feeding ranges, the numbers of adult and neonate turtles encountered in PEL 82 may therefore be seasonally high.

Turtles marked with titanium flipper tags have revealed that South African loggerheads and leatherbacks have a remigration interval of 2 – 3 years, migrating to foraging grounds throughout the Southwestern Indian Ocean (SWIO) as well as in the eastern Atlantic Ocean. They follow different post-nesting migration routes (Hughes *et al.* 1998; Luschi *et al.* 2006). Loggerheads use one of 3 migration corridors between their nesting and foraging grounds of which the coast-associated Mozambique Corridor is the most commonly used (>80% of the population). Leatherbacks largely follow the same corridors as the loggerheads, with most riding the Agulhas Current southward to forage in high seas regions of the Agulhas Plateau (Hughes *et al.* 1998; Luschi *et al.* 2003b; Luschi *et al.* 2006), at which point they either swim east following the Agulhas Retroflection (Agulhas-Retroflection Corridor) as far north as the Mascarene Plateau or enter the Benguela Current to migrate into the southeastern Atlantic, as far north as central Angola (Agulhas-Benguela Corridor) (Figure 3-20) (Lambardi et al. 2008; de Wet 2013; Harris *et al.* 2018).

Ocean circulation models and numerical dispersal simulations have recently provided insights into the cryptic 'lost years' of neonate turtles (Hamann *et al.* 2011; Putman *et al.* 2012; Putman & Naro-Maciel 2013; Le Gouvello *et al*. 2020; Putman *et al.* 2020; DuBois *et al.* 2021; Le Gouvello *et al*. 2024). After ~10 years, juvenile loggerheads return to coastal areas to feed on crustaceans, fish and molluscs and subsequently remain in these neritic habitats (Hughes 1974). In contrast, leatherbacks remain in pelagic waters feeding primarily on jellyfish until they become sexually mature and return to coastal regions to breed. While hunting they may dive to over 600 m and remain submerged for up to 54 minutes (Hays *et al.* 2004).

Leatherback Turtles are listed as 'Vulnerable' worldwide by the IUCN and are in the highest categories in terms of need for conservation in CITES (Convention on International Trade in Endangered Species), and CMS (Convention on Migratory Species).

Loggerhead and Olive Ridley turtles are globally listed as 'Vulnerable' whereas Hawksbill are globally listed as 'Critically Endangered', and Green turtles as 'Endangered'. The most recent conservation status, which assessed the species on a scale of Regional Management Units (RMU)3, is provided in

[3] Regional Management Units (RMUs) organise marine turtles that might be on independent evolutionary trajectories within regional entities into units of protection above the level of nesting populations, but below the level of species.

Table 3-3. From this it is evident that leatherback and loggerhead turtles, the two species most likely to be encountered in the license area, are rated as 'Critically Endangered' and 'Near Threatened', respectively in the Southwest Indian RMU. Although not a signatory of CMS, Namibia has endorsed and signed a CMS International Memorandum of Understanding specific to the conservation of marine turtles. Namibia is thus committed to conserve these species at an international level.

FIGURE 3-21 DISPERSAL MAPS SHOWING TRAJECTORIES OF 5000 PARTICLES RELEASED FROM THE RESPECTIVE NESTING SITES (WHITE CIRCLES) IN MARCH 2018 FOR LOGGERHEADS (TOP) AND LEATHERBACKS (BOTTOM). COLOURS (BLUE TO RED) INDICATE THE NUMBER OF DAYS SINCE RELEASE (ADAPTED FROM LE GOUVELLE ET AL. 2020). PEL 82 IS DEPICTED AS A SMALL BLACK SQUARE.

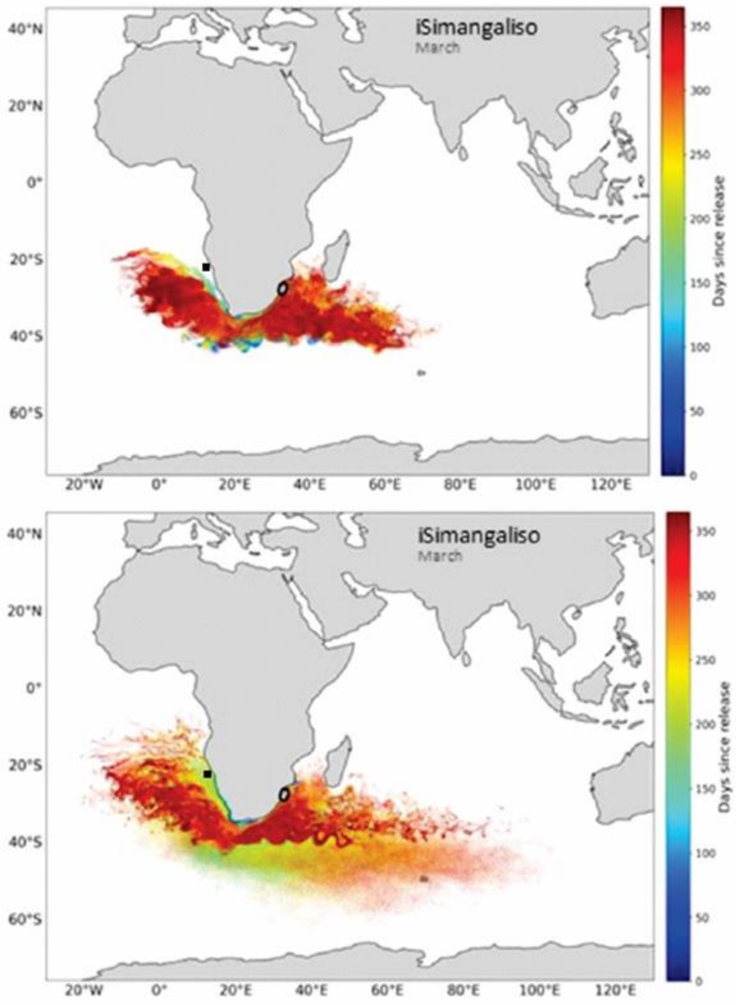


TABLE 3-3 GLOBAL AND REGIONAL CONSERVATION STATUS OF THE TURTLES OCCURRING OFF THE SOUTHERN AFRICAN COASTLINE SHOWING VARIATION DEPENDING ON THE LISTING USED.

Listing	Leatherback	Loggerhead	Green	Hawksbill	Olive Ridley
IUCN Red List:					
Species (date)	V (2013)	V (2017)	E (2004)	CR (2008)	V (2008)
Population (RMU)	CR (2013)	NT (2017)	*	*	*
Sub-Regional/National (RSA)					
NEMBA TOPS (2007)	CR	CR	E	CR	E
Hughes & Nel (2014)	E	V	NT	NT	DD

NT – Near Threatened V – Vulnerable E – Endangered CR – Critically Endangered
DD – Data Deficient * Not yet assessed

3.3.1.5 MARINE MAMMALS

Marine mammals occurring off the central Benguela ecosystem include cetaceans (whales and dolphins) and seals. The cetacean fauna of central Namibia comprises 33 species of whales and dolphins known (historic sightings or strandings) or likely (habitat projections based on known species parameters) to occur here (Table 3-4), and their known seasonality (Table 3-5). Apart from the resident species such as the endemic Heaviside's dolphin, bottlenose and dusky dolphins, Namibia's waters also host species that migrate between Antarctic feeding grounds and warmer low latitude breeding grounds, as well as species with a circum-global distribution. The Namibian shelf and deeper waters have been poorly studied with most available information in deeper waters (>200 m) arising from historic whaling records, although data from marine mammal observers and passive acoustic monitoring is improving knowledge in recent years. Current information on the distribution, population sizes and trends of most cetacean species occurring in Namibian waters is lacking. Information on smaller cetaceans in deeper waters (>100 m) is particularly poor and the precautionary principal must be used when considering possible encounters with cetaceans in this area.

Although the location of PEL 82 can be considered to be truly within the Benguela Ecosystem, the warmer waters that occur more than ~100 km offshore provide an entirely different habitat than the Benguela Ecosystem, that despite the relatively high latitude may host some species associated with the more tropical and temperate parts of the Atlantic such as rough toothed dolphins, striped dolphins, Pan-tropical spotted dolphins and short finned pilot whales.

The distribution of cetaceans in Namibian waters can largely be split into those associated with the continental shelf and those that occur in deep, oceanic water. Importantly, species from both environments may be found in the shelf edge area (200-1,000 m) making this the most species-rich area for cetaceans. Cetacean density on the continental shelf is usually higher than in pelagic waters as species associated with the pelagic environment tend to be wide ranging across 1,000s of kilometers. The most common species within the broader project area (in terms of likely encounter rate due to local abundance rather than total population sizes) are likely to be the humpback whale and pilot whale.

Cetaceans comprise two basic taxonomic groups, the mysticetes (filter feeding whales with baleen) and the odontocetes (predatory whales and dolphins with teeth). The term ‘whale’ is used to describe cetaceans larger than approximately 4 m in length, in both these groups and is taxonomically meaningless (e.g. the killer whale and pilot whale are members of the Odontocetes and the family Delphinidae and are thus dolphins, not whales). Due to large differences in their size, sociality, communication abilities, ranging behaviour and principally, acoustic behaviour, these two groups are considered separately.

Table 3-4 lists the cetaceans likely to be found within the license area based on data sourced from: Findlay *et al.* (1992), Best (2007), Weir (2011), Dr J-P Roux, (MFMR pers comm) and unpublished records held by the Namibian Dolphin Project, which includes sightings from fisheries observers and MMOs working on seismic surveys in the area (de Rock *et al.* 2019). From MMO sightings (

Figure 3-22) it is evident that many species do occur as far offshore as PEL 82, particularly sei, sperm, fin, pilot and humpback whales.

The South African red list of cetacean fauna was updated in 2016 and global reviews are underway. As the Namibian list has not been updated recently the South African red list ratings are used as the most up to date. Of the 33 species listed, one is ‘critically endangered’, two are ‘endangered’ and one is considered ‘vulnerable’. Altogether 11 species are listed as ‘data deficient’, underlining how little is known about cetaceans, their distributions and population trends in Namibian waters. A review of the distribution and seasonality of the key cetacean species likely to be found within the broader project area is provided below, based on information provided by the Sea Search - Namibian Dolphin Project (NDP), which has been conducting research in Namibian waters since 2008. The NDP holds the most up-to-date data of cetacean occurrence and distribution since whaling times, with the records including a total database of over 7,000 records with more than 1,000 sightings made by MMOs on seismic or mining vessels and fisheries observers operating in shelf or pelagic waters.

Mysticete (Baleen) whales

The majority of mysticetes whales fall into the family Balaenidae. Those occurring in the study area include the blue, fin, sei, Antarctic minke, dwarf minke, humpback and Bryde’s whale (see Table 3-4 for scientific names). The majority of these species occur in pelagic waters with only the occasional visit to shelf waters. All of these species show some degree of migration either to, or through the latitudes of PEL 82 when *en route* between higher latitude (Antarctic or Sub Antarctic) feeding grounds and lower latitude breeding grounds. Depending on the ultimate location of these feeding and breeding grounds, seasonality in Namibian waters can be either unimodal, usually in winter months, or bimodal (e.g. May-July and October-November) reflecting a northward and southward migration through the area. Northward and southward migrations may take place at different distances from the coast due to whales following geographic or oceanographic features, thereby influencing the seasonality of occurrence at different locations. Due to the complexities of the migration patterns, each species is discussed in further detail below.

There is very little information on sei whales in Namibian waters and most information on the species from the southern African sub-region originates from whaling data from 1958-1963. Sei whales spend time at high altitudes (40-50°S) during summer months and migrate north through South African waters (where they were historically hunted in relatively high numbers) to unknown breeding grounds further north (Best 2007). As whaling catches were confirmed off both Congo and Angola, it is likely that they migrate through Namibian waters. Due to their migration pattern, densities in the project area are likely to show a bimodal peak with numbers predicted to be highest in May and June, and again in August, September, and October. All whales were historically caught in waters deeper than 200 m with most catches from deeper than 1,000 m (Best & Lockyer 2002). There is no current information on the abundance or distribution of this species in the region, but a recent sighting of a mother and calf in March 2012 (NDP unpublished data) and a stranding in Walvis Bay in July 2013 (NDP unpublished data) confirms their contemporary and probably year-round occurrence on the Namibian continental shelf and beyond. Sei whales are likely to be encountered in the project area.

Two genetically and morphologically distinct populations of Bryde's whales live off the west coast of southern Africa (Best 2001; Penry 2010). The "offshore population" lives beyond the shelf (>200 m depth) off west Africa and migrates between wintering grounds off equatorial west Africa (Gabon) and summering grounds off western South Africa. Its seasonality on the west coast is thus opposite to the majority of the balaenopterids with abundance likely to be highest in the project area in January - March. Several strandings of adult offshore Bryde's whales have occurred in central Namibia including in January 2012 and November 2017 near Walvis Bay, Namibia. The "inshore population" of Bryde's whales is unique amongst baleen whales in the region by being non-migratory.

The published range of the population is the continental shelf and Agulhas Bank of South Africa ranging from Durban in the east to at least St Helena Bay off the west coast with possible movements further north into the winter months (Best 2007). A live stranding of a calf of this population (population assigned genetically – G Penry pers. comm.) in Walvis Bay, Namibia confirms the current occurrence of this population in Namibian waters. An additional live sighting in the Namibian Islands Marine Protected Area (NIMPA) and a third stranding of a Bryde's whale adult in April 2013 have not been assigned to population but supports regular, year-round occurrence of both populations of the species in the central Benguela ecosystem. Sightings of Bryde's whales were made in the vicinity of PEL 82 (

Figure 3-22). Bryde's whales are likely to be encountered in the project area.

TABLE 3-4 CETACEANS OCCURRENCE OFF THE SOUTHERN NAMIBIAN COAST, THEIR SEASONALITY, LIKELY ENCOUNTER FREQUENCY WITH PROPOSED EXPLORATION ACTIVITIES AND SOUTH AFRICAN (CHILD ET AL. 2016) AND GLOBAL IUCN RED LIST CONSERVATION STATUS.

Common Name	Species	Hearing Frequency	Shelf (<200 m)	Offshore (>200 m)	Seasonality	RSA Regional Assessment	IUCN Global Assessment
Delphinids							
Dusky dolphin	*Lagenorhynchus obscurus*	HF	Yes (0- 800 m)	No	Year round	Least Concern	Least Concern
Heaviside's dolphin	*Cephalorhynchus heavisidii*	VHF	Yes (0-200 m)	No	Year round	Least Concern	Near Threatened
Common bottlenose dolphin	*Tursiops truncatus*	HF	Yes	Yes	Year round	Least Concern	Least Concern
Common dolphin	*Delphinus delphis*	HF	Yes	Yes	Year round	Least Concern	Least Concern
Southern right whale dolphin	*Lissodelphis peronii*	HF	Yes	Yes	Year round	Least Concern	Least Concern
Striped dolphin	*Stenella coeruleoalba*	HF	No	Yes	Year round	Least Concern	Least Concern
Pantropical spotted dolphin	*Stenella attenuata*	HF	Edge	Yes	Year round	Least Concern	Least Concern
Long-finned pilot whale	*Globicephala melas*	HF	Edge	Yes	Year round	Least Concern	Least Concern
Short-finned pilot whale	*Globicephala macrorhynchus*	HF	Edge	Yes	Year round	Least Concern	Least Concern
Rough-toothed dolphin	*Steno bredanensis*	HF	No	Yes	Year round	Not Assessed	Least Concern
Killer whale	*Orcinus orca*	HF	Occasional	Yes	Year round	Least Concern	Data deficient
False killer whale	*Pseudorca crassidens*	HF	Occasional	Yes	Year round	Least Concern	Near Threatened
Pygmy killer whale	*Feresa attenuata*	HF	No	Yes	Year round	Least Concern	Least Concern
Risso's dolphin	*Grampus griseus*	HF	Yes (edge)	Yes	Year round	Data Deficient	Least Concern
Sperm whales							
Pygmy sperm whale	*Kogia breviceps*	VHF	Edge	Yes	Year round	Data Deficient	Least Concern
Dwarf sperm whale	*Kogia sima*	VHF	Edge	Yes	Year round	Data Deficient	Least Concern
Sperm whale	*Physeter macrocephalus*	HF	Edge	Yes	Year round	Vulnerable	Vulnerable

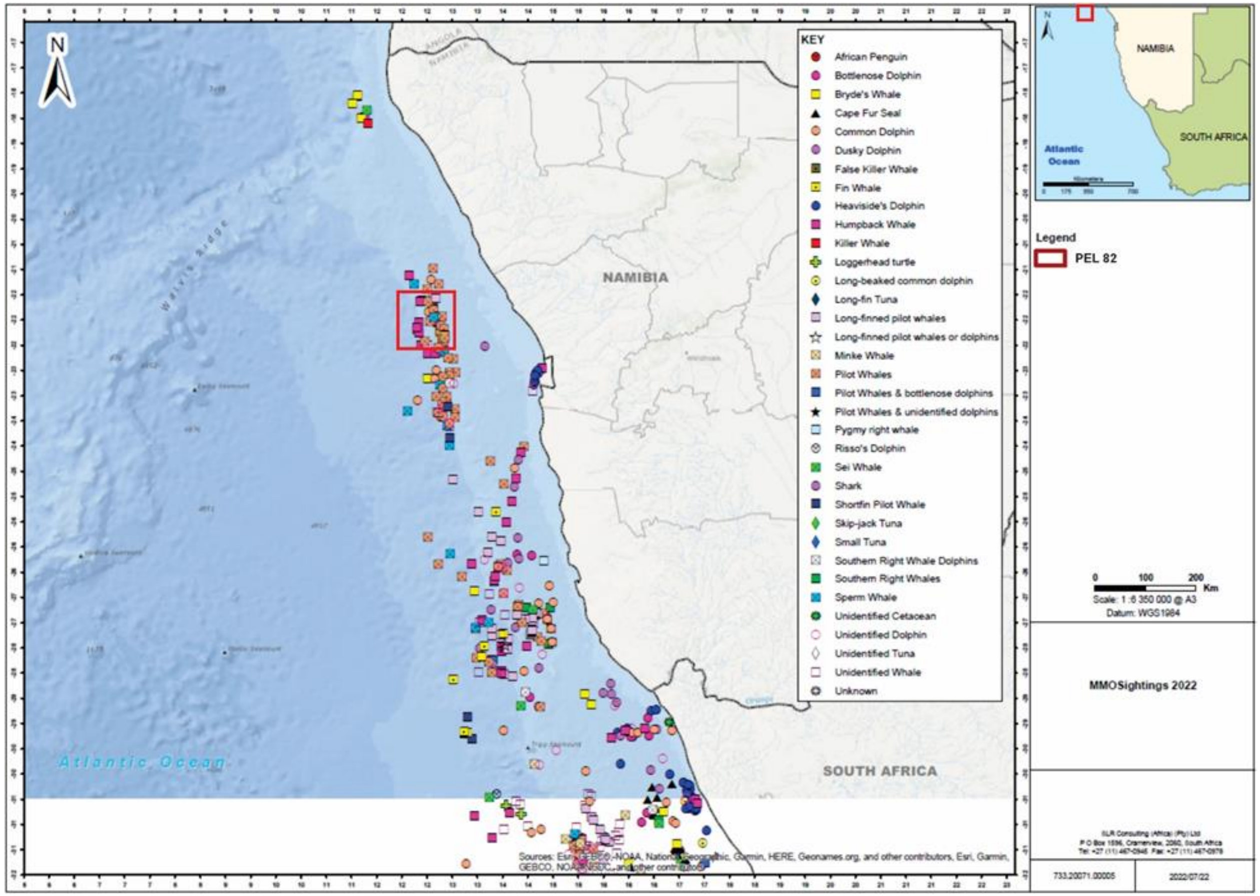
Common Name	Species	Hearing Frequency	Shelf (<200 m)	Offshore (>200 m)	Seasonality	RSA Regional Assessment	IUCN Global Assessment
Beaked whales							
Cuvier's	*Ziphius cavirostris*	HF	No	Yes	Year round	Data Deficient	Least Concern
Arnoux's	*Berardius arnuxii*	HF	No	Yes	Year round	Data Deficient	Least Concern
Southern bottlenose	*Hyperoodon planifrons*	HF	No	Yes	Year round	Least Concern	Least Concern
Layard's	*Mesoplodon layardii*	HF	No	Yes	Year round	Data Deficient	Least Concern
True's	*Mesoplodon mirus*	HF	No	Yes	Year round	Data Deficient	Least Concern
Gray's	*Mesoplodon grayi*	HF	No	Yes	Year round	Data Deficient	Least Concern
Blainville's	*Mesoplodon densirostris*	HF	No	Yes	Year round	Data Deficient	Least Concern
Baleen whales							
Antarctic Minke	*Balaenoptera bonaerensis*	LF	Yes	Yes	>Winter	Least Concern	Near Threatened
Dwarf minke	*B. acutorostrata*	LF	Yes	Yes	Year round	Least Concern	Least Concern
Fin whale	*B. physalus*	LF	Yes	Yes	MJJ & ON	Endangered	Vulnerable
Blue whale (Antarctic)	*B. musculus intermedia*	LF	No	Yes	Winter peak	Critically Endangered	Critically Endangered
Sei whale	*B. borealis*	LF	Yes	Yes	MJ & ASO	Endangered	Endangered
Bryde's (inshore)	*B. edeni (subspp)*	LF	Yes	Edge	Year round	Vulnerable	Least Concern
Bryde's (offshore)	*B. edeni*	LF	Edge	Yes	Summer (JFM)	Data Deficient	Least Concern
Pygmy right	*Caperea marginata*	LF	Yes	?	Year round	Least Concern	Least Concern
Humpback sp.	*Megaptera novaeangliae*	LF	Yes	Yes	Year round, SONDJF	Least Concern	Least Concern
Humpback B2 population	*Megaptera novaeangliae*	LF	Yes	Yes	Spring/Summer peak ONDJF	Vulnerable	Not Assessed
Southern Right	*Eubalaena australis*	LF	Yes	No	Year round, ONDJFMA	Least Concern	Least Concern

- Marine animals do not hear equally well at all frequencies within their functional hearing range. Based on the hearing range and sensitivities, Southall *et al*. (2019) have categorised noise sensitive marine mammal species into six underwater hearing groups: low-frequency (LF), high-frequency (HF) and very high-frequency (VHF) cetaceans, Sirenians (SI), Phocid carnivores in water (PCW) and other marine carnivores in water (OCW).

TABLE 3-5 SEASONALITY OF BALEEN WHALES IN THE BROADER PROJECT AREA BASED ON DATA FROM MULTIPLE SOURCES, PREDOMINANTLY COMMERCIAL CATCHES (BEST 2007 AND OTHER SOURCES) AND DATA FROM STRANDING EVENTS (NDP UNPUBL DATA). VALUES OF HIGH (H), MEDIUM (M) AND LOW (L) ARE RELATIVE WITHIN EACH ROW (SPECIES) AND NOT COMPARABLE BETWEEN SPECIES. FOR ABUNDANCE / LIKELY ENCOUNTER RATE WITHIN THE BROADER PROJECT AREA, SEE TABLE 3-4.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bryde's Inshore	L	L	L	L	L	L	L	L	L	L	L	L
Bryde's Offshore	H	H	H	L	L	L	L	L	L	L	L	L
Sei	L	L	L	L	H	H	L	H	H	H	L	L
Fin	M	M	M	H	H	H	M	H	H	H	M	M
Blue	L	L	L	L	L	H	H	H	L	M	L	L
Minke	M	M	M	H	H	H	M	H	H	H	M	M
Humpback	M	M	L	L	L	H	H	M	M	L	M	H
Southern Right	H	M	L	L	L	H	H	H	M	M	H	H
Pygmy right	H	H	H	M	L	L	L	L	L	L	M	M

FIGURE 3-22 PEL 82 (RED POLYGON) IN RELATION TO THE DISTRIBUTION AND MOVEMENT OF CETACEANS SIGHTED BY MMOS WITHIN THE NAMIBIAN EEZ, COLLATED BETWEEN 2001 AND 2022 (SLR MMO DATABASE).



Fin whales were historically caught off the west coast of South Africa and Namibia. A bimodal peak in the catch data from South African shore-based stations suggests animals were migrating further north to breed (during May-June) before returning to Antarctic feeding grounds (during August-October). However, the location of the breeding ground (if any) and how far north it is, remains a mystery (Best 2007). Some juvenile animals may feed year-round in deeper waters off the shelf (Best 2007). Four strandings have occurred between Walvis Bay and the Kunene River, Namibia in the last decade during January, April (2) and October (NDP unpubl. data). Groups of 5-8 animals have been seen on multiple occasions on the coast either side of Lüderitz in April, May of 2014 and January 2015 (NDP unpubl. data) confirming their contemporary occurrence in Namibian waters and potential use of the upwelling areas for feeding. To date, most sightings or strandings have occurred in late summer (April-May), supporting evidence from whaling data that this is a peak time of occurrence in southern Namibia. Sightings of fin whales were made in the vicinity of PEL 82 (

Figure 3-22).

Antarctic **blue whales** were historically caught in high numbers during commercial whaling activities, with a single peak in catch rates during July in Walvis Bay, Namibia and Namibe, Angola suggesting that in the eastern South Atlantic these latitudes are close to the northern migration limit for the species (Best 2007). Evidence of blue whale presence off Namibia is rapidly increasing. Recent acoustic detections of blue whales in the Antarctic peak between December and January (Tomisch *et al.* 2016) and in northern Namibia between May and July (Thomisch 2017) supporting observed timing from whaling records. Several recent (2014-2015) sightings of blue whales have occurred during seismic surveys off the southern part of Namibia in water >1,000 m deep confirming their current existence in the area and occurrence in Autumn months. Encounters in the project area may occur.

Two forms of **minke whale** occur in the southern Hemisphere, the Antarctic minke whale and the dwarf minke whale; both species occur in the Benguela (Best 2007; NDP unpubl. data). Antarctic minke whales range from the pack ice of Antarctica to tropical waters and are usually seen more than ~50 km offshore. Although adults of the species do migrate from the Southern Ocean (summer) to tropical/temperate waters (winter) where they are thought to breed, some animals, especially juveniles, are known to stay in tropical/temperate waters year-round. Regular sightings of semi-resident Antarctic minke whales in Lüderitz Bay, especially in summer months (December - March) and a stranding of a single animal in Walvis Bay (in February 2014) confirm the contemporary occurrence of the species in Namibia (NDP unpubl. data). Recent data available from passive acoustic monitoring over a two-year period off the Walvis Ridge shows acoustic presence in June - August and November - December (Thomisch *et al.* 2016), supporting observations from whaling records. The dwarf minke whale has a more temperate distribution than the Antarctic minke and they do not range further south than 60-65°S. Dwarf minke whales have a similar migration pattern to Antarctic minkes with at least some animals migrating to the Southern Ocean in summer months. Around southern Africa, dwarf minke whales occur closer to shore than Antarctic minkes and have been seen <2 km from shore on several occasions around South Africa. Both species are generally solitary and densities are likely to be low in the license area, but encounters may occur.

The **pygmy right whale** is the smallest of the baleen whales reaching only 6 m total length as an adult (Best 2007). The species is typically associated with cool temperate waters between 30°S and 55°S and records in Namibia there are the northern most for the species with no confirmed records north of Walvis Bay (Leeney *et al.* 2013).

The most abundant baleen whales in the Benguela are southern right whales and humpback whales (Figure 3-23). In the last decade, both species have been increasingly observed to remain on the west coast of South Africa well after the 'traditional' South African whale season (June - November) into spring and summer (October - February) where they have been observed feeding in upwelling zones, especially off Saldanha and St Helena Bays (Barendse *et al.* 2011; Mate *et al.* 2011). Increasing numbers of summer records of both species, suggest that animals may also be feeding in upwelling areas off Namibia, especially the southern half of the country near the Lüderitz upwelling cell (NDP unpubl. data) and will therefore occur in or pass through the project area.

The southern African population of **southern right whales** historically extended from southern Mozambique (Maputo Bay) to southern Angola (Baie dos Tigres) and is considered to be a single population within this range (Roux *et al.* 2015). The most recent abundance estimate for this population is available for 2017 which estimated the population at ~6 100 individuals including all age and sex classes, and still growing at ~6.5% per annum (Brandaõ *et al.* 2017). When the population numbers crashed in response to commercial whaling, the range contracted down to just the south coast of South Africa. As the population recovers following their protection in 1935, it is repopulating its historic grounds including Namibia (Roux *et al.* 2001, 2015; de Rock *et al.* 2019) and Mozambique (Banks *et al.* 2011).

FIGURE 3-23 THE SOUTHERN RIGHT WHALE *EUBALAENA AUSTRALIS* (LEFT) AND THE HUMPBACK WHALE *MEGAPTERA NOVAEANGLIAE* (RIGHT) MIGRATE ALONG THE COASTAL AND SHELF WATERS OF SOUTHERN AFRICA, INCLUDING NAMIBIA (PHOTOS: WWW.NAMIBIANDOLPHINPROJECT.COM).

Southern right whales are seen regularly in Namibian coastal waters (<3 km from shore), especially in the southern half of the Namibian coastline (Roux *et al.* 2001, 2011). Right whales have been recorded in Namibian waters in all months of the year (J-P Roux pers comm) but with numbers peaking in winter (June - August). A secondary peak in summer (November - January) also occurs, probably associated with animals feeding off the west coast of South Africa performing exploratory trips into southern Namibia (NDP unpubl. data). Notably, all available records have been very close to shore with only a few out to 100 m depth, so they are unlikely to be encountered in PEL 82.

The majority of humpback whales passing through the Benguela are migrating to breeding grounds off tropical West Africa, between Angola and the Gulf of Guinea (Rosenbaum *et al.* 2009; Barendse *et al.* 2010). A recent synthesis of available humpback whale data from Namibia (Elwen *et al.* 2014) shows that in coastal waters, the northward migration stream is larger than the southward peak supporting earlier observations from whale catches (Best & Allison 2010). This supports previous suggestions that animals migrating north strike the coast at varying places mostly north of St Helena Bay (South Africa) resulting in increasing whale density on shelf waters as one moves north towards Angola, but no clear migration 'corridor'. On the southward migration, there is evidence from satellite tagged animals and the smaller secondary peak in numbers in Walvis Bay, that many humpback whales follow the Walvis Ridge offshore then head directly to high latitude feeding grounds, while others follow a more coastal route (including the majority of mother-calf pairs), possibly lingering in the feeding grounds off west South Africa in summer (Elwen *et al.* 2014, Rosenbaum *et al.* 2014) (Figure 3-24). Although migrating through the Benguela, there is no existing evidence of a clear 'corridor' and humpback whales appear to be spread out widely across the shelf and into deeper pelagic waters, especially during the southward migration (Barendse *et al.* 2010; Best & Allison 2010; Elwen *et al.* 2014). Regular sightings of humpback whales in <u>spring and summer months</u> in Namibia, especially in the Lüderitz area, suggest that summer feeding is occurring in Namibian waters as well (or at least that animals foraging off West South Africa range up into southern Namibia). The most recent abundance estimates available put the number of animals in the west African breeding population to be in excess of 9 000 individuals in 2005 (IWC 2012) and it is likely to have increased since this time at about 5% per annum (IWC 2012). Humpback whales are thus likely to be the most frequently encountered baleen whale in PEL 82, ranging from the coast out beyond the shelf, with year-round presence but numbers peaking in June – July (northern migration) and a smaller peak with the southern breeding migration around September – October but with regular encounters until February associated with subsequent feeding in the Benguela ecosystem.

In the first half of 2017 (when numbers are expected to be at their lowest) more than 10 humpback whales were reported stranded along the Namibian and west South African coasts. A similar event was recorded in late 2021-early 2022 when numerous strandings of young humpbacks were reported along the Western Cape Coast and in Namibia (Simon Elwen, Sea Search, pers. comm.). The cause of these deaths is not known, but a similar event off Brazil in 2010 was linked to possible infectious disease or malnutrition (Siciliano *et al.* 2013), which suggests the West African population may be undergoing similar stresses and caution should be taken in increasing stress through human activities. Unusual mortality events of humpback whales between 2016 and 2022 have similarly been reported along the US Atlantic Coast from Maine to Florida (https://www.fisheries.noaa.gov/national/marine-life-distress/2016-2022-humpback-whale-unusual-mortality-event-along-atlantic-coast). The West African population may be undergoing similar stresses in response to changes in their ecosystem (see for example Kershaw *et al.* 2021). It is not yet understood what may be driving these ecosystem changes and what the long-term effects to populations could potentially be.

FIGURE 3-24 PEL 82 (RED POLYGON) IN RELATION TO 'BLUE CORRIDORS' OR 'WHALE SUPERHIGHWAYS' SHOWING TRACKS OF HUMPBACK WHALES (ORANGE) AND SOUTHERN RIGHT WHALES (GREEN) BETWEEN SOUTHERN AFRICA AND THE SOUTHERN OCEAN FEEDING GROUNDS (ADAPTED FROM JOHNSON ET AL. 2022).

Odontocete (toothed) whales

The Odontoceti are a varied group of animals including the dolphins, porpoises, beaked whales and sperm whales. Species occurring within the broader project area display a diversity of features, for example their ranging patterns vary from extremely coastal and highly site specific to oceanic and wide ranging. Those in the region can range in size from 1.6 m long (Heaviside's dolphin) to 17 m (bull sperm whale).

All information about **sperm whales** in the southern African subregion stems from data collected during commercial whaling activities, *i.e.* pre 1985 (Best 2007). Sperm whales are the largest of the toothed whales and have a complex, structured social system with adult males behaving differently to younger males and female groups. They live in deep ocean waters, usually greater than 1,000 m depth, although they occasionally come into waters 500-200 m deep on the shelf (Best 2007). They are relatively abundant globally (Whitehead 2002), although no estimates are available for the southern African subregion. Seasonality of catches off west South Africa suggests that medium and large sized males are more abundant in winter months, while female groups are more abundant in autumn (March-

April), although animals occur year round (Best 2007). Sperm whales were one of the most frequently seen cetacean species from offshore seismic survey vessels operating between Angola and the Gulf of Guinea. All sightings were made in water deeper than 780 m, and numbers peaked during April – June (Weir 2011). Multiple sightings of sperm whales have been recorded by MMOs operating around Tripp Sea Mount off Southern Namibia in the last decade (NDP Unpublished data, De Rock *et al.* 2019). Sperm whales feed at great depths during dives in excess of 30 minutes making them difficult to detect visually. The regular echolocation clicks made by the species when diving, however, make them relatively easy to detect acoustically using Passive Acoustic Monitoring (PAM). Sperm whales in the project area are likely to be encountered in deeper waters (>500 m), predominantly in the winter months (April - October).

There are almost no data available on the abundance, distribution, or seasonality of the smaller odontocetes (including the beaked whales and dolphins) known to occur in oceanic waters (greater than 200 m) off the Namibian continental shelf (see Table 3-4). Beaked whales are all considered to be true deep-water species, usually recorded in waters in excess of 1,000 – 2,000 m (see various species accounts in Best 2007) and thus may be encountered in the project area.

Beaked whales seem to be particularly susceptible to man-made sounds and several strandings and deaths at sea, often *en masse,* have been recorded in association with naval mid-frequency sonar (Cox *et al.* 2006; MacLeod & D'Amico 2006). Although the exact reason that beaked whales seem particularly vulnerable to man-made noise is not yet fully understood, the existing evidence clearly shows that animals change their dive behaviour in response to acoustic disturbance (Tyack *et al.* 2011), and all possible precautions should be taken to avoid causing any harm. Sightings of beaked whales in the project area are expected to be very low.

The genus *Kogia* currently contains two recognised species, the dwarf (*K. sima*) and pygmy (*K. breviceps*) sperm whales, both of which occur worldwide in pelagic and shelf edge waters, with few sighting records of live animals in their natural habitat (McAlpine 2018). Both species are deep water specialists living primarily off the shelf. There is preliminary evidence of species level genetic differentiation between *K. sima* populations in the Indian and Atlantic Oceans (Chivers *et al.* 2004). Due to their small body size, cryptic behaviour and small school sizes, these whales are difficult to observe at sea, and morphological similarities make field identification to species level problematic, although their narrow-band high frequency echolocation clicks make them detectable and identifiable (at least to the genus) using passive acoustic monitoring equipment. The majority of what is known about Kogiid whales in the southern African subregion results from studies of stranded specimens (e.g. Ross 1979; Findlay *et al.* 1992; Plön 2004; Elwen *et al.* 2013, but see also Moura *et al*. 2016). There are >30 records of *K. breviceps* collected along the Namibian coastline with a peak in strandings in June and August. A single account of *K. sima* collected in Walvis Bay in 2010, demonstrates that this species also occurs in

Namibian waters (Elwen *et al.* 2014). *Kogia* species are most frequently occur in pelagic and shelf edge waters, are thus likely to occur in the project area at low levels; seasonality is unknown. Dwarf sperm whales are associated with warmer tropical and warm-temperate waters, being recorded from both the Benguela and Agulhas ecosystem (Best 2007) in waters deeper than ~1,000 m.

Killer whales have a circum-global distribution being found in all oceans from the equator to the ice edge (Best 2007). Killer whales occur year round in low densities off western South Africa (Best *et al.* 2010), Namibia (Elwen & Leeney 2011) and in the Eastern Tropical Atlantic (Weir *et al.* 2010). Killer whales are found in all depths from the coast to deep open ocean environments and may thus be encountered in the license area at low levels.

False killer whales are recognized as a single species globally, although clear differences in morphological and genetic characteristics between different study sites show that there is substantial difference between populations and a revision of the species taxonomy may be needed (Best 2007). The species has a tropical to temperate distribution and most sightings off southern Africa have occurred in water deeper than 1000 m but with a few close to shore as well (Findlay *et al.* 1992; NDP Unpubl. data). False killer whales usually occur in groups ranging in size from 1-100 animals (mean 20.2) (Best 2007) and are thus likely to be fairly easily seen in most weather conditions. However, the strong bonds and matrilineal social structure of this species makes it vulnerable to mass stranding (8 instances of 4 or more animals stranding together have occurred in the western Cape, South Africa, all between St Helena Bay and Cape Agulhas (Kirkman *et al.* 2010)), which may aggrandize the consequences of any injury or disturbance by seismic airguns or associated activities. There is no information on population numbers of conservation status and no evidence of seasonality in the region (Best 2007).

Long- and short-finned pilot whales (*Globicephala melas and G.macrorhynchus*) display a preference for temperate waters and are usually associated with the continental shelf or deep water adjacent to it (Mate *et al.* 2005; Findlay *et al.* 1992; Weir 2011; Seakamela *et al*. 2022). They are regularly seen associated with the shelf edge by MMOs, fisheries observers and researchers operating in Namibian waters (NDP unpubl. data; De Rock *et al.* 2019). The distinction between long-finned and short finned (*G. macrorhynchus*) pilot whales is difficult to make at sea. Short finned pilot whales are regarded as a more tropical species (Best 2007), and most sightings within the Benguela Ecosystem are thought to be long-finned pilot whales, however, due to the low latitude and offshore nature of the project, it is likely that either could be encountered. There are many confirmed sighting of pilot whales along the shelf edge of South Africa and Namibia including within the project area since 2010 (de Rock *et al.* 2019; Sea Search unpublished data, SLR data). Observed group sizes range from 8-100 individuals (Seakamela *et al*. 2022). Pilot whales are commonly sighting by MMOs and detected by PAM during seismic surveys.

Dusky dolphins (*Lagenorhynchus obscurus*) (Figure 3-25, left) are likely to be the most frequently encountered small cetacean in water less than 500 m deep. The species is very boat friendly and will often approach boats to bowride. This species is resident year round throughout the Benguela ecosystem in waters from the coast to at least 500 m deep (Findlay *et al.* 1992). Although no information is available on the size of the population, they are regularly encountered in near shore waters off South Africa and Lüderitz, although encounters near-shore are rare along the central Namibian coast (Walvis Bay area), with most records coming from beyond 5 nautical miles from the coast (Elwen *et al.* 2010a; NDP unpubl. data). In a recent survey of the Namibian Islands Marine Protected Area (between latitudes of 24°29' S and 27°57' S and depths of 30-200 m) dusky dolphin were the most commonly detected cetacean species with group sizes ranging from 1 to 70 individuals (NDP unpubl. data), although group sizes up to 800 have been reported in southern African waters (Findlay *et al.* 1992). However, due to the offshore location of PEL 82, encounters within the project area are unlikely.

Heaviside's dolphins (Figure 3-25, right) are relatively abundant in both the southern and northern Benguela ecosystem within the region of 10,000 animals estimated to live in the 400 km of coast between Cape Town and Lamberts Bay (Elwen *et al.* 2009a) and several hundred animals living in the areas around Walvis Bay and Lüderitz. Heaviside's dolphins are resident year-round. This species occupies waters from the coast to at least 200 m depth (Elwen *et al.* 2006; Best 2007), and may show a diurnal onshore-offshore movement pattern feeding offshore at night, although this varies throughout the range (Elwen *et al.* 2009b). This species occupies waters from the coast to at least 200 m depth (Elwen *et al.* 2006; Best 2007; Elwen *et al.* 2010), suggesting they are unlikely to be encountered in the project area.

FIGURE 3-25 THE DUSKY DOLPHIN *LAGENORHYNCHUS OBSCURUS* (LEFT) AND ENDEMIC HEAVISIDE'S DOLPHIN *CEPHALORHYNCHUS HEAVISIDII* (RIGHT) (PHOTOS: WWW.NAMIBIANDOLPHINPROJECT.COM)).

The **common dolphin** (*Delphinus delphis*) is known to occur offshore in Namibian waters (Findlay *et al.* 1992). Two forms of common dolphins occur around southern Africa, a long-beaked and short-beaked form (Findlay *et al.* 1992; Best 2007), although they are currently considered part of a single global species (Cunha *et al.* 2015). The long-beaked common dolphin lives on the continental shelf of South Africa rarely being observed north of St Helena Bay on the west coast or in waters more 500 m deep (Best 2007), although more recent sightings, including those from MMOs, suggest sightings regularly out to 1,000 m or more (SLR data, Sea Search data). A stranding in Lüderitz (May 2012, NDP unpublished data) and MMO reports have confirmed their occurrence in the region. Although group sizes can be large, averaging 267 (± *SD* 287) for the southern African region (Findlay *et al.* 1992), average sizes of 37 (± *SD* 31) have been reported for the Namibian region (NDP unpublished data). They are more frequently seen in the warmer waters offshore and to the north of the country, and all sightings to date have been in water deeper than 500 m. There is no evidence of seasonality. Thus, encounters in the license area may occur. Far less is known about the short-beaked form, which is challenging to differentiate at sea from the long-beaked form. Group sizes are also typically large. It is likely that common dolphins encountered deeper than 2,000 m are of the short-beaked form.

Common bottlenose dolphins (*Tursiops truncatus*) are widely distributed in tropical and temperate waters throughout the world, but frequently occur in small (10s to low 100s) isolated coastal populations. Within Nambian waters two populations of bottlenose dolphins occur. A small population inhabits the very near shore coastal waters (mostly <15 m deep) of the central Namibian coastline from approximately Lüderitz in the south to at least Cape Cross in the north, and is considered a conservation concern. The population is thought to number less than 100 individuals (Elwen *et al.* 2011), but its nearshore habitat makes it unlikely to be impacted by the proposed exploration-drilling activities. An offshore 'form' of common bottlenose dolphins occurs around the coast of southern Africa including Namibia and Angola (Best 2007) with sightings restricted to the continental shelf edge and deeper. Offshore bottlenose dolphins frequently form mixed species groups, often with pilot whales or Risso's dolphins.

The cold waters of the Benguela provide a northwards extension of the normally sub Antarctic habitat of Southern right whale dolphins (*Lissodelphis peronii*) (Best 2007). Most records in the region originate in a relatively restricted region between 26°S and 30°S roughly between Lüderitz and Tripp Seamount in water 100-2,000 m deep (Rose & Payne 1991; Best 2007; NDP Unpublished data). There has been a recent live stranding of two individuals in Lüderitz Bay in December 2013. They are often seen in mixed species groups with other dolphins such as dusky dolphins. It is possible that the Namibian sightings represent a regionally unique and resident population (Findlay *et al.* 1992) and as such caution is needed to minimize negative effects of hydrocarbon exploration. Encounters in the project area are likely to be low.

Several other species of toothed whales that might occur in the deeper waters of license area at low levels include the pygmy killer whale, Risso's, and Striped dolphins, and Cuvier's and Layard's beaked whales. Nothing is known about the population size or density of these species in the project area but it is likely that encounters would be rare (Findlay *et al.* 1992; Best 2007).

Beaked whales were never targeted commercially and their pelagic distribution makes them largely inaccessible to most researchers making them the most poorly studied group of cetaceans. With recorded dives of well over an hour and in excess of 2 km deep, beaked whales are amongst the most extreme divers of any air breathing animals (Tyack *et al.* 2011), but they also appear to be particularly vulnerable to certain types of anthropogenic noise. Several species of beaked whale (mainly Cuvier's but also Blainville's and Gervais' beaked whales) have been recorded to strand or die at sea, often *en masse,* in response to man-made sounds, particularly mid frequency naval sonar and potentially multi-beam echo-sounders (Cox *et al.* 2006, MacLeod & D'Amico, 2006). Although the exact reason for this vulnerability is not yet fully understood, the existing evidence clearly shows that these animals are susceptible to man-made noise and precautions should be taken to avoid causing any harm. All the beaked whales that may be encountered in the project area are pelagic species that tend to occur in small groups usually less than five, although larger aggregations of some species are known (MacLeod & D'Amico 2006; Best 2007). The long, deep dives of beaked whales make them difficult to detect visually, but PAM will increase the probability of detection as animals frequently echo-locate when on foraging dives.

In summary, there is very little current data on the presence, density or conservation status of any cetaceans within the project area. All information provided above is based on at least some level of projection of information from studies elsewhere in the region, at some time in the past (often decades ago) or extrapolated from knowledge of habitat choice of the species. The large whale species for which there are current data available are the humpback and southern right whale, although with almost all data being limited to the continental shelf. Both these species are known to use feeding grounds around Cape Columbine in South Africa, with numbers there highest between September and February, and not during winter as is common on the South Coast breeding grounds. Whaling data indicates that several other large whale species are also most abundant on the West Coast during this period: fin whales peak in May-July and October-November; sei whale numbers peak in May-June and again in August-October and offshore Bryde's whale numbers are likely to be highest in January-March. Whale numbers on the shelf and in offshore waters are thus likely to be highest between October and February.

Of the migratory cetaceans, the Blue whale is considered 'Critically Endangered', and Sei and Fin whales are listed as 'Endangered' in the IUCN Red Data book. All whales and dolphins are given protection under the Namibian Law. The regulations under the Namibian Marine Resources Act, 2000 (No. 27 of 2000) states that no whales or dolphins may be harassed, killed or fished.

Seals

The Cape fur seal (*Arctocephalus pusillus pusillus*) (

Figure 3-26) is the only species of seal resident along the west coast of Africa, occurring at numerous breeding and non-breeding sites on the mainland and on nearshore islands and reefs (see Figure 3-37). Vagrant records from four other species of seal more usually associated with the sub Antarctic environment have also been recorded: southern elephant seal (*Mirounga leoninas),* sub Antarctic fur seal (*Arctocephalus tropicalis),* crabeater *(Lobodon carcinophagus)* and leopard seals (*Hydrurga leptonyx)* (David 1989).

FIGURE 3-26 COLONY OF CAPE FUR SEALS *ARCTOCEPHALUS PUSILLUS PUSILLUS* (PHOTO: J. KEMPER).

The southern colonies (Spencer Bay to Baker's Bay) historically contributed ~62% to the overall seal population in Namibia. With the distributional shift of the seal population northwards in response to environmental change and altered prey distributions, the southern colonies currently comprise just less than a third of the total Namibian seal population (J-P Roux pers comm.). Population estimates fluctuate widely between years in terms of pup production, particularly since the mid-1990s (MFMR unpubl. Data; Kirkman *et al.* 2007). The colony closest to PEL 82 is at Cape Cross approximately 100 km inshore of the license area where about 51,000 pups are born annually (MFMR unpubl. Data). The colony supports an estimated 157,000 adults (Hampton 2003), with unpublished data from Marine and Coastal Management (MCM, South Africa) suggesting a number of 187,000 (Mecenero *et al*. 2006). A further colony of ~9,600 individuals exists on Hollamsbird Island south of Sandwich Harbour, approximately 285 km south-east of PEL 82. There are also seal colonies at Cape Frio and Möwe Bay, which are located approximately 360 km and 240 km north of PEL 82, respectively. The colony at Pelican Point in Walvis Bay is primarily a haul-out site. The mainland seal colonies present a focal point of carnivore and scavenger activity in the area, as jackals and hyena are drawn to this important food source.

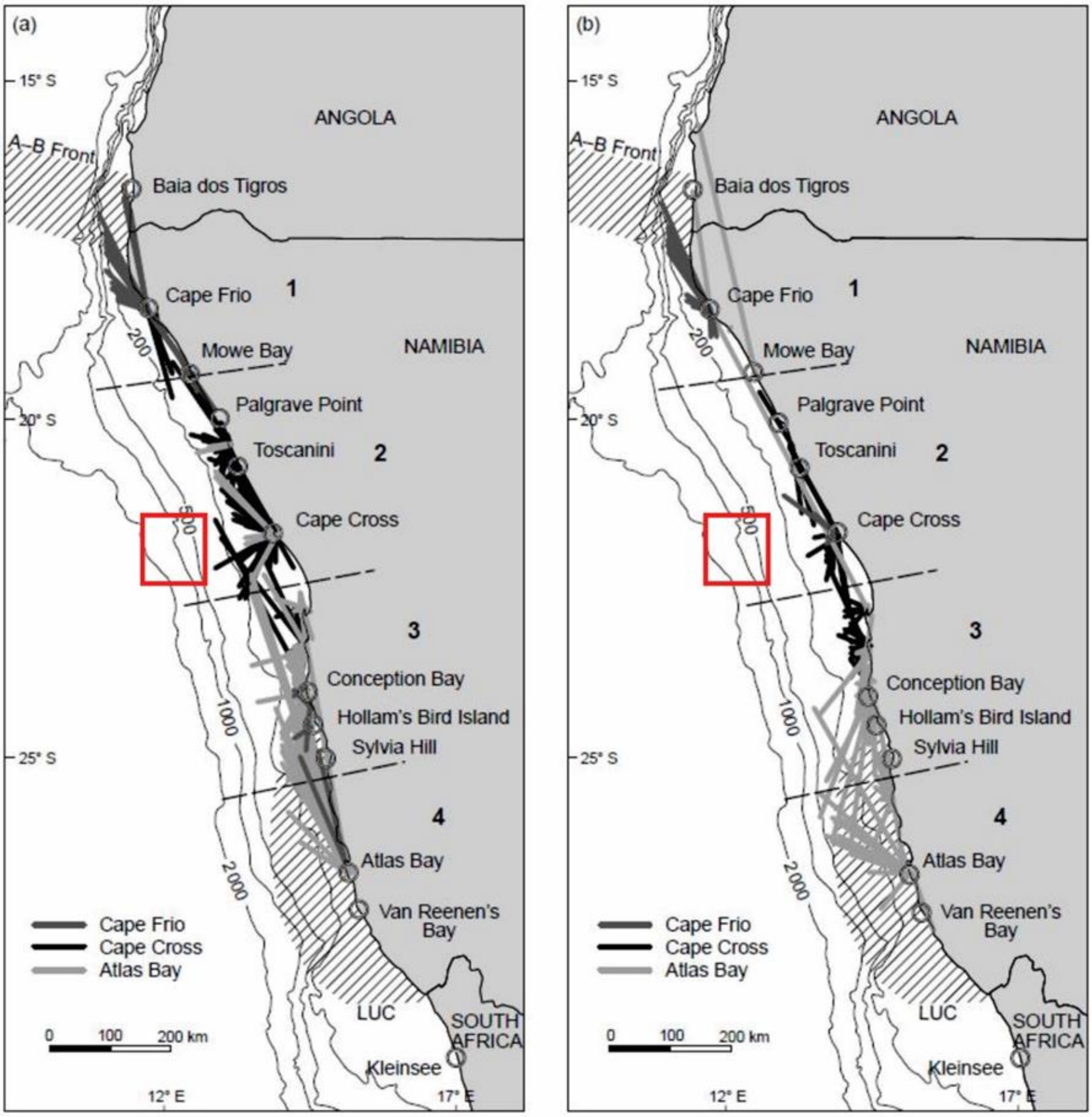
The Cape fur seal population in the Benguela is regularly monitored by the South African and Namibian governments (e.g. Kirkman *et al.* 2012). Surveys of the full species range are periodically undertaken providing data on seal pup production (which can be translated to adult population size), thereby allowing for the generation of data on the population dynamics of this species. The population is considered to be healthy and stable in size although there has been a northward shift in the distribution of the breeding population (Kirkman *et al.* 2007; Skern-Mauritzen *et al.* 2009; Kirkman *et al.* 2012).

Seals are highly mobile animals with a general foraging area covering the continental shelf up to 120 nautical miles (~220 km) offshore (Shaughnessy 1979), with bulls ranging further out to sea than females. The foraging area of tracked seals from Namibian colonies and the South African West Coast colonies was provided in Skern-Mauritzen et al. (2009) (

FIGURE 3-27). PEL 82 lies well offshore of the foraging ranges from these colonies. The timing of the annual breeding cycle is very regular occurring between November and January. Breeding success is highly dependent on the local abundance of food, territorial bulls and lactating females being most vulnerable to local fluctuations as they feed in the vicinity of the colonies prior to and after the pupping season (Oosthuizen 1991).

There is a controlled annual quota, determined by government policy, for the harvesting of Cape fur seals on the Namibian coastline. The Total Allowable Catch (TAC) for 2020 and 2021 stands at 60,000 pups and 8 000 bulls, distributed among seven license holders at Cape Cross and a further three in Lüderitz. The annual quotas are seldom filled with concessionaires typically only harvesting 50% of the bulls and 30% of the pups. The seals are exploited mainly for their pelts (pups), blubber and genitalia (bulls). The pups are clubbed and the adults shot. These harvesting practices have raised concern among environmental and animal welfare organisations (Molloy & Reinikainen 2003).

FIGURE 3-27 PEL 82 (RED POLYGON) IN RELATION TO FORAGING TRIPS OF (A) FEMALES AND (B) MALES OF CAPE FUR SEALS AT THE CAPE FRIO, CAPE CROSS AND ATLAS BAY COLONIES. TRIPS ARE DEPICTED AS STRAIGHT LINES BETWEEN THE START LOCATION AND THE LOCATION WHERE THE SEALS SPENT MOST TIME DURING A TRIP (ADAPTED FROM SKERN-MAURITZEN ET AL. 2009).



In South Africa, an unprecedented mortality event was recorded between September and December 2021 at colonies around the West Coast Peninsula and north to Lambert's Bay and Elands Bay. Primarily pups and juveniles were affected. Post-mortem investigations revealed that seals died in a poor condition with reduced blubber reserves, and protein energy malnutrition was detected for aborted foetuses, for juveniles and subadults. Although no unusual environmental conditions were identified that may have triggered the die-off, or caused it indirectly (e.g. HABs), 2021 was a year of below average recruitment of anchovy and sardine, the main food source for seals. While a lack of food, as a result of possibly climate change and/or overfishing, has been predicted to be the cause of this mass mortality, the underlying causes of the mortality event remain uncertain (Seakamela *et al.* 2022). In Namibia, similar mortality events typically related to prey shortage occur periodically, the most recent being a large-scale abortion event in 2020, especially at the colonies in central Namibia (J.-P. Roux, pers.comm.).

3.2.12 DEMERSAL COMMUNITIES

3.3.2.1 BENTHIC INVERTEBRATE MACROFAUNA

The seabed communities in the PEL 82 area lie within the Namib sub-photic and continental slope biozones, which extend from a 30 m depth to the shelf edge, and beyond to the lower deepsea slope, respectively. The benthic and coastal habitats of Namibia were mapped as part of the Benguela Current Commission’s Spatial Biodiversity Assessment (BCC-SBA) (Holness *et al*. 2014) (Figure 3-29). The benthic habitats were subsequently assigned an ecosystem threat status based on their level of protection (

Table 3-6). Submarine canyons were also mapped as biodiversity features, although descriptions of their geographical situations were not sufficiently accurate to include them in the benthic habitat map4 (

[4] Marine canyons identified by the international Deep Ocean project mapped them as lines. The lines were buffered by 5 km to make sure that both the canyon and its associated adjacent ecosystems were included.

Figure 3-28). PEL 82 mostly overlaps with benthic habitat considered of 'Least Concern', however, those along the 500 m depth contour in the eastern portion of PEL 82 have been assigned a threat status of 'Vulnerable', with those further inshore to the 100 m depth contour considered 'Endangered' by the BCC-SBA (Holness *et al*. 2014) (Figure 3-29).

The benthic biota of unconsolidated marine sediments constitute invertebrates that live on (epifauna) or burrow within (infauna) the sediments, and are generally divided into macrofauna (animals >1 mm) and meiofauna (<1 mm). Numerous studies have been conducted on southern African West Coast continental shelf benthos, mostly focused on mining, pollution or demersal trawling impacts (Christie and Moldan 1977; Moldan 1978; Jackson and McGibbon 1991; Environmental Evaluation Unit 1996; Parkins and Field 1997; 1998; Pulfrich and Penney 1999; Goosen *et al*. 2000; Savage *et al*. 2001; Steffani and Pulfrich 2004a, 2004b; 2007; Steffani 2007a; 2007b; Atkinson 2009; Steffani 2009a, 2009b, 2009c, 2010a, 2010b, 2010c; Atkinson *et al.* 2011; Steffani 2012a, 2012b, 2014; Karenyi 2014; Steffani *et al.* 2015; Biccard & Clark 2016; Biccard *et al.* 2016; Duna *et al.* 2016; Karenyi *et al.* 2016; Biccard *et al.* 2017, 2018; Gihwala *et al.* 2018; Biccard *et al.*2019; Giwhala *et al.* 2019). The description below is drawn from the various baseline and monitoring surveys conducted by diamond mining companies (Bickerton and Carter 1995; Steffani and Pulfrich 2007; Steffani 2007a; 2007b). These studies, however, concentrated on the continental shelf and nearshore regions, and consequently the benthic fauna of the outer shelf and continental slope (beyond ~450 m depth) are very poorly known. This is primarily due to limited opportunities for sampling as well as the lack of access to Remote Operated Vehicles (ROVs) for visual sampling of hard substrata. To date very few areas of the continental slope off the southern African West Coast have been biologically surveyed.

Polychaetes, crustaceans and molluscs make up the largest proportion of individuals, biomass and species on the west coast. The distribution of species within these communities are inherently patchy reflecting the high natural spatial and temporal variability associated with macro-infauna of unconsolidated sediments (e.g. Kenny *et al*. 1998; Kendall and Widdicombe 1999; van Dalfsen *et al*. 2000; Zajac *et al*. 2000; Parry *et al*. 2003), with evidence of mass mortalities and substantial recruitments recorded on the South African West Coast (Steffani and Pulfrich 2004a). Generally species richness increases from the inner shelf across the mid shelf and is influenced by sediment type (Karenyi unpublished data). The highest total abundance and species diversity was measured in sandy sediments of the mid-shelf. Biomass is highest in the inshore (± 50 g/m^2 wet weight) and decreases across the mid-shelf averaging around 30 g/m^2 wet weight. The midshelf mudbelt, however, is a particularly rich benthic habitat where biomass can attain 60 g/m^2 dry weight (Christie 1974; see also Steffani 2007b). The comparatively high benthic biomass in this mudbelt region represents an important food source to carnivores such as the mantis shrimp, cephalopods and demersal fish species (Lane and Carter 1999). In deeper water beyond this rich zone biomass declines to 4.9 g/m^2 at 200 m depth and then is consistently low (<3 g/m^2) on the outer shelf (Christie 1974).

FIGURE 3-28 PEL 82 (RED POLYGON) IN RELATION TO THE NAMIBIAN BENTHIC HABITATS. THE POSITIONS OF POTENTIAL SUBMARINE CANYONS ARE ALSO SHOWN (ADAPTED FROM HOLNESS ET AL. 2014).

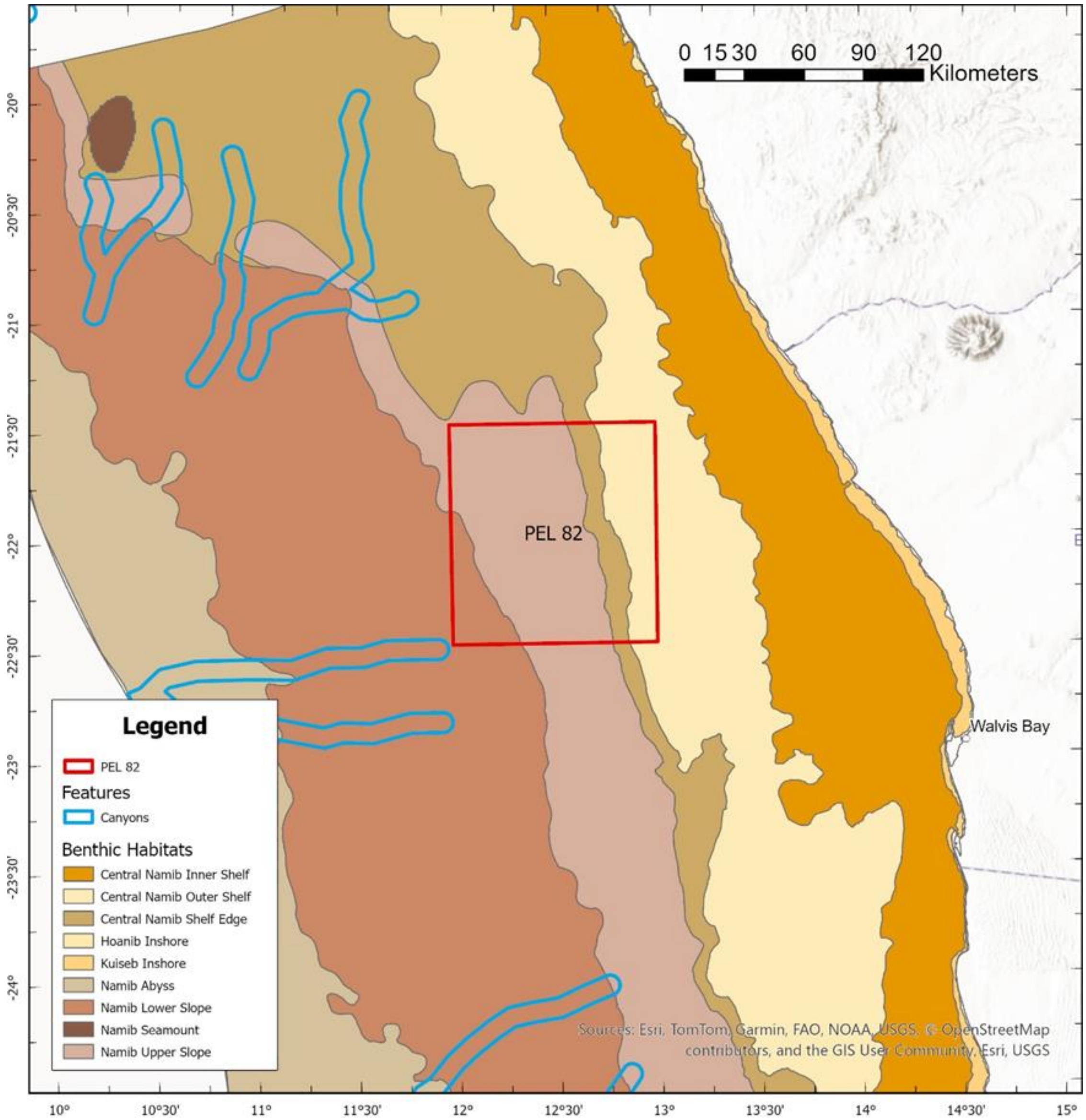


FIGURE 3-29 PEL 82 (RED POLYGON) IN RELATION TO ECOSYSTEM THREAT STATUS FOR OFFSHORE BENTHIC HABITAT TYPES OFF CENTRAL NAMIBIA (ADAPTED FROM HOLNESS ET AL. 2014).

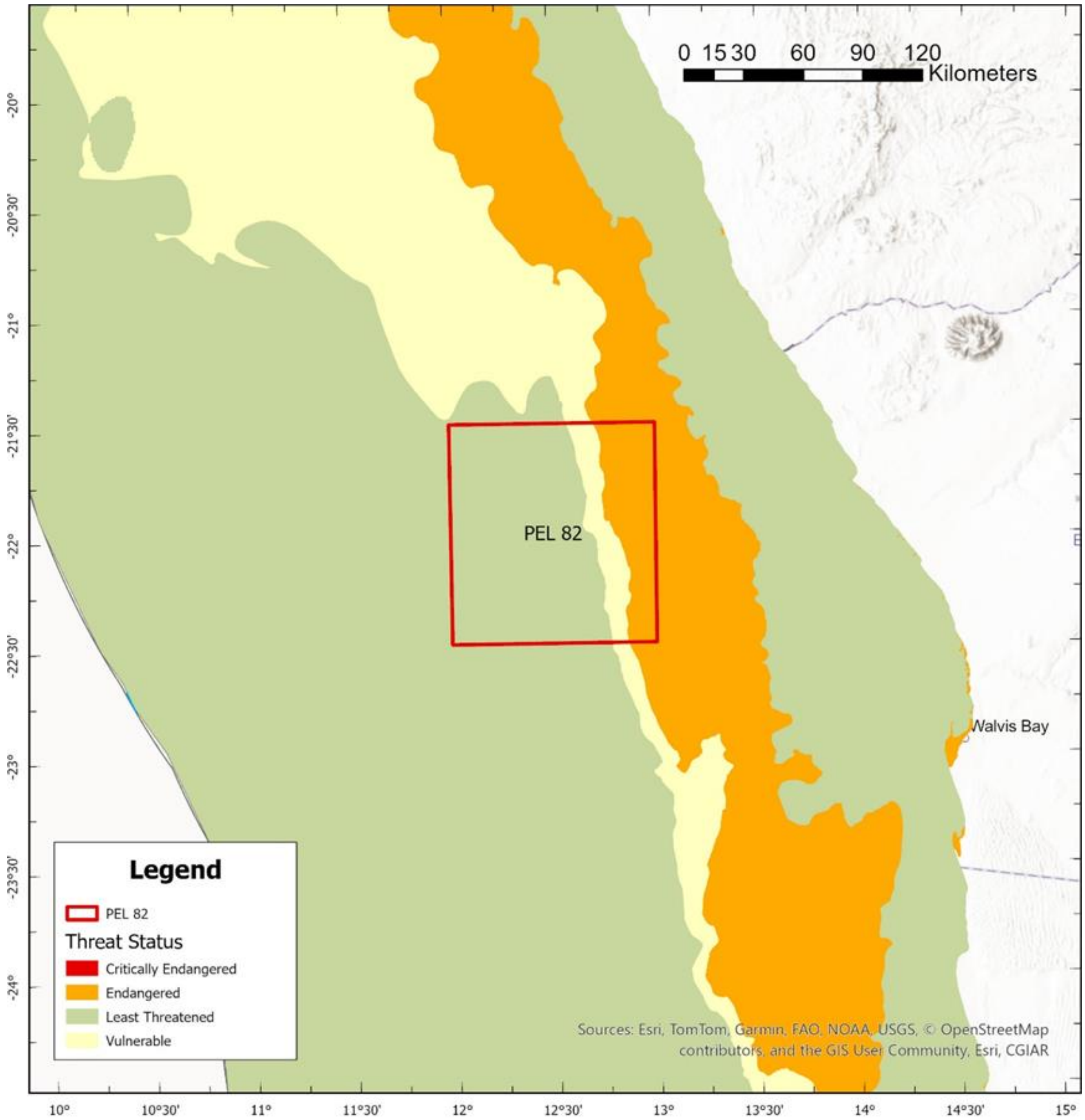


TABLE 3-6 ECOSYSTEM THREAT STATUS FOR MARINE HABITAT TYPES ON THE NAMIBIAN COAST (ADAPTED FROM HOLNESS ET AL. 2014). THOSE HABITATS POTENTIALLY AFFECTED BY THE PROPOSED WELL DRILLING ARE SHADED.

Habitat Type	Threat Status	Area (km^2)
Namib Abyss	Least Threatened	800.93
Namib Lower Slope	Least Threatened	1,380.13
Namib Upper Slope	Least Threatened	590.66
Namaqua Shelf Edge	Endangered	44.40
Namaqua Outer Shelf	Least Threatened	175.29
Namaqua Inner Shelf	Least Threatened	69.48
Namaqua Inshore	Vulnerable	4.45
Namib Seamount	Least Threatened	26.83
Lüderitz Shelf Edge	Critically Endangered	87.55
Lüderitz Outer Shelf	Vulnerable	184.70
Lüderitz Inner Shelf	Least Threatened	62.91
Lüderitz Islands	Least Threatened	13.32
Central Namib Shelf Edge	Vulnerable	327.46
Central Namib Outer Shelf	Endangered	409.40
Central Namib Inner Shelf	Least Threatened	382.44
Kuiseb Inshore	Least Threatened	29.11
Hoanib Inshore	Least Threatened	7.85
Cunene Abyss	Least Threatened	2,488.57
Cunene Lower Slope	Least Threatened	308.96
Cunene Upper Slope	Least Threatened	113.21
Cunene Shelf Edge	Vulnerable	116.62
Cunene Outer Shelf	Endangered	54.61
Cunene Inner Shelf	Least Threatened	43.75
Cunene Inshore	Least Threatened	10.18

Whilst many empirical studies related community structure to sediment composition (e.g. Christie 1974; Warwick *et al.* 1991; Yates *et al.* 1993; Desprez 2000; van Dalfsen *et al.* 2000), other studies have illustrated the high natural variability of soft-bottom communities, both in space and time, on scales of hundreds of metres to metres (e.g. Kenny *et al.* 1998; Kendall and Widdicombe 1999; van Dalfsen *et al.* 2000; Zajac *et al.* 2000; Parry *et al.* 2003), with evidence of mass mortalities and substantial recruitments (Steffani and Pulfrich 2004a). It is likely that the distribution of marine communities in the mixed deposits of the coastal zone is controlled by complex interactions between physical and biological factors at the sediment–water interface, rather than by the granulometric properties of the sediments alone (Snelgrove and Butman 1994; Seiderer and Newell 1999). For example, off central Namibia it is likely that periodic intrusion of low oxygen water masses is a major cause of this variability (Monteiro and van der Plas 2006; Pulfrich *et al.* 2006). Although there is a poor understanding of the responses of local continental shelf macrofauna to low oxygen conditions, it is safe to assume that in areas of frequent oxygen deficiency the communities will be characterised by species able to survive chronic low oxygen conditions, or colonising and fast-growing species able to rapidly recruit into areas that have suffered complete oxygen depletion. Local hydrodynamic conditions, and patchy settlement of larvae, will also contribute to small-scale variability of benthic community structure.

It is evident that an array of environmental factors and their complex interplay is ultimately responsible for the structure of benthic communities. Yet the relative importance of each of these factors is difficult to determine as these factors interact and combine to define a distinct habitat in which the animals occur. However, it is clear that water depth and sediment composition are two of the major components of the physical environment determining the macrofauna community structure off the west coast of southern Africa (Steffani and Pulfrich 2004a, 2004b, 2007; Steffani 2007a, 2007b, 2009a, 2009b, 2009c, 2010). However, in the deepwater shelf areas off central and Northern Namibia, the occurrence of Oxygen Minimum Zones (OMZs), the periodic intrusion of low oxygen water masses and diffusive hydrogen sulphide flux have been found to play a major role in determining variability in community structure (Monteiro and van der Plas 2006; Zettler et al. 2009, 2013; Eisenbarth and Zettler 2016; Amorim and Zettler 2023).

Specialised benthic assemblages (protozoans and metazoans) can thrive in OMZs (Levin 2003) and many organisms have adapted to low oxygen conditions by developing highly efficient ways to extract oxygen from depleted water. Within OMZs, benthic foraminiferans, meiofauna and macrofauna typically exhibit high dominance and relatively low species richness. In the OMZ core, where oxygen concentration is lowest, macrofauna and megafauna (>10 cm) often have depressed densities and low diversity, despite being able to form dense aggregations at OMZ edges (Levin 2003; Levin *et al.* 2009). Taxa most tolerant of severe oxygen depletion (~0.2 ml/L) include calcareous foraminiferans, nematodes, and polychaetes, with agglutinated protozoans, harpacticoid copepods, and calcified invertebrates typically being less tolerant. Small-bodied animals, with greater surface area for O_2 adsorption, are thought to be more prevalent than large-bodied taxa under conditions of permanent hypoxia as they are better able to cover their metabolic demands and often able to metabolise anaerobically (Levin 2003). Meiofauna may thus increase in dominance in relation to macro- and megafauna. This was not the case, however, within the lower OMZs of the Oman (Levin *et al.* 2000) and Pakistan margins (Levin *et al.* 2009), where the abundant food supply in the lower or edge OMZs is thought to be responsible for promoting larger macrofaunal body size.

There is a poor understanding of the responses of local continental shelf macrofauna to low oxygen conditions, as very little is known about the benthic fauna specific to the Namibian OMZ. It is safe to assume that in areas of frequent oxygen deficiency the communities will be characterised by species able to survive chronic low oxygen conditions, or colonising and fast-growing species able to rapidly recruit into areas that have suffered complete oxygen depletion. Local hydrodynamic conditions, and patchy settlement of larvae, will also contribute to small-scale variability of benthic community structure.

Data collected from between 150 m and 300 m depth offshore of the area between Meob Bay and Conception Bay showed that overall species richness of benthic macrofauna assemblages was relatively low and strongly dominated by polychaetes, particularly the spionid polychaete *Paraprionospio pinnata*. This species is dominant in oxygen-constrained environments worldwide. Crustaceans were poorly represented, both in terms of abundance and biomass (Steffani 2011). The phyla distribution is generally in common with other OMZs around the world.

In contrast, Amorim and Zettler (2023), who studied the distribution of macrofaunal assemblages between 17°S and 25°S latitudes and between 25 m and 1523 m water depth off northern Namibia, reported that the Namibian benthic macrofauna, in general, shows high total biomasses and high representativeness of molluscs compared to OMZs worldwide. Deep communities tended to show high diversity but low biomass. A further study that sampled stations between 30 m to 2,513 m depth at 20°S found 5 different communities along the depth gradient with three shelf communities, one continental margin community and one deep-sea community. Species richness was highest along the continental margin between 400 and 1,300 m water depth. Polychaetes and molluscs contributed most to the biomass on the shelf (Eisenbarth and Zettler 2016). These authors concluded that macrozoobenthic diversity off northern Namibia is strongly affected by temporary oxygen deficiency.

Also associated with soft-bottom substrates are demersal communities that comprise epifauna and bottom-dwelling invertebrate and vertebrate species, many of which are dependent on the invertebrate benthic macrofauna as a food source. An invertebrate demersal species of commercial importance in Namibia is the deepsea red crab *Chaceon maritae*, which occurs at depths of 300-1,000 m along the entire west coast of Africa from West Sahara to central Namibia. In Namibia, densities are highest between the Kunene and latitude 18°S. Larger animals tend to occur more frequently between latitudes 20° - 23°S, where densities are lower. The species is slow-growing taking up to 25-30 years to reach maximum size. Females occur at depths of 350-500 m, whereas males become more dominant in deeper water (Le Roux 1998). Spawning occurs throughout the year.

3.3.2.2 DEEP-WATER CORAL COMMUNITIES

There has been increasing interest in deep-water corals in recent years because of their likely sensitivity to disturbance and their long generation times. These benthic filter-feeders generally occur at depths exceeding 150 m. Some species form reefs while others are smaller and remain solitary. Corals add structural complexity to otherwise uniform seabed habitats thereby creating areas of high biological diversity (Breeze et al. 1997; MacIssac et al. 2001). Deep water corals establish themselves below the thermocline where there is a continuous and regular supply of concentrated particulate organic matter, caused by the flow of a relatively strong current over special topographical formations which cause eddies to form. Nutrient seepage from the substratum might also promote a location for settlement (Hovland et al. 2002). Substantial shelf areas in the productive Benguela region should thus potentially be capable of supporting rich, cold water, benthic, filter-feeding communities. Such communities would also be expected with topographic features such as the Walvis Ridge (and its associated seamounts) to the north and west of PEL 82. The high habitat heterogeneity of the ridge supports moderately diverse biological communities, including benthic macrofauna such as brachiopods, sponges, octocorals, deep-water hexacorals, gastropods, bivalves, polychaetes, bryozoans, cirriped crustaceans, basket stars, ascidians, isopods and amphipods (GEOMAR 2014), which are assumed to extent along the full extent of the ridge. The Ridge as a whole remains largely unexplored. Productivity along Walvis Ridge increases from SW to NE, with sediment organic carbon and the abundance and diversity of phytoplankton communities increasing towards the Namibian shelf. This is thought to reflect patterns of nutrient transport and upwelling in the north-flowing Benguela Current that are more intense closer to the African continent (GEOMAR 2014).

3.3.2.3 DEMERSAL FISH SPECIES

As many as 110 species of bony and cartilaginous fish have been identified in the demersal communities on the continental shelf of the southern African West Coast (Roel 1987). Changes in fish communities occur with increasing depth (Roel 1987; Smale *et al*. 1993; MacPherson and Gordoa 1992; Bianchi *et al*. 2001; Atkinson 2009), with the most substantial change in species composition occurring in the shelf break region between 300 m and 400 m depth (Roel 1987; Atkinson 2009). Common commercial demersal species found mostly on the continental shelf but also extending beyond 500 m water depth include both the shallow-water hake, *Merluccuis capensis* and the deep-water hake (*Merluccius paradoxus*), monkfish (*Lophius vomerinus*), and kingklip (*Genypterus capensis*). There are also many other demersal ‘bycatch’ species that include jacopever (*Helicolenus dactylopterus*), angelfish/pomfret (*Brama brama*), and gurnard (*Chelidonichtyes* sp), as well as several cephalopod species (such as squid and cuttlefishes) and many elasmobranch (sharks and rays) species (Compagno *et al*. 1991).

Roel (1987) showed seasonal variations in the distribution ranges shelf communities, with species such as the pelagic goby *Sufflogobius bibarbatus*, and West Coast sole *Austroglossus microlepis* occurring in shallow water during summer only. The deep-sea community was found to be homogenous both spatially and temporally. In a more recent study, however, Atkinson (2009) identified two long-term community shifts in demersal fish communities; the first (early to mid-1990s) being associated with an overall increase in density of many species, whilst many species decreased in density during the second shift (mid-2000s). These community shifts correspond temporally with regime shifts detected in environmental forcing variables (Sea Surface Temperatures and upwelling anomalies) (Howard *et al*. 2007) and with the eastward shifts observed in small pelagic fish species and rock lobster populations (Coetzee *et al*. 2008, Cockcroft *et al*. 2000).

3.2.13 SEAMOUNT COMMUNITIES

Features such as banks, knolls and seamounts (referred to collectively here as 'seamounts'), which protrude into the water column, are subject to, and interact with, the water currents surrounding them. The effects of such seabed features on the surrounding water masses can include the up-welling of relatively cool, nutrient-rich water into nutrient-poor surface water thereby resulting in higher productivity (Clark *et al.* 1999), which can in turn strongly influences the distribution of organisms on and around seamounts. Evidence of enrichment of bottom-associated communities and high abundances of demersal fishes has been regularly reported over such seabed features.

The enhanced fluxes of detritus and plankton that develop in response to the complex current regimes lead to the development of detritivore-based food-webs, which in turn lead to the presence of seamount scavengers and predators. Seamounts provide an important habitat for commercial deepwater fish stocks such as orange roughy, oreos, alfonsino and Patagonian toothfish, which aggregate around these features for either spawning or feeding (Koslow 1996).

Such complex benthic ecosystems in turn enhance foraging opportunities for many other predators, serving as mid-ocean focal points for a variety of pelagic species with large ranges (turtles, tunas and billfish, pelagic sharks, cetaceans and pelagic seabirds) that may migrate large distances in search of food or may only congregate on seamounts at certain times (Hui 1985; Haney *et al.* 1995). Seamounts thus serve as feeding grounds, spawning and nursery grounds and possibly navigational markers for a large number of species (SPRFMO 2007).

Enhanced currents, steep slopes and volcanic rocky substrata, in combination with locally generated detritus, favour the development of suspension feeders in the benthic communities characterising seamounts (Rogers 1994). Deep- and cold-water corals (including stony corals, black corals and soft corals) are a prominent component of the suspension-feeding fauna of many seamounts, accompanied by barnacles, bryozoans, polychaetes, molluscs, sponges, sea squirts, basket stars, brittle stars and crinoids (reviewed in Rogers 2004). There is also associated mobile benthic fauna that includes echinoderms (sea urchins and sea cucumbers) and crustaceans (crabs and lobsters) (reviewed by Rogers 1994). Some of the smaller cnidarians species remain solitary while others form reefs thereby adding structural complexity to otherwise uniform seabed habitats. The coral frameworks offer refugia for a great variety of invertebrates and fish (including commercially important species) within, or in association with, the living and dead coral framework thereby creating spatially fragmented areas of high biological diversity. Compared to the surrounding deep-sea environment, seamounts typically form biological hotspots with a distinct, abundant and diverse fauna, many species of which remain unidentified. Consequently, the fauna of seamounts is usually highly unique and may have a limited distribution restricted to a single geographic region, a seamount chain or even a single seamount location (Rogers *et al.* 2008). Levels of endemism on seamounts are also relatively high compared to the deep sea. As a result of conservative life histories (*i.e*. very slow growing, slow to mature, high longevity, low levels of recruitment) and sensitivity to changes in environmental conditions, such biological communities have been identified as Vulnerable Marine Ecosystems (VMEs). They are recognised as being particularly sensitive to anthropogenic disturbance (primarily deep-water trawl fisheries and mining), and once damaged are very slow to recover, or may never recover (FAO 2008).

It is not always the case that seamount habitats are VMEs, as some seamounts may not host communities of fragile animals or be associated with high levels of endemism. Evidence from video footage taken on hard-substrate habitats in 100 - 120 m depth off southern Namibia (Figure 3-30) suggest that vulnerable communities including gorgonians, octocorals and reef-building sponges occur on the continental shelf. Similar communities have been reported on the seamounts associated with the Walvis Ridge, with *Lophelia*, gorgonian and bamboo corals being among those which have been discovered growing at various heights on the seamounts (https://highseasalliance.org/wp-content/uploads/2024/01/Walvis-Ridge.pdf). Ramil & Gil (2015) reported that VME indicators have been located in all seamounts prospected but differences in structure and development state were observed. In some seamounts coral rubble, sediment-clogged, mostly dead coral framework and living coral framework were observed from the base to the summit all along the slope.

FIGURE 3-30 TOP: GORGONIANS RECORDED ON DEEP-WATER REEFS (100-120 M) OFF THE SOUTHERN AFRICAN WEST COAST (PHOTOS: DE BEERS MARINE). BOTTOM: VME INDICATOR SPECIES RECORDED FROM THE WALVIS RIDGE (RAMIL & GIL 2015).

3.2.14 SEABIRDS

The Namibian coastline sustains large populations of breeding and foraging seabird and shorebird species, which require suitable foraging and breeding habitats for their survival. In total, 11 species of seabirds are known to breed along the Namibian coast (Table 3-7). Most seabirds breeding in Namibia are restricted to areas where they are safe from land predators, although some species are able to breed on the mainland coast in inaccessible places. In general most breed on the islands off the southern Namibian coast, or on the man-made guano platforms in Walvis Bay, Swakopmund and Cape Cross, approximately 280 km to the southeast and 120 km to the east of PEL 82, respectively. The southern Namibian islands and guano platforms therefore provide a vital breeding habitat to most species of seabirds that breed in Namibia. However, the number of successfully breeding birds at the particular breeding sites varies with food abundance (J. Kemper, MFMR Lüderitz, pers. comm.). With the exception of Kelp Gull, Greater Crested Tern and White-breasted Cormorants all the breeding species are listed in the threatened categories in Namibia.

Most of the seabird species breeding in Namibia feed relatively close inshore (10-30 km), although exceptions occur (Ludynia *et al*. 2012), particularly when birds are forced to alter their dispersal patterns in response to environmental change (Sherley *et al.* 2017). Cape

Gannets (Table 3-7 Namibian breeding seabird species with their Namibian and global IUCN Red-listing classification (from Kemper et al. 2007; Simmons et al. 2015).

Species	Namibian	Global IUCN
*African Penguin *Spheniscus demersus*	Endangered	Endangered
*Bank Cormorant *Phalacrocorax neglectus*	Endangered	Endangered
*Cape Cormorant *Phalacrocorax capensis*	Endangered	Endangered
*Cape Gannet *Morus capensis*	Critically Endangered	Endangered
*Crowned Cormorant *Microcarbo coronatus*	Near Threatened	Near Threatened
*African Black Oystercatcher *Haematopus moquini*	Near Threatened	Near Threatened
White-breasted cormorant *Phalacrocorax lucidus*	Least Concern	Least Concern
Kelp Gull *Larus dominicanus*	Least Concern	Least Concern
*Hartlaub's Gull *Chroicocephalus hartlaubii*	Vulnerable	Least Concern
Caspian Tern *Hydroprogne caspia*	Vulnerable	Least Concern
*Greater Crested (Swift) Tern *Thallaseus bergii bergii*	Least Concern	Least Concern
*Damara Tern *Sternula balaenarum*	Near Threatened	Vulnerable

Notes:

In the IUCN scheme Endangered is a more extinction-prone class than Vulnerable, and differences between Namibia and global classifications are the result of local population size, and the extent and duration of declines locally.

FIGURE 3-31, left), however, are known to forage up to 140 km offshore (Dundee 2006; Ludynia 2007) (Figure 3-32) and African Penguins (Table 3-7 Namibian breeding seabird species with their Namibian and global IUCN Red-listing classification (from Kemper et al. 2007; Simmons et al. 2015).

Species	Namibian	Global IUCN
*African Penguin *Spheniscus demersus*	Endangered	Endangered
*Bank Cormorant *Phalacrocorax neglectus*	Endangered	Endangered
*Cape Cormorant *Phalacrocorax capensis*	Endangered	Endangered
*Cape Gannet *Morus capensis*	Critically Endangered	Endangered
*Crowned Cormorant *Microcarbo coronatus*	Near Threatened	Near Threatened
*African Black Oystercatcher *Haematopus moquini*	Near Threatened	Near Threatened
White-breasted cormorant *Phalacrocorax lucidus*	Least Concern	Least Concern
Kelp Gull *Larus dominicanus*	Least Concern	Least Concern
*Hartlaub's Gull *Chroicocephalus hartlaubii*	Vulnerable	Least Concern
Caspian Tern *Hydroprogne caspia*	Vulnerable	Least Concern
*Greater Crested (Swift) Tern *Thallaseus bergii bergii*	Least Concern	Least Concern
*Damara Tern *Sternula balaenarum*	Near Threatened	Vulnerable

Notes:

In the IUCN scheme Endangered is a more extinction-prone class than Vulnerable, and differences between Namibia and global classifications are the result of local population size, and the extent and duration of declines locally.

FIGURE 3-31, right) have also been recorded as far as 60 km offshore (Ludynia *et al*. 2012). The closest Cape Gannet and African penguin colonies to PEL 82 are at Mercury and Ichaboe Islands some 345 km and 460 km to the southeast, with smaller penguin colonies reported at Hollamsbird Island, at the caves at Sylvia Hills and Oyster Cliffs and on Neglectus Islet. As the project area is ~80 km offshore at its closest point and north of the northern-most islands, encounters with these species during exploration drilling operations in PEL 82 is likely to be rare.

TABLE 3-7 NAMIBIAN BREEDING SEABIRD SPECIES WITH THEIR NAMIBIAN AND GLOBAL IUCN RED-LISTING CLASSIFICATION (FROM KEMPER ET AL. 2007; SIMMONS ET AL. 2015).

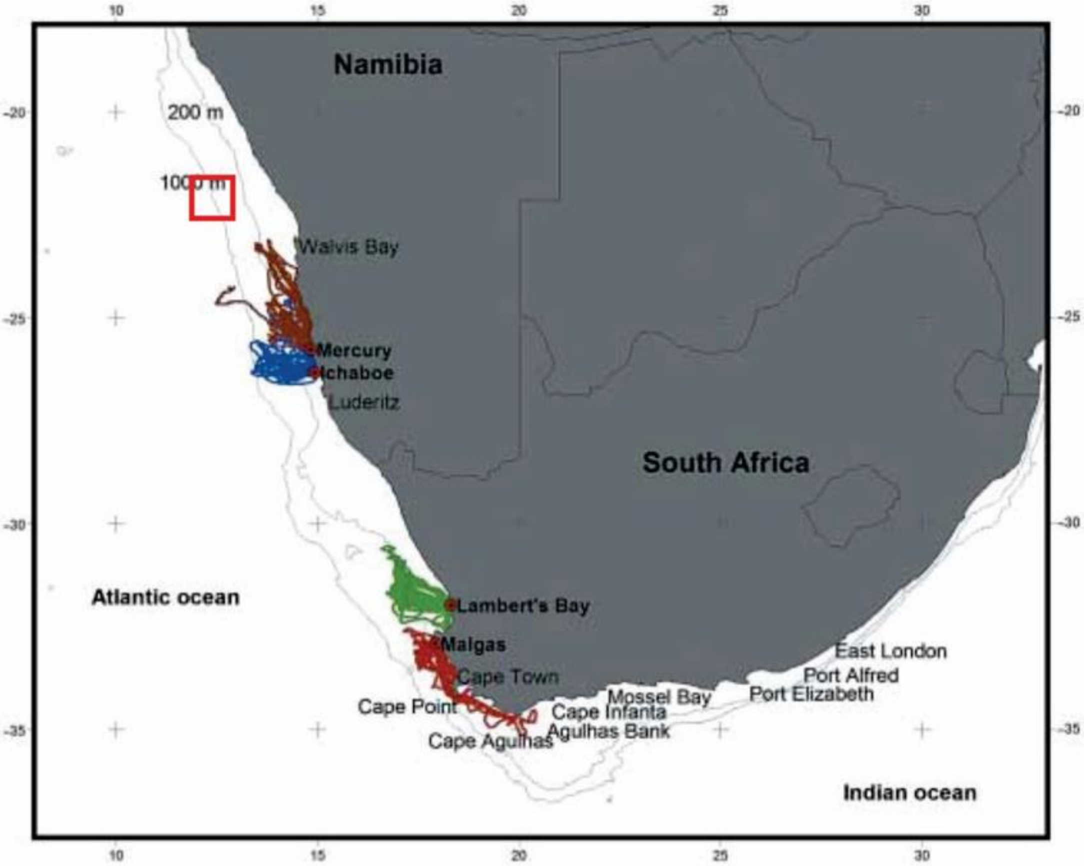
Species	Namibian	Global IUCN
*African Penguin *Spheniscus demersus*	Endangered	Endangered
*Bank Cormorant *Phalacrocorax neglectus*	Endangered	Endangered
*Cape Cormorant *Phalacrocorax capensis*	Endangered	Endangered
*Cape Gannet *Morus capensis*	Critically Endangered	Endangered
*Crowned Cormorant *Microcarbo coronatus*	Near Threatened	Near Threatened
*African Black Oystercatcher *Haematopus moquini*	Near Threatened	Near Threatened
White-breasted cormorant *Phalacrocorax lucidus*	Least Concern	Least Concern
Kelp Gull *Larus dominicanus*	Least Concern	Least Concern
*Hartlaub's Gull *Chroicocephalus hartlaubii*	Vulnerable	Least Concern
Caspian Tern *Hydroprogne caspia*	Vulnerable	Least Concern
*Greater Crested (Swift) Tern *Thallaseus bergii bergii*	Least Concern	Least Concern
*Damara Tern *Sternula balaenarum*	Near Threatened	Vulnerable

Notes:

In the IUCN scheme Endangered is a more extinction-prone class than Vulnerable, and differences between Namibia and global classifications are the result of local population size, and the extent and duration of declines locally.

FIGURE 3-31 CAPE GANNETS *MORUS CAPENSIS* (LEFT) (PHOTO: NACOMA) AND AFRICAN PENGUINS *SPHENISCUS DEMERSUS* (RIGHT) (PHOTO: KLAUS JOST) BREED PRIMARILY ON THE OFFSHORE ISLANDS.

FIGURE 3-32 PEL 82 (RED POLYGON) IN RELATION TO GPS TRACKS RECORDED FOR 93 CAPE GANNETS FORAGING OFF FOUR BREEDING COLONIES IN SOUTH AFRICA AND NAMIBIA (ADAPTED FROM GRÉMILLET ET AL. 2008).



Other Red-listed species found foraging, or roosting along the coastline of southern and central Namibia are listed in Table 3-8. Among the other species present off Namibia's coast there are at least nine species of albatrosses, petrels or giant-petrels recorded (Boyer & Boyer 2015, Benthic Solutions Ltd 2019). However, none of these species breed in Namibia, and the numbers foraging in Namibian waters are poorly known, although some tracking data are available (

FIGURE 3-33). Forty-nine species of pelagic seabirds have been recorded in the region, of which 14 are resident. Highest pelagic seabird densities occur offshore of the shelf-break in winter. Pelagic seabirds potentially encountered in PEL 82 are provided in Table 3-8.

In central Namibia, the 30 km long shoreline between Walvis Bay and Swakopmund has the highest linear count of birds in southern Africa at ~450 birds/km with totals exceeding 13,000 shorebirds of 31 species, most of which are Palearctic migrants (Simmons *et al*. 1999; Molloy and Reinikainen 2003; http://www.ramsar.org/profile/profiles_namibia .htm). Individual 10 km sections, peak even higher at 770 birds/km. Birds reported from the 30 km stretch of coast between Walvis Bay and Swakopmund include African Black Oystercatcher, Kelp Gull, Cape cormorant, Turnstone (*Arenaria interpres*), Curlew Sandpiper (*Calidris ferruginea*), Grey plover (*Pluvialis squatarola*), Swift Tern, Damara tern and Common Tern (*Sterna hirundo*) (Simmons *et al*. 1999).

TABLE 3-8 OTHER RED-LISTED BIRD SPECIES THAT OCCUR IN NAMIBIA, WITH THEIR NAMIBIAN AND GLOBAL IUCN RED-LISTING CLASSIFICATION (FROM KEMPER ET AL. 2007; SIMMONS ET AL. 2015; IUCN 2025).

Species	Namibian	Global IUCN
Tristan Albatross *Diomedea dabbenena*	Critically Endangered	Critically Endangered
Atlantic Yellow-nosed Albatross *Thalassarche chlororhynchos*	Endangered	Endangered
Black-browed Albatross *Thalassarche melanophrys*	Endangered	Least Concern
Wandering Albatross *Diomedea exulans*	Vulnerable	Vulnerable
Shy Albatross *Thalassarche cauta*	Near Threatened	Near Threatened
White-capped Albatross *Thalassarche sneadi*	Near Threatened	Near Threatened
Spectacled Petrel *Procellaria conspicillata*	Vulnerable	Vulnerable
Northern Giant-Petrel *Macronectes halli*	Near Threatened	Least Concern
Southern Giant-Petrel *Macronectes giganteus*	Not listed	Least Concern
Cape (Pintado) Petrel *Daption capense*	Not listed	Least Concern
Kerguelen Petrel *Aphrodroma brevirostris*	Not listed	Least Concern
Great-winged Petrel *Pterodroma macroptera*	Not listed	Least Concern
Soft-plumaged Petrel *Pterodroma mollis*	Not listed	Least Concern
White-chinned Petrel *Procellaria aequinoctialis*	Vulnerable	Vulnerable
Leach's Storm-Petrel *Oceanodroma leucorhoa*	Not listed	Vulnerable
Wilson's Storm-Petrel *Oceanites oceanicus*	Not listed	Least Concern
European Storm-Petrel *Hydrobates pelagicus*	Not listed	Least Concern
Sabine's Gull *Xema sabini*	Not listed	Least Concern
Arctic Tern *Sterna paradisaea*	Not listed	Least Concern
Red Phalarope *Phalaropus fulicarius*	Not listed	Least Concern
Brown (Sub-Antarctic) Skua *Catharacta antarctica*	Not listed	Least Concern
Pomarine Jaeger (Skua) *Stercorarius pomarinus*	Not listed	Least Concern
Antarctic Prion *Pachyptila desolata*	Not listed	Least Concern

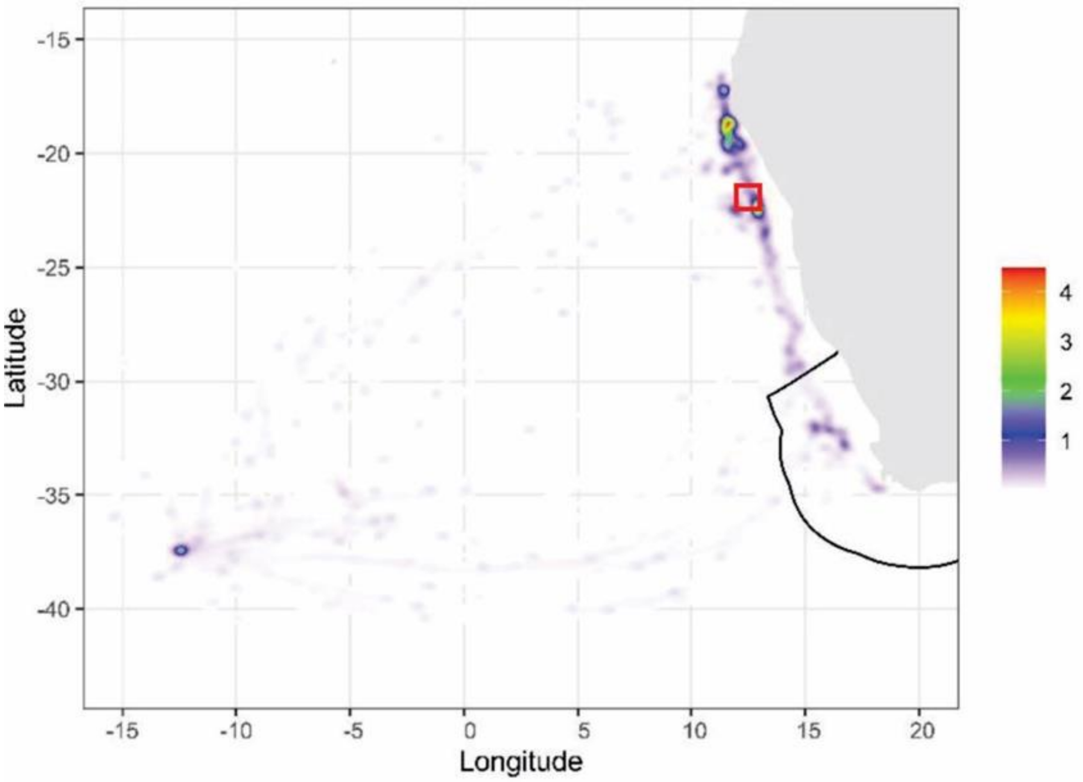
Species	Namibian	Global IUCN
Long-Tailed Jaeger (Skua) *Stercorarius longicaudus*	Not listed	Least Concern
Sooty Shearwater *Ardenna grisea*	Near Threatened	Near Threatened
Cory's Shearwater *Calonectris borealis*	Not listed	Least Concern
Scopoli's Shearwater *Calonectris diomedea*	Not listed	Least Concern
Manx Shearwater *Puffinus puffinus*	Not listed	Least Concern
Great Shearwater *Ardenna gravis*	Not listed	Least Concern

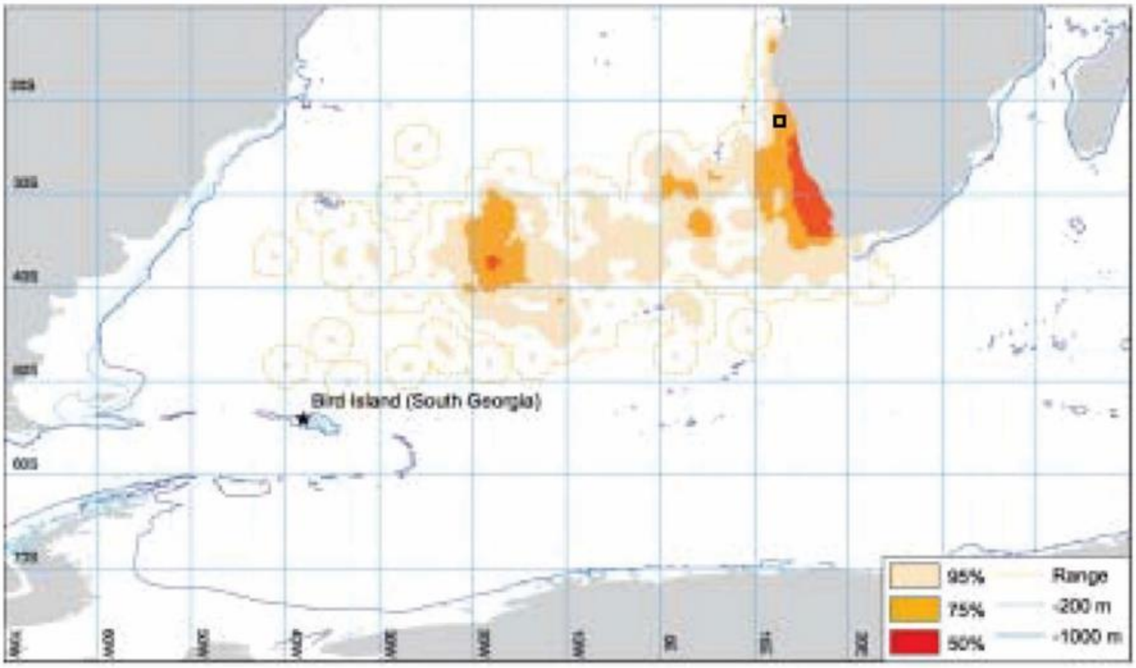
Notes:
In the IUCN scheme 'Endangered' is a more extinction-prone class than 'Vulnerable', and differences between Namibia and global classifications are the result of local population size and importance, and the extent and duration of declines locally / globally.

The coastline between Walvis Bay and Cape Cross also boasts three man-made guano platforms: "Bird Rock" north of Walvis Bay is 200 m offshore, whereas those north of Swakopmund and at Cape Cross have been erected in salt pans. The platforms are unique in the world and produce about 2,500 tons of guano per season. About 99% of the birds occurring on the platforms are Cape Cormorants, although White-breasted Cormorants, Crowned Cormorants and Great White Pelicans also breed on the platforms (http://www.namibweb. com/guano.htm; http://web.uct.ac.za/ depts/stats/adu/walvisbay guano platform.htm).

The Kunene River mouth and its estuary at the border with Angola also serves as an extremely important wetland for coastal birds, particularly the near threatened Damara Tern, which has been recorded in high numbers (2,000 – 5,000) within and to the south of the mouth.

FIGURE 3-33 PEL 82 (RED AND BLACK POLYGONS) IN RELATION TO THE UTILIZATION DISTRIBUTION OF INCUBATING ATLANTIC YELLOW-NOSED ALBATROSSES FROM GOUGH ISLAND (TOP), SOUTHERN OCEAN, AND BLACK-BROWED ALBATROSS FROM BIRD ISLAND, SOUTH GEORGIA (BOTTOM) (ADAPTED FROM BIRDLIFE AFRICA 2004, 2022).




Bird Island (South Georgia)
95%
75%
50%
Range
-200 m
-1000 m

3.3 OTHER USES OF THE PROPOSED LICENSE AREA

3.3.1 BENEFICIAL USES

The license area is located well offshore at depths beyond 200 m. Other users of the area include the commercial fishing industry (see Specialist Report on Fisheries), and oil and gas license holders. In Namibia various restrictions apply to areas permittable to commercial fisheries. No trawling or long-lining is permitted inshore of the 200 m depth contour, and south of 25°S no freezer trawlers or hake trawlers are permitted inshore of the 350 m depth contour. Marine mining (diamonds and marine phosphates) concessions and Exclusive Prospecting Licenses (EPLs) are located inshore of PEL 82 (Figure 3-34). Current activities in the EPLs are minimal to non-existent, the only active operations being diamond mining south of Lüderitz. Recreational use of the coastline and inshore areas is negligible and restricted primarily to the area around Henties Bay, Swakopmund, Walvis Bay and Lüderitz, all of which lie well inshore and to the southeast of PEL 82. Recreational activities offshore of the Namib-Naukluft and the Skeleton Coast National Park are similarly limited.

The main shipping lanes around southern Africa lie seawards of PEL 82, however, the license area lies within the main trawling lanes and traffic routes into and out of Walvis Bay. Both coastal shipping and fishing craft may therefore be encountered in the license area, particularly the eastern portion of PEL 82 (Figure 3-35).

Various subsea telecommunications cable traverse across the Namibian EEZ, of which two come ashore at Swakopmund. These cables, however all lie south and offshore of PEL 82.

Other current and proposed industrial uses of the marine environment include the intake of cooling water for power plants, intake of feed-water for desalination plants, and seawater intakes for fish processing, or mariculture operations. There is also limited guano harvesting on the guano platforms and salt production in Walvis Bay, Swakopmund and at Cape Cross. These activities are all located well inshore of PEL 82 and should in no way be affected by offshore well-drilling activities.

Mariculture activities are being conducted at an increasing scale in Walvis Bay, and at present there are over 20 companies engaged in cultivation of Pacific oyster (*Crassostrea gigas*) and European flat oyster (*Ostrea edulis*) in the bay. Oyster cultivation is also conducted in the feed-water ponds of the Walvis Bay and Swakopmund salt works. These various mariculture activities should likewise not be affected in any way by offshore exploration well-drilling.

FIGURE 3-34 PEL 82 IN RELATION TO PROJECT - ENVIRONMENT INTERACTION POINTS ON THE NAMIBIAN COAST, ILLUSTRATING THE MARINE DIAMOND MINING CONCESSIONS AND OTHER USERS OF THE MARINE ENVIRONMENT.

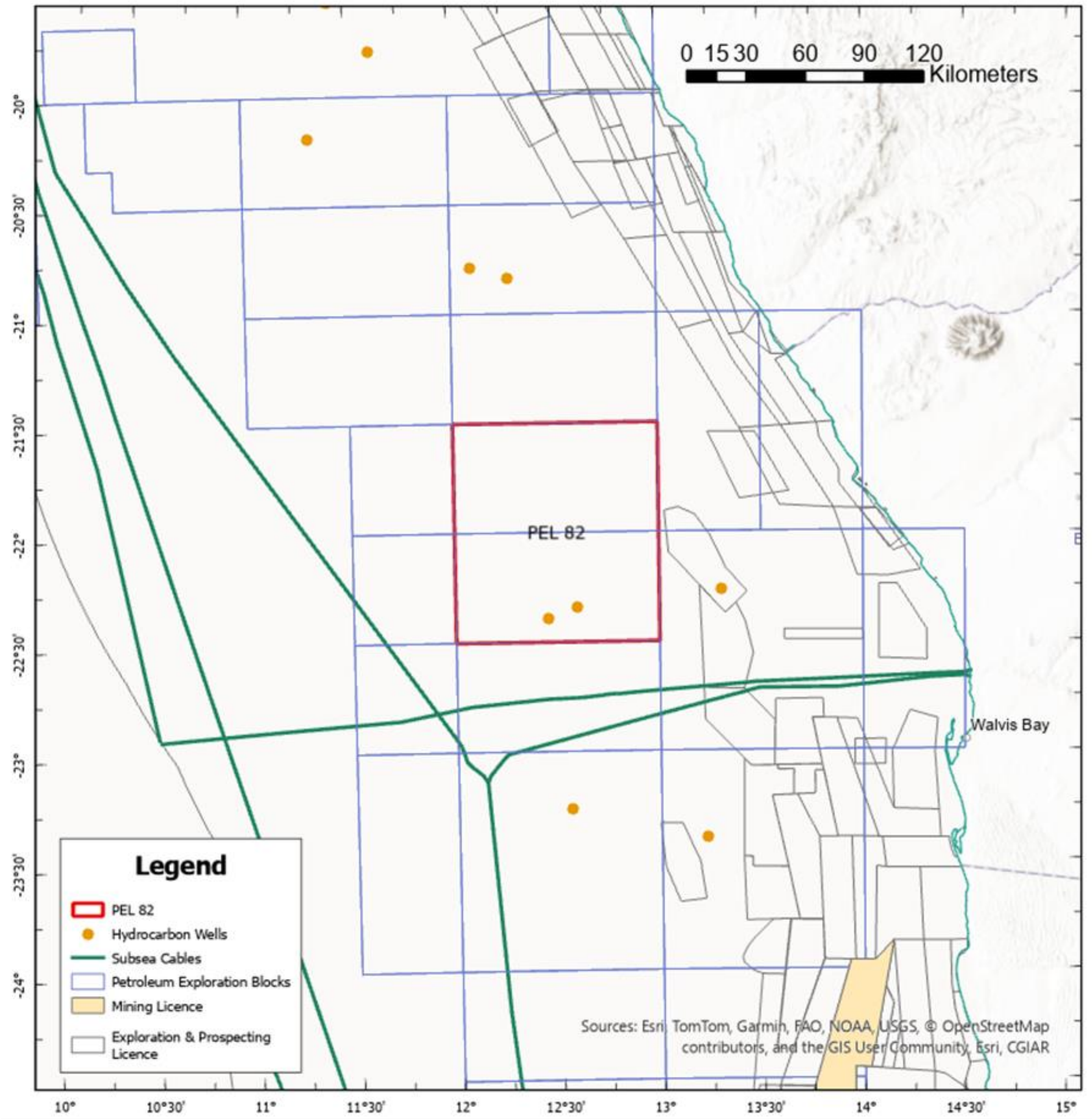
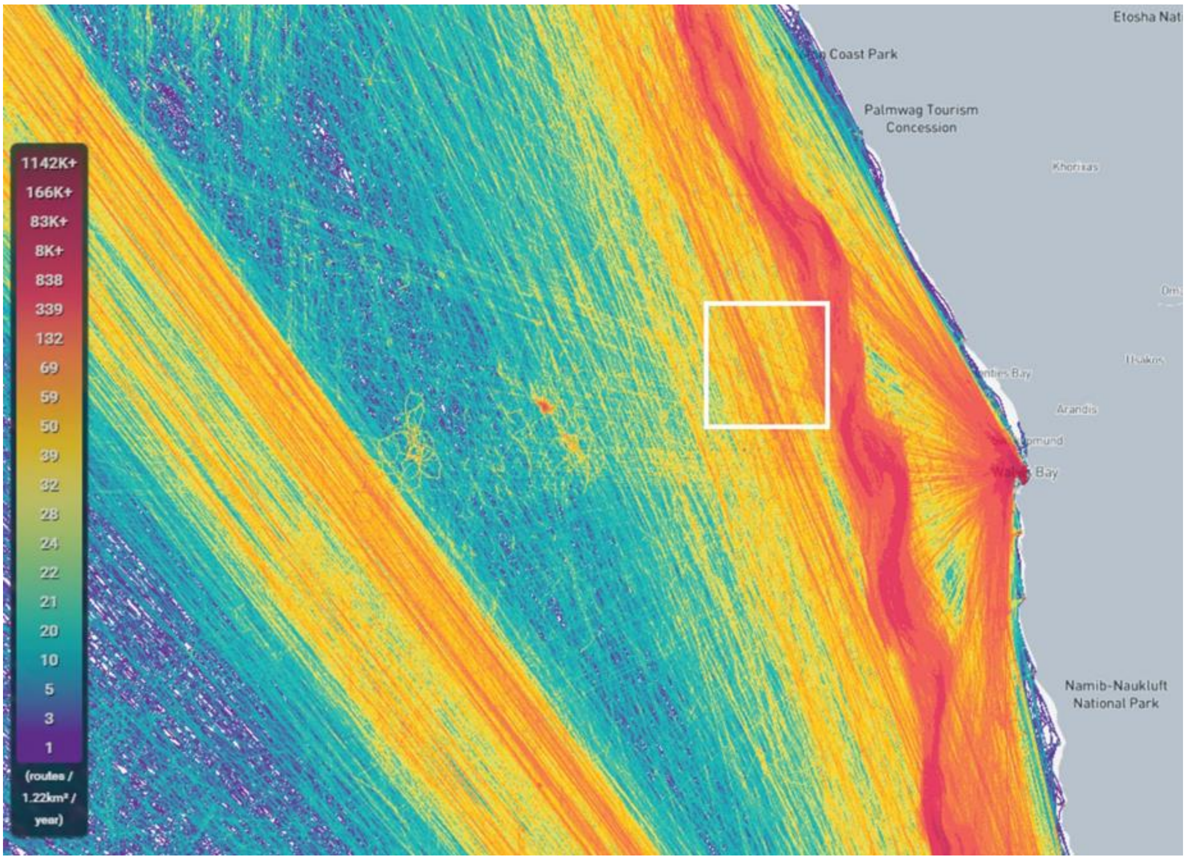


FIGURE 3-35 PEL 82 (WHITE POLYGON) IN RELATION TO OFFSHORE VESSEL TRAFFIC (ADAPTED FROM WWW.MARINETRAFFIC.COM/EN/AIS/HOME, ACCESSED APRIL 2025).



3.3.2 CONSERVATION AREAS AND MARINE PROTECTED AREAS

3.3.2.1 NATIONAL PARKS

Inshore of PEL 82, the coastline of Namibia is part of a continuum of protected areas that stretch along the entire Namibian coastline, a distance of about 1,570 km, from Southern Angola into Namaqualand in South Africa. Recently proclaimed as the Namib-Skeleton Coast National Park it incorporates four terrestrial Management Areas, namely the Skeleton Coast National Park, the Dorob National Park, the Namib-Naukluft National Park and the Tsau//Khaeb-Sperrgebiet National Park (see Figure 3-38). The Namib-Skeleton Coast National Park is the 8th largest protected area in the world, the 6th largest terrestrial protected area globally and the largest park in Africa, covering an area of 107,540 km^2. In the south across the Orange River it borders on the Richtersveld in South Africa, which comprises a protected area of about 1,600 km^2 within a multiple-use buffer zone of about 3,984 km^2. This whole area forms the Ai-Ais/Richtersveld Transfrontier Conservation Area (TFCA) under a formal co-operative agreement between the governments of Namibia and South Africa. To the north across the Kunene River it joins the Iona National Park in Angola, which covers about 5,850 km^2. The governments of Namibia and Angola have signed an agreement to promote transfrontier co-operation between these parks.

The central and northern components of the Namib-Skeleton Coast National Park are described briefly below:

The Skeleton Coast National Park extends 500 km from the Ugab River in the south to the Kunene River in the north, covering a total land-area of approximately 16,400 km^2. The coastline is characterised by many shipwrecks, dense coastal fogs and cold onshore winds. The general public has access only to the southern section between the Ugab and Hoanib rivers, staying at Terrace Bay and Torra Bay. Although open all year to linefish boats, Torra Bay and Terrace Bay are partly closed or restricted to rock- and surf-anglers. There is a seal colony at Cape Frio. The northern section of the Skeleton Coast Park is a tourism concession area and restricted to fly-in safaris only. The park is managed as a wilderness area by the Ministry of Environment and Tourism (MET) due to its ecological sensitivity.

The Dorob National Park, formerly the National West Coast Tourist Recreation Area, was gazetted as a national park under the Nature Conservation Ordinance No. 4 of 1975 in December 2010. The park extends along the coastline between the Kuiseb Delta and the Ugab River, and covers an area of 57,740 km^2. While tourism, sports and recreational activities are allowed in non-sensitive areas, the remainder of the park has been divided into zones, which include Damara tern breeding sites, gravel plains, important birds areas, the Kuiseb Delta, Sandwich Harbour, Swakop River, Tsumas Delta, Walvis Bay Lagoon, birding areas and lichen fields.

The Cape Cross Seal Reserve, which is located within the Dorob National Park, is situated approximately 130 km north of Swakopmund. With a surrounding area of 60 km^2, the Cape Cross Seal Reserve was proclaimed in 1968 to protect the largest of the 23 breeding colonies of Cape fur seals along the southern African West Coast. Emergent offshore reefs, which serve as seabird nesting areas, are also protected.

Of the three designated coastal Ramsar sites in Namibia, the Walvis Bay wetlands and Sandwich Harbour fall within the broader project area and are described briefly below.

The Walvis Bay Wetland is one of the most important coastal wetlands in Southern Africa. As the largest single area of shallow sheltered water along the Namibian coastline, it encompasses the lagoon and mudflats exposed at low tide, and sandbars serving as roosting and feeding sites for resident and migratory birds, Paaltjies beach on the Pelican Point peninsula, the Walvis Bay saltworks, and sand dunes and gravel fields extending to the boundary of the Namib-Naukluft Park (Barnard 1998; www.nacoma.org.na). The estimated total area for these wetlands is 35 - 40 km^2. It was proclaimed a Ramsar site in 1995

Sandwich Harbour, located 55 km south of Walvis Bay, is one of southern Africa's richest and most unique coastal wetlands. Situated within the Namib-Naukluft Park, the area consists of two distinct parts. Firstly, a northern saltmarsh and adjoining intertidal sand flat area (5 km x 300 m), which supports emergent freshwater vegetation (37 species) and 4,000 – 5,500 wetlands birds. The more extensive (40 km²) southern area of unvegetated tidal mudflats and raised shingle bars supports up to 175,000 birds, mainly waders, terns, pelicans and flamingos. Although the area is not directly associated with a river, water from an inland aquifer seeps into the northern portion of Sandwich Harbour, filling the lagoon and sustaining freshwater vegetation at the base of the dunes. Also 36 species of fish and eight Namibian Red Data bird species can be found at Sandwich Harbour. The wetland and shallow lagoon is protected from the open ocean by a sand barrier thus supporting an extremely rich avifauna including eight endangered species among the large numbers of waders, terns, pelicans and flamingos. Bird numbers are reported to reach maximum concentrations of 238,000 birds, with Palearctic waders reaching densities of 7,800 birds per km^2. Several archaeological sites dating back 1,000 years also exist within the area (Barnard 1998).

The Namib-Naukluft National Park has an area of 49,800 km² and encompasses part of the Namib Desert, the Naukluft mountain range, Sandwich Harbour and Sossusvlei, which is a main visitor attraction in Namibia.

3.3.2.2 MARINE SANCTUARIES

Sanctuaries are considered a type of management area within Namibia's multi-purpose National Park and MPA network in which access and/or resource use is prohibited.

The Lüderitz Bay and Ichaboe Island Rock-Lobster Sanctuaries were proclaimed by South Africa in 1939 and 1951, respectively (Matthews & Smit 1979), and subsequently maintained as reserves by MFMR after Namibian independence. There is no restriction on other activities within these reserves. These sanctuaries are well to the south of PEL 82.

3.3.2.3 MARINE PROTECTED AREAS

The first (and to date only) Namibian MPA was launched on 2 July 2009 under the Namibian Marine Resources Act (No. 29 of 1992 and No. 27 of 2000), with the purpose of protecting sensitive ecosystems and breeding and foraging areas for seabirds and marine mammals, as well as protecting important spawning and nursery grounds for fish and other marine resources (such as rock lobster). The MPA comprises a coastal strip extending from Hollamsbird Island (24°38´S) in the north, to Chamais Bay (27°57´S) in the south, spanning approximately three degrees of latitude and an average width of 30 km, including 16 specified offshore islands, islets and rocks (Currie *et al.* 2009). The Namibian Islands' Marine Protected Area (NIMPA) spans an area of 9,555 km^2, and includes a rock-lobster sanctuary constituting 478 km^2 between Chameis Bay and Prince of Wales Bay. The offshore islands, whose combined surface area amounts to only 2.35 km^2 have been given priority conservation and highest protection status (Currie *et al.* 2009). The area has been zoned into four degrees of incremental protection. These are detailed in Currie *et al.* (2009).

The NIMPA lies ~260 km southeast of PEL 82.

3.3.2.4 SENSITIVE AREAS

Despite the current lack of knowledge of the community structure and endemicity of southern African macro-infauna off the edge of the continental shelf, the spatial marine biodiversity assessment (Holness *et al.* 2014), rated the Namib upper and lower slope unconsolidated habitat types that characterise depths beyond 1.000 m, as being of 'Least concern' (Figure 3-29), reflecting the great extent of these habitats in the Namibian EEZ. However, those ecosystem types occurring along the shelf edge in the Central Namib biozone are considered 'Vulnerable, with those on the outer shelf rated as 'Endangered'. PEL 82 spans all three of these habitats.

Notwithstanding the development of the offshore EBSAs a number of 'Vulnerable' ecosystem types in the broader project area are currently considered 'not well protected' or 'moderately protected' and further effort is needed to improve protection of these threatened ecosystem types (Holness *et al*. 2014) (Figure 3-36). Ideally, all highly threatened ('Critically Endangered' and 'Endangered') ecosystem types should be well protected. Currently, however, most of the upper and lower slope of the Namib biozone receives no protection at all, with the 'Endangered' Outer Shelf being 'moderately protected'. Most of PEL 82 lies within an area receiving no protection, with only the eastern portion being 'moderately protected'.

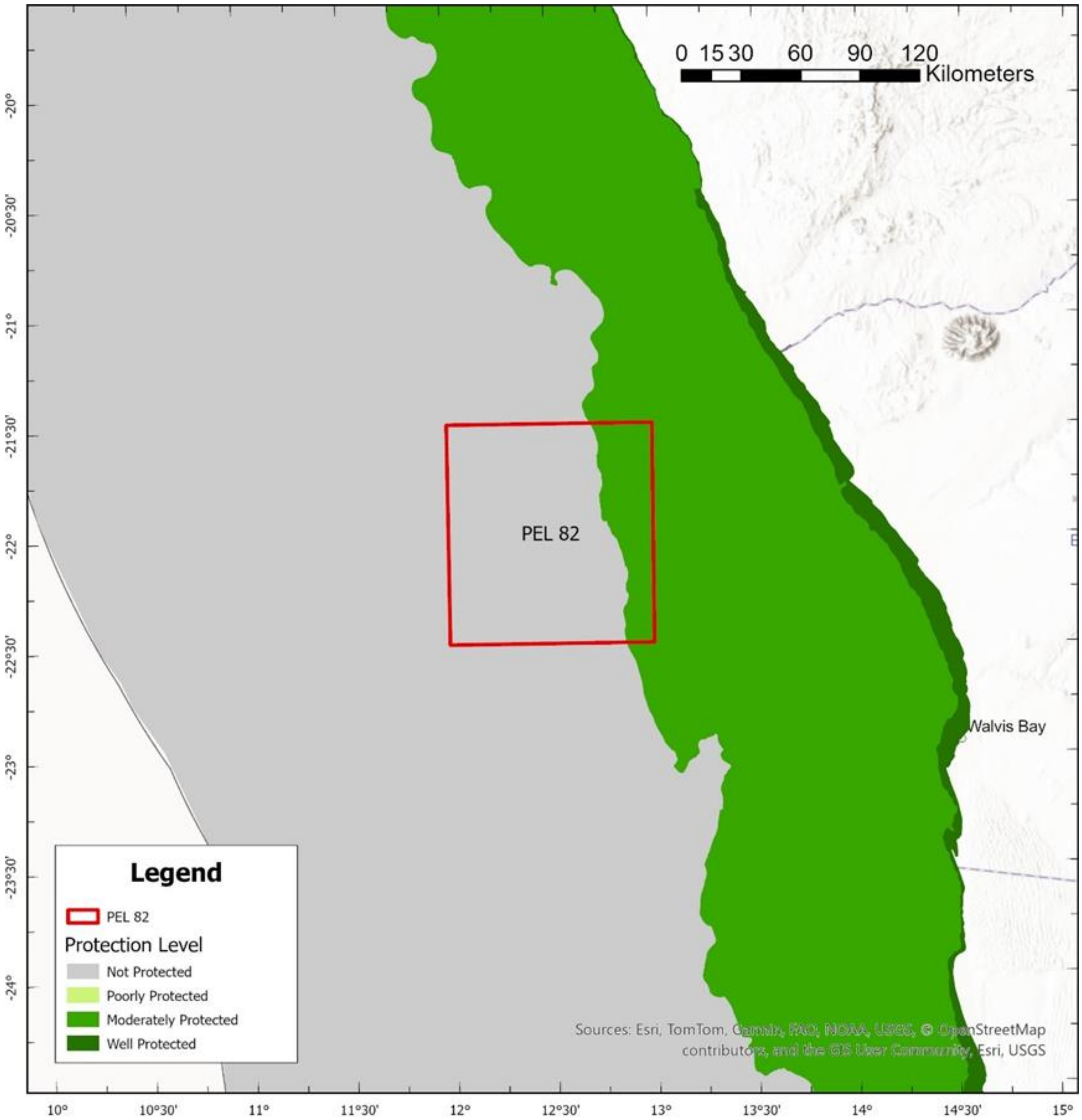
3.3.2.5 ECOLOGICALLY OR BIOLOGICALLY SIGNIFICANT AREAS

In the spatial marine biodiversity assessment undertaken for Namibia (Holness *et al*. 2014), a number of offshore and coastal area were identified as being of high priority for place-based conservation measures. To this end, Ecologically or Biologically Significant Areas (EBSA) spanning the coastline between Angola and South Africa were proposed and inscribed under the Convention of Biological Diversity (CBD). The principal objective of the EBSAs is identification of features of higher ecological value that may require enhanced conservation and management measures. No specific management actions have been formulated for the EBSAs at this stage and they carry no legal status. Any future decisions in relation to management of the areas and possible restrictions of human activities are within the mandate of the responsible authorities.

Of the eight identified EBSAs off Namibia, two fall solely within Namibian national jurisdiction (Namib Flyway and Namibian Islands), while one is shared with Angola (Namibe) and two are shared with South Africa (Orange Shelf Edge and Orange Cone) (Figure 3-37). The Benguela Upwelling System transboundary EBSA extends along the entire southern African West Coast from Cape Point to the Kunene River and includes a portion of the high seas beyond the Angolan EEZ. The following summaries are adapted from http://cmr.mandela.ac.za/EBSA-Portal/Namibia/.

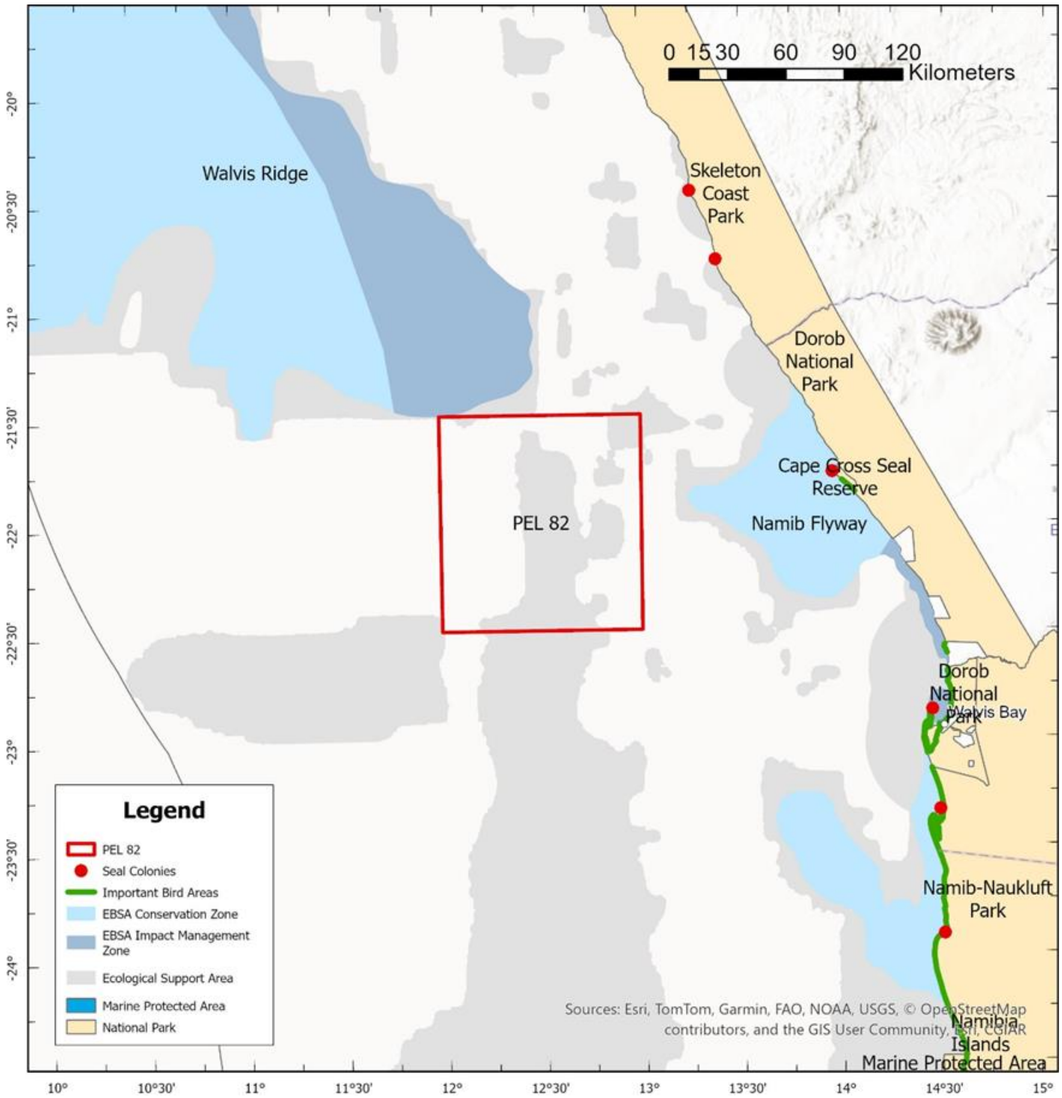
In the Namibe trans-boundary EBSA, the Kunene River, its mouth and associated wetlands strongly influence the salinity, sediment and productivity within the Tigres Island-Bay complex, which lies ~50 km north of the river mouth. This link, which underpins the elevated local productivity, is a regionally unique feature. Similarly, the shelf-incising canyons and seamounts in the EBSA footprint, also contribute to elevated productivity and foraging habitat. The Namibe EBSA supports a highly diverse collection of species and habitats in very close proximity, many of which are also threatened. The high productivity supports the life-histories of numerous key species, as well as providing foraging, breeding and resting habitats for seals, fish, turtles, and migratory and resident birds.

FIGURE 3-36 PEL 82 (RED POLYGON) IN RELATION TO THE PROTECTION LEVELS OF BENTHIC HABITAT TYPES AS ASSESSED BY HOLNESS ET AL. (2014).



Cape Fria is a coastal EBSA located 50 km south of the Kunene River mouth and encompasses Cape Fria itself, and Angra Fria: a small, prominent bay to the north. Here, where the continental shelf is at its narrowest there is an intense upwelling cell which enhances local productivity and marks the northern boundary of the Benguela Current. Consequently, several top predators use this area as a foraging ground. The EBSA extends 100 km along the shore, and 40 km offshore to depths of <250 m in the north (where seals forage) and 5 km offshore in the south (where Damara Terns forage). Cape Fria therefore falls within a biogeographic transition zone, with a relatively high local biodiversity because it comprises species at both the northern and southern limits of their distributions. The area is critical for aggregations of almost the entire global population of Damara Tern during specific periods of the year. It is also an important breeding site for Cape fur seals.

FIGURE 3-37 PEL 82 IN RELATION TO PROJECT - ENVIRONMENT INTERACTION POINTS ON THE NAMIBIAN COAST, ILLUSTRATING SEAL COLONIES, IMPORTANT BIRD AREAS, MARINE PROTECTED AREAS (MPAS) AND ECOLOGICALLY AND BIOLOGICALLY SIGNIFICANT AREAS (EBSAS).



The Walvis Ridge Namibia EBSA lies contiguous to the Walvis Ridge EBSA in the high seas. Together, these two EBSAs span the full extent of the significant hotspot track (seamount chain formed by submarine volcanism) that comprises the aseismic Walvis Ridge and the Guyot Province. This unique feature forms a submarine ridge running north-east to south-west from the Namibian continental margin to Tristan da Cunha and Gough islands at the southern Mid-Atlantic Ridge. The Walvis Ridge Namibia EBSA encompasses the globally rare connection of a hotspot track to continental flood basalt in the Namibian EEZ. Given the high habitat heterogeneity associated with the complex benthic topography, it is likely that the area supports a relatively higher biological diversity, and is likely to be of special importance to vulnerable sessile macrofauna and demersal fish associated with seamounts. Productivity in the Namibian portion of Walvis Ridge is also particularly high because of upwelling resulting from the interaction between the geomorphology of the feature and the nutrient-rich, north-flowing Benguela Current.

The Namib Flyway is a highly productive area in the Benguela system that attracts large numbers of sea- and shorebirds, marine mammals, sea turtles and other fauna. It contains two marine Ramsar sites, six terrestrial IBAs, two proposed marine IBAs, and key spawning and nursery areas for some fish species. As the upwelling cell off Lüderitz has its effect further north with the longshore drift and predominant onshore winds, primary production of the Benguela current is highest in the central regions of the Namibian coast, driven by delayed blooming. This area is thus highly relevant in terms of its importance for life-history stages of species, threatened, endangered or declining species and/or habitats, and biological productivity. PEL 82 lies offshore of this EBSA.

The Benguela Upwelling System is a transboundary EBSA is globally unique as the only cold-water upwelling system to be bounded in the north and south by warm-water current systems, and is characterized by very high primary production (>1,000 mg C/m^2/day). It includes important spawning and nursery areas for fish as well as foraging areas for threatened vertebrates, such as sea- and shorebirds, turtles, sharks, and marine mammals. Another key characteristic feature is the diatomaceous mud-belt in the Northern Benguela, which supports regionally unique low-oxygen benthic communities that depend on sulphide oxidising bacteria. PEL 82 falls within this EBSA.

The Namibian Islands are located offshore of the central Namibian coastline and within the intensive Lüderitz upwelling cell. These islands and their surrounding waters are significant for life history stages of threatened seabird species as they serve as crucial seabird breeding sites within the existing Namibian Islands Marine Protected Area (NIMPA). The surrounding waters are also key foraging grounds for both seabirds and for 'Critically Endangered' leatherback turtles that nest along the northeastern coast of South Africa.

3.3.2.6 BIODIVERSITY PRIORITY AREAS AND MARINE SPATIAL PLANNING

In addition to EBSAs, Ecological Support Areas (ESAs) have been identified. Although these areas do not meet the EBSA criteria they reflect secondary priority conservation areas with special attributes that support a healthy and functioning marine ecosystem (Figure 3-37). ESAs cover 37.4% of the total area of PEL 82.

Namibia recently embarked on a Marine Spatial Planning (MSP) process implemented as a development planning approach to organize the use of the country's marine territory in such way that comprehensive, integrated and complementary planning and management across sectors and for all ocean uses is enabled. MSP in Namibia is highly precautionary and forward-looking given the relatively low intensity of current uses, has a strong ecosystem-based perspective due to the fairly pristine environment, is driven by a social equity and distributive justice agenda, and features a strong collaborative process governance (Finke *et al*. 2020a, 2020b). Although at this stage MSP lacks legislation and has only weak links to broader ocean governance, the MSP process has resulted in a clear framework for the development of the first marine plan (MFMR 2019), as it was linked to a systematic conservation planning process from the outset.

The objectives and principles for MSP, as well as the steps each planning process is expected to follow, are set out in the National MSP Framework (MFMR 2019). The Framework provides high-level direction to provide consistent and coherent plan development, implementation and review across Namibia's marine space and its three proposed planning areas: a northern, central and southern area. It also describes the background to MSP and its overarching objectives in Namibia and identifies relevant institutional structures, roles and responsibilities (MFMR 2022). The first MSP for Namibia is being developed for the central area, followed by the northern and the southern areas. Although all three areas have sites of high ecological sensitivity and importance, growing economic interests and increasingly overlapping human uses, particularly in the central and southern MSP areas call for improved management.

The Marine Spatial Plans in each of the three planning areas will translate the National Framework for MSP into integrated and strategic sustainable development plans that guide users, developers and regulators in their decision-making, setting out which activities should take place where, when and under what conditions. Any future licensing decisions would need to be in line with the provisions set out in the respective plans.

3.3.2.7 RAMSAR SITES AND IMPORTANT BIRD AREAS

The Walvis Bay wetland was proclaimed a Ramsar site in December 1995, supporting up to 250,000 birds at peak times during the summer season and about 80,000 to 100,000 birds during winter (Wearne & Underhill 2005). The wetland serves primarily as a dry-season and drought refuge for intra-African migrants and as a non-breeding area for Palaearctic migrants. Key species are Greater and Lesser Flamingos, Chestnut-banded Plover, Black-necked Grebe and the African Black Oystercatcher (www.nnf.org.na/CTEN).

Eleven threatened bird species are regularly observed (http://www.ramsar.org/ profile/ profiles_namibia. htm).

Sandwich Harbour, a natural tidal lagoon, is located 55 km south of Walvis Bay. The area hosts upwards of 70,000 birds, mostly seasonal migrants from the northern hemisphere (Kolberg 2015). It was proclaimed a Ramsar site in December 1995.

These coastal Ramsar sites all lie more than 100 km to the east and south of PEL 82.

Of the 19 Important Bird Areas (IBAs) designated by BirdLife International in Namibia, those located along the coastline of the broader project area are listed in Table 3-9. RAMSAR sites are described in Table 3-10.

TABLE 3-9 LIST OF IMPORTANT BIRD AREAS (IBAS) AND THEIR CRITERIA LISTINGS. THOSE DESIGNATED AS RAMSAR SITES ARE SHADED.

Site Name	IBA Criteria
Cape Cross lagoon	A1, A4i, A4iii
Namib-Naukluft Park	A1, A2, A3, A4i
Mile 4 saltworks	A1, A4i, A4iii
30-Kilometre Beach: Walvis-Swakopmund	A1, A4i
Walvis Bay Wetland	A1, A4i, A4iii
Sandwich Harbour	A1, A4i, A4iii
Ichaboe Island	A1, A4i, A4ii, A4iii
Lüderitz Bay Islands	A1, A4i, A4iii
Possession Island	A1, A4i, A4ii, A4iii
Sperrgebiet	A1, A2, A3, A4i

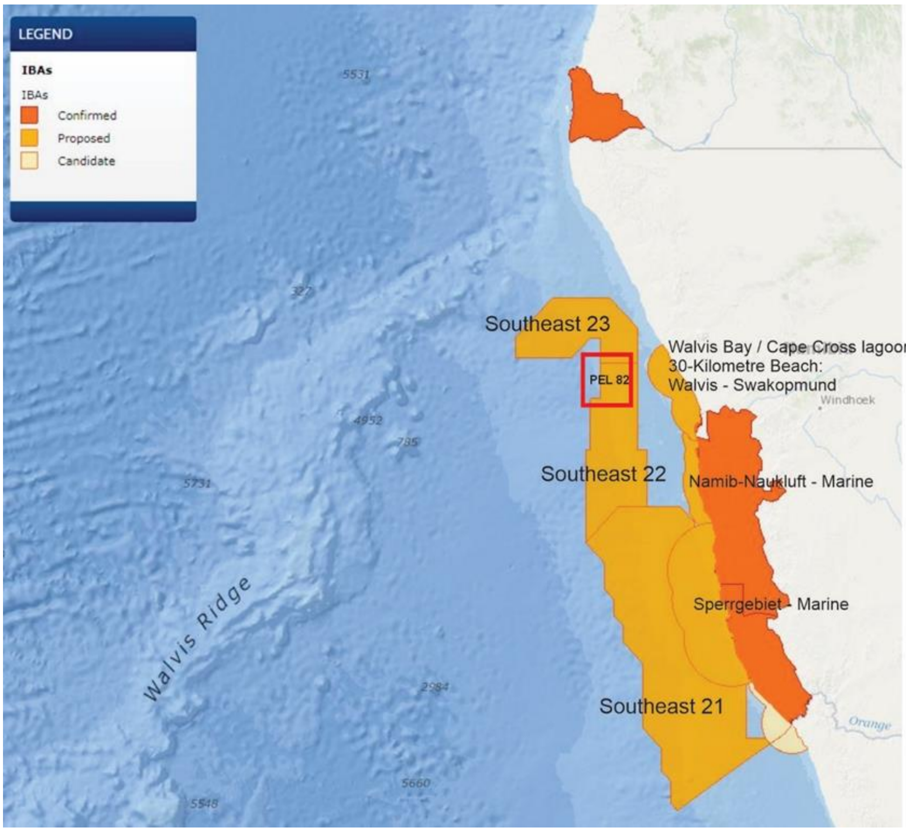
A1. Globally threatened species
A2. Restricted-range species
A3. Biome-restricted species
A4. Congregations
i. applies to 'waterbird' species
ii. This includes those seabird species not covered under i.
iii. modeled on criterion 5 of the Ramsar Convention for identifying wetlands of international importance. The use of this criterion is discouraged where quantitative data are good enough to permit the application of A4i and A4ii.

TABLE 3-10 LIST OF COASTAL RAMSAR SITES IN THE AREA OF INFLUENCE OF PEL 82.

Name	Size (ha)	Description
Walvis Bay Wetlands	10,550	Ramsar site no. 742. A tidal lagoon consisting of adjacent intertidal areas, Pelican Point, mudflats exposed at low tide, and sandbars serving as roosting sites. The site supports varying numbers of wetland birds (37,000 to 79,000 individuals); some species such as flamingos occur in large numbers. Eleven endangered bird species are regularly observed. Human activities include recreation and salt production. Residential development exists along the lagoon, and natural siltation may eventually lead to its infilling.
Sandwich Harbour	13,825	Ramsar site no. 743. Two distinct wetlands and associated mudflats. One is aquifer-fed and supports typical emergent vegetation, but is slowly disappearing due to natural causes. The second, under tidal influence, consists of mudflats and raised shingle bars. One of Namibia's most important coastal wetlands, supporting eight endangered species among the large numbers of wading birds. Several archaeological sites dating back 1,000 years exist within the site. The site is used for scientific research, with surrounding areas used for tourism, recreation, and angling.

Various marine IBAs have also been proposed in Namibian territorial waters, with a candidate trans-boundary marine IBA suggested off the Orange River mouth (Figure 3-38). PEL 82 overlaps with the proposed Southeast 22 and Southeast 23 Marine IBAs to protect Atlantic Yellow-nosed Albatross and White-chinned Petrel.

FIGURE 3-38 PEL 82 IN RELATION TO COASTAL AND MARINE IBAS IN NAMIBIA (SOURCE: HTTPS://MAPS.BIRDLIFE.ORG/MARINEIBAS).



3.3.2.8 IMPORTANT MARINE MAMMAL AREAS (IMMAS)

Important Marine Mammal Areas (IMMAs) were introduced in 2016 by the IUCN Marine Mammal Protected Areas Task Force to support marine mammal and marine biodiversity conservation. Complementing other marine spatial assessment tools, including the EBSAs and Key Biodiversity Areas (KBAs), IMMAs are identified on the basis of four main scientific criteria, namely species or population vulnerability, distribution and abundance, key life cycle activities and special attributes. Designed to capture critical aspects of marine mammal biology, ecology and population structure, they are devised through a biocentric expert process that is independent of any political and socio-economic pressure or concern. IMMAs are not prescriptive but comprise an advisory, expert-based classification of areas that merit monitoring and place-based protection for marine mammals and broader biodiversity.

Modelled on the BirdLife International process for determining IBAs, IMMAs are assessed against a number of criteria and sub-criteria, which are designed to capture critical aspects of marine mammal biology, ecology and population structure. These criteria are:

Criterion A – Species or Population Vulnerability

Areas containing habitat important for the survival and recovery of threatened and declining species.

Criterion B – Distribution and Abundance

Sub-criterion B1 – Small and Resident Populations: Areas supporting at least one resident population, containing an important proportion of that species or population, that are occupied consistently.

Sub-criterion B2 – Aggregations: Areas with underlying qualities that support important concentrations of a species or population.

Criterion C – Key Life Cycle Activities

Sub-criterion C1 – Reproductive Areas: Areas that are important for a species or population to mate, give birth, and/or care for young until weaning.

Sub-criterion C2 – Feeding Areas: Areas and conditions that provide an important nutritional base on which a species or population depends.

Sub-criterion C3 – Migration Routes: Areas used for important migration or other movements, often connecting distinct life-cycle areas or the different parts of the year-round range of a non-migratory population.

Criterion D – Special Attributes

Sub-criterion D1 – Distinctiveness: Areas which sustain populations with important genetic, behavioural or ecologically distinctive characteristics.

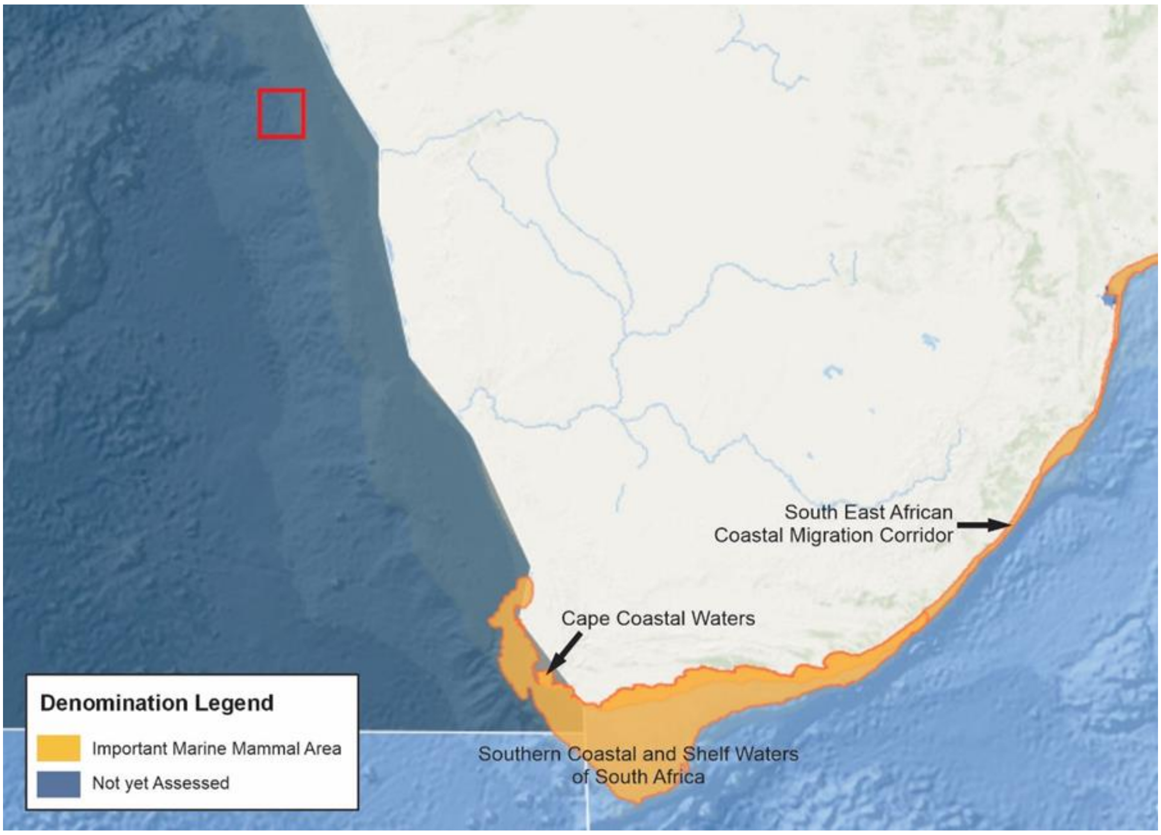
Sub-criterion D2 – Diversity: Areas containing habitat that supports an important diversity of marine mammal species

Although much of the west coast of southern Africa has not yet been assessed with respect to its relevance as an IMMA, the coastline from the Olifants River mouth on the South African West Coast to the Mozambiquan border overlaps with three declared IMMAs (Figure 3-39) namely the

- Southern Coastal and Shelf Waters of South Africa IMMA (166,700 km^2),
- Cape Coastal Waters IMMA (6,359 km^2), and
- South East African Coastal Migration Corridor IMMA (47,060 km^2).

These all lie well to the south of PEL 82.

FIGURE 3-39 PEL 82 (RED POLYGON) IN RELATION TO COASTAL AND MARINE IMMAS (SOURCE: WWW.MARINEMAMMALHABITAT.ORG/IMMA-EATLAS/).



3.3.3 ECOLOGICAL NETWORK CONCEPTUAL MODEL

Figure 3-40 provides a simplified conceptual model for the nearshore and offshore receiving environment on the West Coast illustrating key variables, processes, linkages, relationships, dependencies and feed-back-loops.

The upwelling of nutrients in the southern Benguela is the main driver that supports substantial seasonal phytoplankton production, which in turn serves as the basis for a rich food chain up through zooplankton, pelagic fish, cephalopods, and marine mammals, as well as demersal species and benthic fauna. High phytoplankton productivity in the upper layers again depletes the nutrients in these surface waters, resulting in a wind-related cycle of plankton production, mortality, sinking of detritus and eventual nutrient enrichment and remineralisation through the microbial loops active in the water column and on the seabed.

The natural annual input of millions of tonnes of organic material onto the seabed provides most of the food requirements of the particulate and filter-feeding benthic communities, resulting in the high organic content of the muds in the region. Organic detritus not directly consumed enters the seabed decomposition cycle, potentially resulting in the depletion of oxygen in deeper waters and the formation of hydrogen sulphide by anaerobic bacteria.

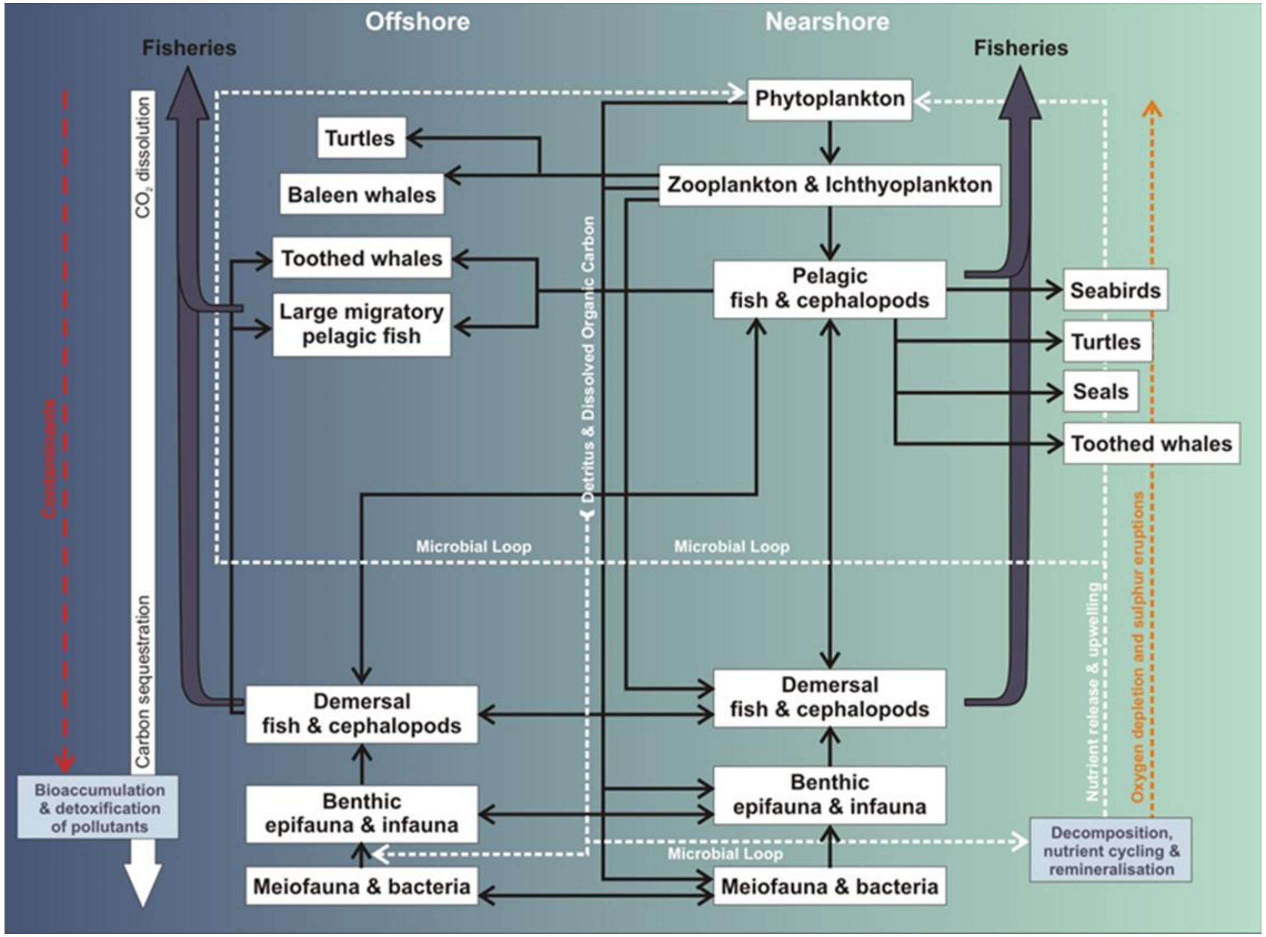
In the offshore oceanic environment in the vicinity of a seamount or a submarine canyon, similar processes of decomposition and remineralisation, upwelling of nutrients and enhanced localised primary and secondary production would apply, thereby serving as focal points for higher order consumers. The cold-water corals typically associated with seamounts and canyons also add structural complexity to otherwise uniform seabed habitats thereby creating areas of high biological diversity and the development of detritivore-based food-webs, which in turn lead to the presence of seamount scavengers and predators. Seamounts also provide an important habitat for commercial deepwater fish stocks.

Ecosystem functions of the offshore deepwater environment include the support of highly productive fisheries, the dissolution of CO_2 from the atmosphere and subsequent sequestering of carbon in seabed sediments, as well as waste absorption and detoxification. The structure and function of these nearshore and offshore marine ecosystems is influenced both by natural environmental variation (e.g. El Niño Southern Oscillation (ENSO)) and multiple human uses, such as hydrocarbon developments and the harvest of marine living resources.

A brief discussion of potential population-level and ecosystem-wide effects of disturbance and the application of the integrated ecosystem assessment framework for evaluating the cumulative impacts of multiple pressures on multiple ecosystem components is provided below. This focuses mainly on the ecosystem-wide effects of anthropogenic noise, as similar research approaches to determining the effects of exploration-well drilling and hydrocarbon production at population and ecosystem level are as yet lacking.

With growing evidence of the ecosystem-wide effects of anthropogenic noise in the ocean (Nieukirk *et al*. 2012; Kavanagh *et al*. 2019; Kyhn *et al*. 2019) and the potential consequences of sub-lethal anthropogenic sounds affecting marine animals at multiple levels (e.g. behaviour, physiology, and in extreme cases survival), there is increasing recognition for the need to consider the effects of anthropogenic noise at population and ecosystem level. The sub-lethal effects of sound exposure may seem subtle, but small changes in behaviour can lead to significant changes in feeding behaviour, reductions in growth and reproduction of individuals (Pirotta *et al*. 2018) and can have effects that go beyond a single species, which may cause changes in food web interactions (Francis *et al*. 2009; Hubert *et al*. 2018; Slabbekoorn & Halfwerk 2009).

FIGURE 3-40 SIMPLIFIED NETWORK DIAGRAM INDICATING THE INTERACTION BETWEEN THE KEY ECOSYSTEM COMPONENTS OFF THE SOUTHERN AFRICAN WEST COAST.



For example, the intensified upwelling events associated with the Cape Canyon, provide highly productive surface waters, which power feeding grounds for cetaceans and seabirds (www.environment.gov.za/dearesearchteam returnfromdeepseaexpedition). Roman & McCarthy (2010) demonstrated the importance of marine mammal faecal matter in replenishing nutrients in the euphotic zone, thereby locally enhancing primary productivity in areas where whales and/or seals gather to feed (Kanwisher & Ridgeway 1983; Nicol *et al*. 2010). Surface excretion may also extend seasonal plankton productivity after a thermocline has formed, and where diving and surfacing of deep-feeding marine mammals (e.g. pilot whales, seals) transcends stratification, the vertical movement of these air-breathing predators may act as a pump bringing nutrients below the thermocline to the surface thereby potentially increasing the carrying capacity for other marine consumers, including commercial fish species (Roman & McCarthy 2010). Behavioural avoidance of marine mammals from such seasonal feeding areas in response to increasing anthropogenic disturbance may thus alter the nutrient fluxes in these zones, with possible ecosystem repercussions.

Likewise, long-lived, slow-reproducing species play important stabilising roles in the marine ecosystem, especially through predation, as they play a vital role in balancing and structuring food webs, thereby maintaining their functioning and productivity. Should such predators be impacted by hydrocarbon exploration at population level, and this have repercussions across multiple parts of a food web, top-down trophic cascades in the marine ecosystem could result (Ripple *et al*. 2016).

At the other end of the scale, significant impacts on plankton by anthropogenic sources can have significant bottom-up ripple effects on ocean ecosystem structure and health as phytoplankton and their zooplankton grazers underpin marine productivity. Healthy populations of fish, top predators and marine mammals are not possible without viable planktonic productivity. Furthermore, as a significant component of zooplankton communities comprises the egg and larval stages of many commercial fisheries species, large-scale disturbances (both natural and anthropogenic) on plankton communities can therefore have knock-on effects on ecosystem services across multiple levels of the food web.

Due to the difficulties in observing population-level and/or ecosystem impacts, numerical models are needed to provide information on the extent to which sound or other anthropogenic disturbances may affect the structure and functioning of populations and ecosystems. Attempts to model noise-induced changes in population parameters were first undertaken for marine mammals using the population consequences of acoustic disturbance (PCAD) or Population Consequences of Disturbance (PCoD) approach (NRC 2005). The PCAD/PCoD framework assesses how observed behavioural responses on the health of an individual translates into changes in critical life-history traits (e.g. growth, reproduction, and survival) to estimate population-level effects. Since then, various frameworks have been developed to enhance our understanding of the consequences of behavioural responses of individuals at a population level. This is typically done through development of bio-energetics models that quantify the reduction in bio-energy intake as a function of disturbance and assess this reduction against the bio-energetic need for critical life-history traits (Costa *et al*. 2016; Keen *et al*. 2021). The consequences of changes in life-history traits on the development of a population are then assessed through population modelling. These frameworks are usually complex and under continual development but have been successfully used to assess the population consequences and ecosystem effects of disturbance in real-life conditions both for marine mammals (Villegas-Amtmann 2015, 2017; Costa *et al*. 2016; Ellison *et al*. 2016; McHuron *et al*. 2018; Pirotta *et al*. 2018; Dunlop *et al*. 2021), fish (Slabbekoorn & Halfwerk 2009; Hawkins *et al*. 2014; Slabbekoorn *et al*. 2019) and invertebrates (Hubert *et al*. 2018). The PCAD/PCoD models use and synthesise data from behavioural monitoring programmes, ecological studies on animal movement, bio-energetics, prey availability and mitigation effectiveness to assess the population-level effects of multiple disturbances over time (Bröker 2019).

There is a wealth of studies on the effects of drilling discharges on benthic communities (reviewed by Bakke *et al*. 2013; Beyer *et al*. 2020). Population and ecosystem effects from drilling discharges is relatively easy to study as they primarily affect the sediment ecosystem for which analysis of community responses to natural and anthropogenic disturbance has a long tradition in marine environmental monitoring (e.g. Gray *et al*. 1988, 1990). The sessile nature of benthic communities more readily facilitates repeated studies of the same sites to assess temporal changes and recovery over time. All evidence suggests that the effects of drilling discharges remain confined to within 1 - 2 km from an outlet both in the waters and on the seabed, that the risk of widespread impact from the operational discharges is low and that recovery of benthic communities at drill sites occurs within 4-10 years (Bakke *et al*. 2011). While some studies suggest that meiofauna respond to cuttings discharges in a similar way to macrofauna (Montagna & Harper 1996; Netto *et al*. 2010), there is, however, very little knowledge on the sensitivity of microfauna, epifauna, hyperfauna and coral and sponge communities to drilling discharges, and there is virtually no information of potential long term effects on benthic population and community functions such as production, reproduction, and trophic interaction (Bakke *et al*. 2013). It is also notoriously difficult to study the effects of drilling discharges on populations of higher order consumers (e.g. of commercial fish stocks) and the structure and function of marine ecosystems.

Although risk assessments on the effects of drilling discharges suggest that population-wide effects are unlikely, the possibility of subtle, cumulative effects from the operational discharges at population or ecosystem level cannot be ignored.

Ecosystem-based management is a holistic living resource management approach that concurrently addresses multiple human uses and the effect such stressors may have on the ability of marine ecosystems to provide ecosystem services and processes (e.g. recreational opportunities, consumption of seafood, coastal developments) (Holsman *et al*. 2017; Spooner *et al*. 2021). Within complex marine ecosystems, the integrated ecosystem assessment framework, which incorporates ecosystem risk assessments, provides a method for evaluating the cumulative impacts of multiple pressures on multiple ecosystem components (Levin *et al*. 2009, 2014; Holsman *et al*. 2017; Spooner *et al*. 2021). It, therefore, has the potential to address cumulative impacts and balance multiple, often conflicting, objectives across ocean management sectors and explicitly evaluate trade-offs. It has been repeatedly explored in fisheries management (Large *et al*. 2015) and more recently in marine spatial planning (Hammar *et al*. 2020; Carlucci *et al*. 2021; Jonsson *et al*. 2021; Harris *et al*. 2022).

However, due primarily to the multi-dimensional nature of both ecosystem pressures and ecosystem responses, quantifying ecosystem-based reference points or thresholds has proven difficult (Large *et al*. 2015). Ecosystem thresholds occur when a small change in a pressure causes either a large response or an abrupt change in the direction of ecosystem state or function. Complex numerical modelling that concurrently identifies thresholds for a suite of ecological indicator responses to multiple pressures is required to evaluate ecosystem reference points to support ecosystem-based management (Large *et al*. 2015).

The required data inputs into such models are currently limited in southern Africa. Slabbekoorn *et al*. (2019) point out that in such cases expert elicitation would be a useful method to synthesise existing knowledge, potentially extending the reach of explicitly quantitative methods to data-poor situations.

1.5 SUMMARY OF KEY SENSITIVITIES

Due to the high diversity of habitats and marine biota along the coast of central Namibia (several of which are of conservation concern), significant biodiversity importance is attributed to many areas inshore of PEL 82. The sensitivity, ecological value, and community relevance of key seabed features, shelf-edge habitats, and deep-water ecosystems overlapping with PEL 82 are summarised below under three thematic categories.

Seabed Features:

- Double Shelf Break: A distinct double shelf break occurs off Walvis Bay, with the outer break beginning at depths of approximately 400 metres, placing it within the eastern portion of PEL 82.
- Sediment Composition: The seabed within PEL 82 is predominantly composed of sandy muds, with muddy sands and sand more common in the eastern portion.
- Phosphate Deposits: PEL 82 overlaps marginally with known phosphate deposits, though the occurrence is low.
- Shelf and Slope Zones: The license block lies within the offshore Central Namib and Namib Biozones, extending beyond the shelf break onto the continental slope and into abyssal depths.
- Benthic Habitat Threat Status: While most of PEL 82 overlaps with benthic habitat considered of 'Least Concern', areas along the 500 m depth contour in the eastern

portion are classified as 'Vulnerable', and further inshore areas are considered 'Endangered'.

- Demersal Fish Communities: Up to 110 species of bony and cartilaginous fish have been recorded on the continental shelf of the southern African West Coast. However, demersal communities beyond the shelf break remain poorly understood.

Community Importance

- Commercial Fisheries: PEL 82 lies within key trawling lanes and shipping routes to and from Walvis Bay, indicating potential interaction with commercial fishing operations and coastal shipping.
- Spawning Grounds: The license area overlaps with spawning grounds for monkfish (northeastern corner) and orange roughy (southeastern corner), which are of economic and ecological importance to local fisheries.
- Marine IBAs: PEL 82 and potential flight paths from Walvis Bay overlap with the proposed Southeast 22 and Southeast 23 Marine Important Bird Areas (IBAs), designated to protect Atlantic Yellow-nosed Albatross and White-chinned Petrel.
- Ecological Support Areas: Although PEL 82 does not overlap with the impact management or conservation zones of adjacent Ecologically or Biologically Significant Areas (EBSAs), it does intersect with Ecological Support Areas by approximately 37.4%, which contribute to broader ecosystem functioning and services.

Ecological Sensitivity

- Inshore Biodiversity: The central Namibian coast hosts a high diversity of habitats and marine biota, many of which are of conservation concern. These areas are considered ecologically significant and sensitive to disturbance.
- Low Oxygen Events and Sulphur Eruptions: The nearshore region around Walvis Bay experiences episodic, large-scale low oxygen events and sulphur eruptions following the decay of extensive algal blooms. These phenomena can have catastrophic impacts on inner shelf marine communities.
- Pelagic Habitat Classification: The northeastern half of PEL 82 falls within a pelagic habitat classified as 'Endangered', while the remainder is rated as 'Least Threatened'.
- Migratory Pelagic Species: Large migratory pelagic species such as tunas, billfish, and sharks are likely to be encountered in PEL 82. Many of these are listed as threatened by the IUCN due to overfishing.
- Marine Turtles: Leatherback and Loggerhead turtles have been opportunistically recorded in offshore waters of PEL 82. Both species are globally listed as 'Vulnerable' by the IUCN.
- Cetaceans: Up to 33 species of whales and dolphins inhabit central Namibian waters. Humpback whales are the most frequently encountered baleen species in PEL 82, with possible year-round presence and seasonal peaks during northern and southern migrations.

- Seabirds: Eleven seabird species breed along the Namibian coast. The Cape Gannet is 'Critically Endangered', while the African Penguin, Bank Cormorant and Cape Cormorant are 'Endangered'. These species forage close to shore and are unlikely to interact with offshore drilling operations.
- Pelagic Seabirds: At least nine species of albatrosses, petrels and giant petrels occur offshore in the South Atlantic area. PEL 82 overlaps with the foraging range of incubating Atlantic Yellow-Nosed Albatrosses (Gough Island) and Black-browed Albatrosses (Bird Island, South Georgia), making encounters unlikely but possible.

4. DESCRIPTION AND ASSESSMENT OF POTENTIAL IMPACTS OF EXPLORATION WELL DRILLING ON MARINE AND COASTAL ECOLOGY

In the Strategic Environmental Assessment (SEA) for the coastal areas of the Erongo and Kunene Regions (Skov et al. 2007) it was identified that the offshore areas of the Kunene Region showed potential for oil and gas exploration. The subsequent SEA for the Bengula Current Large Marine Ecosystem noted that Namibia had commenced with the exploration for both oil and gas, with expansion of the industry expected over the medium term in response to rising energy prices. While it recognised that the exploitation of an oil and gas resource can act as an important catalyst for economic growth and development, the threat of marine pollution associated with oil and gas exploration and production was acknowledged and the potential impacts associated with exploration, construction, production and decommisioning were listed.

For this project, the identification and assessment of impacts relating specifically to the marine ecology cover the four main activity phases (Table 4-1) for an outline of the activities in these phases) of the proposed well-drilling project, namely:

- Pre-drilling Site Survey (PDSS)
- The Mobilisation Phase (MP)
- Operational Phase (OP)
- The Demobilisation Phase (DP)
- Unplanned Activities (UA)

4.1 IDENTIFICATION OF POTENTIAL IMPACTS

The interaction between these activities and the receiving environment leads to various environmental aspects, which may subsequently result in one or more impacts. The identified aspects and their potential impacts are summarised below, providing also the project phases during which the aspects would occur:

- Physical disturbance of the seabed during the pre-drilling ROV surveys (PDSS), discharge of residual cement and well installation (OP), or loss of equipment (UA)
- Disturbance and loss of seabed habitat and associated benthic macrofauna
- Accumulation of excess cement (from cementing and disposed drill cuttings on the seabed (OP)
    - Smothering of seabed habitat and associated benthic fauna
    - Toxicity and bioaccumulation effects on marine fauna
    - Reduced physiological functioning of marine organisms due to the biochemical effects on the water column and seabed sediments
- Discharge of drilling fluids and product water (OP)
    - Increased water turbidity and reduced light penetration
    - Reduced physiological functioning of marine organisms due to the biochemical effects on the water column and seabed sediments
- Alteration of the seabed habitat through the physical presence of subsea structures (placement and abandonment of wellhead) (OP), solidified excess cement (OP, DP), or loss of equipment (UA)
    - Increase in benthic and demersal biodiversity and biomass
- Introduction of invasive alien species in the ballast water of the drilling units (MP)
    - Threats to Benguela ecosystem biodiversity
- Increase in underwater and atmospheric noise levels by seismic equipment, drilling unit, support vessels and helicopters (PDSS, MP, OP, DP)
    - Disturbance / behavioural changes of coastal and marine fauna
    - Avoidance of key feeding areas
    - Effects on key breeding areas (e.g. coastal birds and cetaceans)
    - Abandonment of nests (birds) and young (birds and seals)
- Discharge of waste to sea (e.g. deck and machinery space drainage, sewage and galley wastes) from drilling unit and support vessels, and local reduction in water quality (PDSS, MP, OP, DP)
    - Reduced physiological functioning of marine organisms due to the biochemical effects on the water column and seabed sediments
    - Increased food source for marine fauna
    - Fish aggregation and increased predator-prey interactions
- Increase in ambient lighting from drilling unit and support vessels (PDSS, OP)
    - Disorientation and mortality of marine birds
    - Physiological and behavioural effects on marine fauna
    - Fish aggregation and increased predator-prey interactions
- Localised reduction in water quality due to accidental release of fuel into the sea, discharge of fuel during bunkering and discharge of hydraulic fluid due to pipe rupture

    - Toxic effects on marine biota and reduced faunal health
- Uncontrolled release of oil/gas from the well
    - Toxic effects on marine biota and reduced faunal health
    - Pollution and smothering of coastal habitats

4.2 INDUSTRY STANDARDS AND PRACTICE

The Oil and Gas industry bodies that promote and share information on good industry practice and guidelines are the International Petroleum Industry Environmental Conservation Association (IPIECA) and the International Association of Oil & Gas Producers (IOGP). Both bodies develop, share and promote good practice and knowledge to help the industry and improve its environmental and social performance.

TABLE 4-1 ASPECTS AND POTENTIAL IMPACTS REGISTER RELEVANT TO MARINE FAUNA

Activity Phase		Activity	Aspect	Potential Impact
1. Pre-Drilling Site Surveys		Presence and operation of survey vessels	Increase in underwater noise levels	Disturbance / behavioural changes to marine fauna
				Fish avoidance of key feeding areas
			Discharge of waste to sea (e.g. deck and machinery space drainage, sewage and galley wastes) and local reduction in water quality	Physiological effect on marine fauna
				Increased food source for marine fauna
				Fish aggregation and increased predator - prey interactions
			Increase in ambient lighting	Disorientation and mortality of marine birds
				Increased predator - prey interactions
2. Well Drilling	2.1 Mobilisation Phase	Transit of drilling unit and support vessels to drill site	Underwater noise levels	Disturbance of behaviour (foraging and anti-predator) and physiology of marine fauna
			Discharge of waste to sea (e.g. deck and machinery space drainage, sewage and galley wastes) and local reduction in water quality	Physiological effect on marine fauna
				Increased food source for marine fauna
				Increased predator - prey interactions
		Discharge of ballast water	Introduction of invasive alien species	Loss of biodiversity
2. Well Drilling.	2.2 Operation Phase	Operation of drilling unit and support vessels	Increase in underwater noise levels	Disturbance / behavioural changes to marine fauna
				Fish avoidance of key feeding areas
			Discharge of waste to sea (e.g. deck and machinery space drainage, sewage and galley wastes) and local reduction in water quality	Physiological effect on marine fauna
				Increased food source for marine fauna
				Fish aggregation and increased predator - prey interactions
		Operation of drilling unit and support vessels	Increase in ambient lighting	Disorientation and mortality of marine birds
				Increased predator - prey interactions
		Seabed ROV survey	Sediment disturbance	Physical damage to and mortality of benthic species / habitats
		Well drilling (including spudding)	Sediment disturbance	Physical damage to and mortality of benthic species / habitats
			Increase in underwater noise levels	Disturbance / behavioural changes to marine fauna
				Fish avoidance of key feeding areas
		Discharge of residual cement	Accumulation of cement on seafloor and sediment disturbance	Toxicity and bioaccumulation effects on marine fauna

Activity Phase		Activity	Aspect	Potential Impact
		Discharge of cuttings and drilling fluid	Accumulation of cuttings on seafloor and sediment disturbance	Smothering of benthic fauna
				Toxicity and bioaccumulation effects on marine fauna
				Increased water turbidity and reduced light penetration
				Physiological effect on marine fauna
		Placement of wellhead on seafloor	Increased hard substrate on seafloor	Increase in benthic biodiversity and biomass
		Well logging and VSP	Increase in underwater noise levels	Disturbance / behavioural changes to marine fauna
				Fish avoidance of key feeding areas
		Operation of helicopters	Increase in noise levels	Disturbance of coastal and marine fauna
				Avoidance of key breeding areas (e.g. coastal birds and cetaceans)
				Abandonment of nests (birds) and young (birds and seals)
		Plug well with cement	Accumulation of cement on seafloor and sediment disturbance	Disturbance / behavioural changes to marine fauna
				Toxicity and bioaccumulation effects on marine fauna

	Activity Phase	Activity	Aspect	Potential Impact
2. Well Drilling cont.	2.3 Demobilisation Phase	Abandonment of wellhead on seafloor	Increased hard substrate on seafloor	Increased benthic biodiversity and biomass
			Increase in underwater noise levels during transit	Disturbance to marine fauna
			Discharge of waste to sea (e.g. deck and machinery space drainage, sewage and galley wastes) and local reduction in water quality during transit	Physiological effect on marine fauna
				Increased food source for marine fauna
				Increased predator - prey interactions
		Drilling unit / support vessels leave drill site and transit to port or next destination	Increase in underwater noise levels during transit	Disturbance to marine fauna
			Discharge of waste to sea (e.g. deck and machinery space drainage, sewage and galley wastes) and local reduction in water quality during transit	Physiological effect on marine fauna
				Increased food source for marine fauna
				Increased predator - prey interactions
	2.4 Unplanned Activities	Dropped objects / Lost equipment	Increased hard substrate on seafloor	Physical damage to and mortality of benthic species / habitats
		Loss of fuel from vessel accident	Release of fuel into the sea and localised reduction in water quality	Effect on faunal health (e.g. respiratory damage) or mortality (e.g. suffocation and poisoning)
		Small instantaneous spills	Discharge of fuel into sea during bunkering and localised reduction in water quality	Effect on faunal health (e.g. respiratory damage) or mortality (e.g. suffocation and poisoning)
			Discharge of hydraulic fluid into sea due to pipe rupture and localised reduction in water quality	Effect on faunal health (e.g. respiratory damage) or mortality (e.g. suffocation and poisoning)
		Loss of well control / well blow-out	Uncontrolled release of oil / gas from well	Effect on faunal health (e.g. respiratory damage) or mortality (e.g. suffocation and poisoning)
				Smothering of coastal habitats

4.3 ASSESSMENT OF PLANNED ACTIVITIES

The possible impacts of petroleum exploration drilling activities on marine benthic communities in Namibia's EEZ have to date been insignificant because only 52 offshore hydrocarbonwells have been drilled in Namibia. A comprehensive knowledge base of the deep sea benthic environment off the southern African West Coast is therefore lacking. Although not directly comparable to Namibia, several studies have been conducted in other parts of the world (USA, Mexico, North Sea) where there has been full oil and gas field production since the 1970s (Neff 2005; OGP 2003; Trefry et al. 2013; IOGP 2016, to name a few). These studies provide an indication of possible impacts to benthic habitats that might be expected in future petroleum production activities in Namibia. The identified environmental aspects and the related potential impacts are discussed and assessed below using information from the international literature. The status of the potential impacts described below are negative, unless otherwise stated.

4.3.1 SUMMARY OF MODELLING RESULTS

This section summarises the findings of the various modelling studies, which inform the impact assessment for planned events. The modelling studies are provided in Appendix D and Appendix F of the main ESIA Report.

4.3.1.1 DRILL CUTTINGS DEPOSITION MODELLING STUDY

A Drill Cuttings Deposition Modelling Study was undertaken by ERM (2025a) to assess the spatial extent and environmental fate of discharged cuttings and muds during offshore drilling operations (refer to Appendix D in main ESIA Report). The study assumed a drilling duration of 16 days, with a one-day pause between each section to allow suspended solids to settle. Simulations extended to 21 days to account for post-discharge dispersion. It focused on two locations: the Gemsbok Well in Block 2112B and a potential second well in Block 2212A, in water depth ranging from 900 m to 1,500 m. Seasonal scenarios were modelled for March, June, September and December 2023.

The modelling accessed:

- Total Suspended Solids (TSS) concentrations in the water column
- Seabed accumulation of cuttings, WBM and NADF minerals and NABF
- Hydrocarbon concentrations on the seabed

Across all scenarios, TSS concentrations near the seabed exceeded the 35 mg/L threshold set by MARPOL Resolution MEPC.159(55) and the International Finance Corporation (IFC 2007). Surface water concentrations remained below this threshold.

To assess potential burial impacts, depositional thickness was compared against two conservative thresholds:

- 6.3 mm for instantaneous deposition (Smit *et al.* 2006, 2008)
- 5 cm/month for gradual deposition (Ellis & Heim 1985; MarLIN 2023)

Depositional thickness exceeded both thresholds at both well locations. The Gemsbok Well showed smaller impact areas, with deposition exceeding 6.3 mm generally within a 50 m radius, while the second potential well showed deposition within a 500 m radius (Table 4-2).

TABLE 4-2 SUMMARY OF CUTTINGS DEPOSITION RESULTS FOR THE GEMSBOK WELL AND THE POTENTIAL SECOND WELL LOCATION

Well	Month	Area (m^2) with Thickness> 5 cm threshold	Area (m^2) with Thickness> 6.3 mm threshold
Gemsbok Well (in Block 2112B)	March	4,157	15,869
	June	4,943	33,948
	September	2,574	6,424
	December	2,189	4,451
Potential second well location (in Block 2212A)	March	8,780	364,244
	June	13,212	219,030
	September	15,002	228,540
	December	15,814	243,553

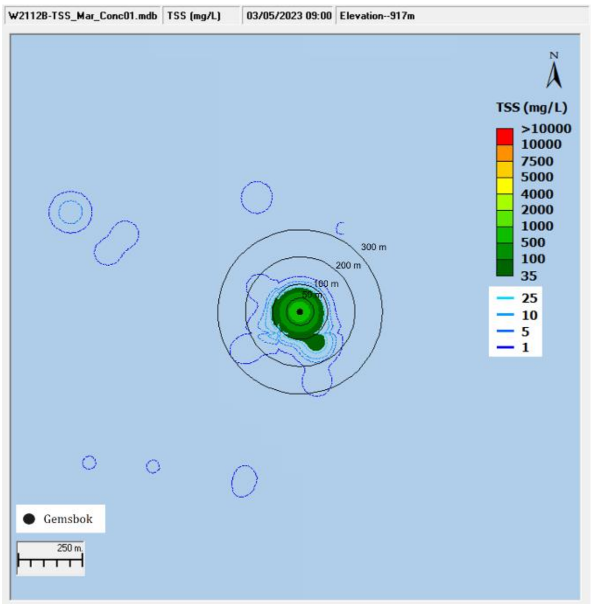
Source ERM, 2025a

Figure 4-1 and Figure 4-2 illustrate the maximum seabed areas where TSS concentrations exceeded the 35 mg/L threshold for each seasonal scenario at both well locations.

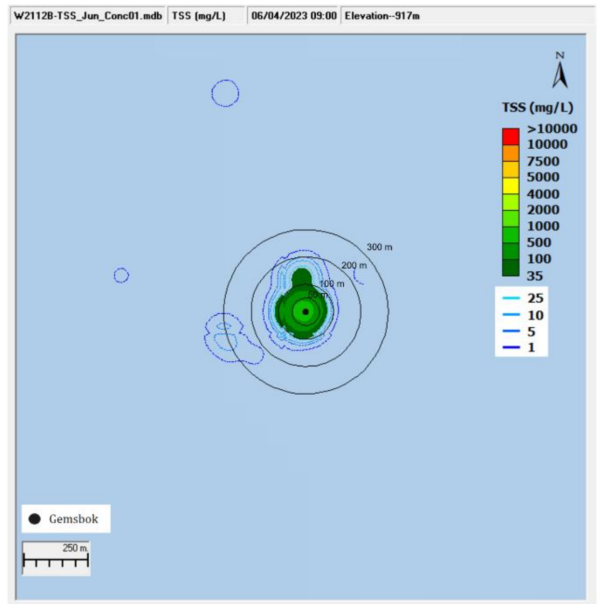
Hydrocarbon deposition from NABF was also evaluated. Although the 10 g/m² concentration threshold applied is not regulatory, it was used to delineate potential accumulation zones. The ecological significance of these concentrations remains uncertain and may warrant further investigation. Table 4-3 presents the seasonal variation in areas where hydrocarbon concentrations exceeded the 10 g/m² threshold. At the Gemsbok Well, the impacted area ranged from 0.619 km² in December to a peak of 6.860 km² in June. In comparison, the second well location exhibited a broader and more consistent impact, with affected areas ranging from 2.943 km² in December to 7.201 km² in June. These results demonstrate seasonal variability and suggest that the second well location may be subject to wider hydrocarbon dispersion, potentially due to differing oceanographic conditions.

FIGURE 4-1 MAXIMUM AREA OF TSS ABOVE THRESHOLD NEAR SEABED IN MARCH, JUNE, SEPTEMBER AND DECEMBER FOR THE GEMSBOK WELL

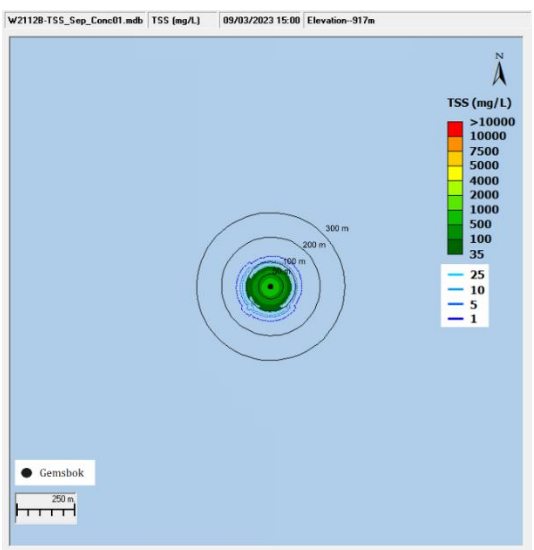
March



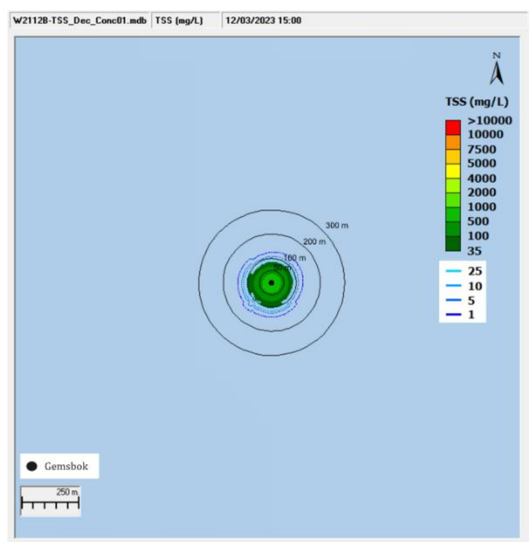
June



September



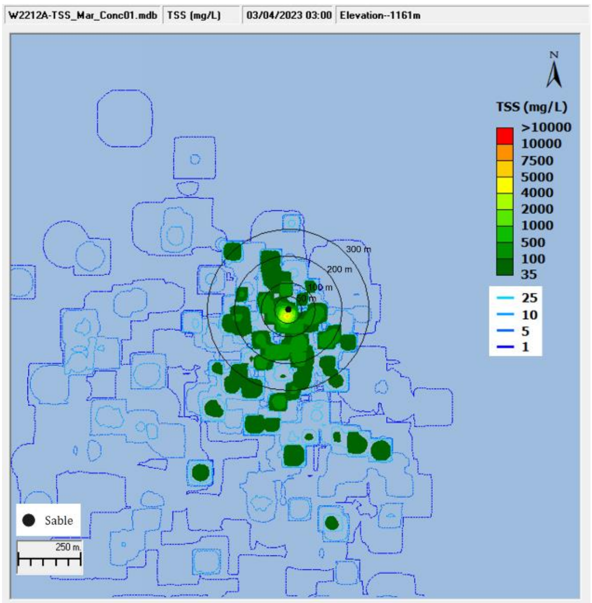
December



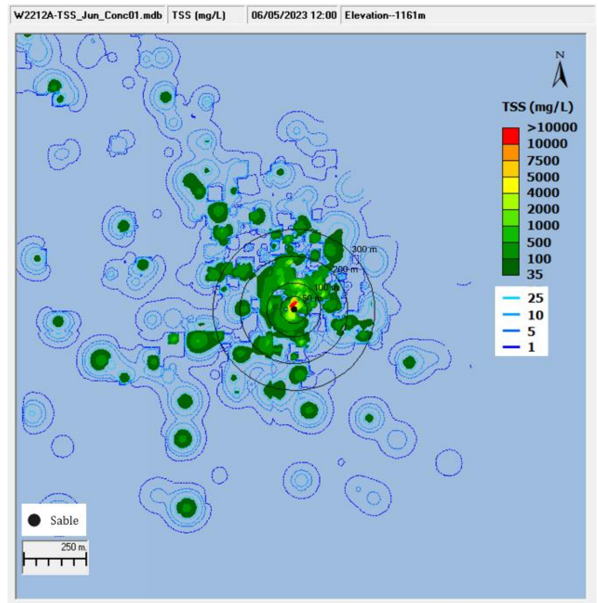
Source ERM, 2025a

FIGURE 4-2 MAXIMUM AREA OF TSS ABOVE THRESHOLD NEAR SEABED IN MARCH, JUNE, SEPTEMBER AND DECEMBER FOR THE POTENTIAL SECOND WELL LOCATION

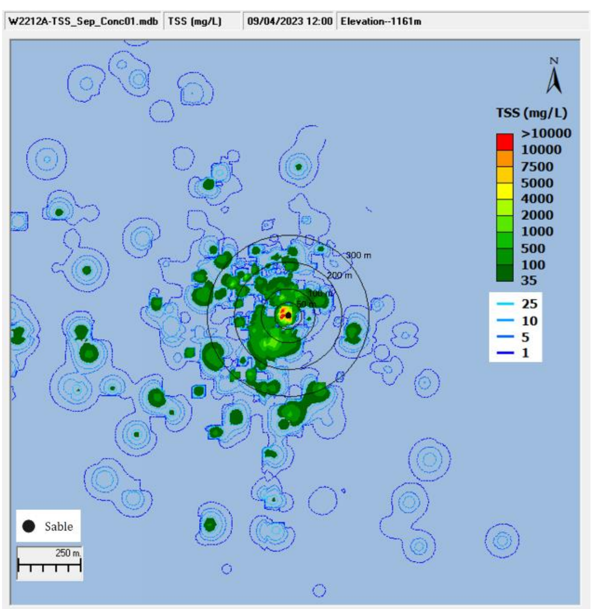
March



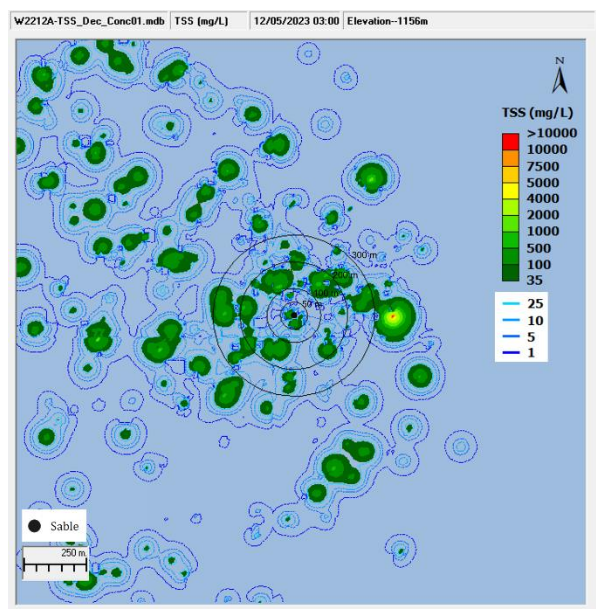
June



September



December



Source ERM, 2025a

TABLE 4-3 SUMMARY OF NABF CONCENTRATION RESULTS FOR THE GEMSBOK WELL AND THE POTENTIAL SECOND WELL LOCATION

Well	Month	Area (km^2) with NABF Concentration > 10 g/m^2
Gemsbok Well (in Block 2112B)	March	3.950
	June	6.860
	September	5.560
	December	0.619
Potential second well location (in Block 2212A)	March	5.128
	June	7.201
	September	2.965
	December	2.943

Source ERM, 2025a

4.3.1.2 UNDERWATER NOISE MODELLING

An Underwater Noise Modelling Study was conducted by ERM (2025c) to assess sound propagation and potential acoustic impacts from drilling and VSP activities at the Gemsbok well (Block 2112B) and a second potential well (Block 2212A) in PEL 82. The study aimed to model underwater acoustic propagation resulting from drilling and VSP operations, evaluate potential effects on marine mammals, fish and sea turtles and delineate potential impact zones associated with auditory injury, temporary threshold shifts (TTS) and behavioural disturbances. Noise impact criteria were established by reviewing the most current guidelines and scientific literature, addressing both physiological and behavioural responses in marine mammals, fish and sea turtles (refer to Appendix F in main ESIA Report).

Noise sources considered included drillship propellers and thrusters, riser drag, supply vessels and drilling operations. VSP, although unlikely to be undertaken, was included as a conservative scenario.

Detailed modelling predictions using ERM's proprietary Marine Mammal Noise Exposure Tool (MMNET), incorporating site-specific bathymetry, seabed characteristics and sound speed profiles were undertaken for noise emissions non-impulsive (drilling unit and support vessels) signals and from impulsive VSP. The potential zones of noise impact were estimated for different marine faunal species based on comparisons between established noise impact criteria for physiological and behavioural impacts (for marine mammals, turtles, fish and eggs and larvae[5]) and the modelled received noise levels. Sound transmission loss modelling was undertaken for two source locations within PEL 82 and the following scenarios:

- Single VSP pulse;
- Exposure to 50 VSP pulses over two hours;
- Cumulative exposure to 250 VSP pulses over 12 hours; and,
- Continuous non-impulsive noise - 24 hr exposure.

Source levels reached:

- 202 dB re 1 µPa RMS for drillship and support vessels;
- 242 dB re 1 µPa peak for VSP airgun arrays.

Thresholds were based on NOAA (2024), Southall et al. (2019), Popper et al. (2014) and Finneran et al. (2017).

Two modelling approaches were used:

- Drilling: SELcum calculated for animals swimming away from the source at 5.4 km/h, using AcTUP algorithms (RAMGEO and Bellhop) up to a distance of 50 km from the drilling location (taking into account swim speed) and then it remains stationary at this point for the rest of the 24-hour assessment period.
- VSP: SELcum calculated for stationary animals under 50-pulse (2-hour) and 250-pulse (12-hour) scenarios.

Key Findings:

<u>Marine Mammals</u>

The predicted potential impact zones for auditory injury (AUD INJ) and TTS from drilling noise are within 100 m of the source for all marine mammal hearing groups. Potential behavioural disturbance related to drilling may extend as far as 9.6 km from the Gemsbok well and up to 11 km from the second potential well, particularly in deeper waters.

For VSP, potential behavioural impact zones for low-frequency cetaceans may reach up to 400 m under a 250-pulse scenario and up to 200 m under a 50-pulse scenario at both wells. For other hearing groups, potential behavioural impact zones stay within 100 m of the source. Under the general 160 dB re 1 µPa RMS criterion for all marine mammals, potential behavioural impact zones are estimated to extend up to 300 m from the Gemsbok well and up to 400 m from the second well.

<u>Fish and Sea Turtles</u>

[5] The noise criteria for fish are presented in Tables 3.3 and 3.4 in the Noise Modelling Report.

Among fish species sensitive to sound, especially those with swim bladders used in hearing, non-impulsive sources such as drilling units and support vessels are expected to create recoverable injury zones within 100 m and TTS zones within 400 m of the source. Fish may exhibit behavioural responses at distances of up to 1 km.

For impulsive noise (VSP), potential impact zones for fish are mainly influenced by cumulative exposure to multiple VSP pulses, with potential impairment zones (TTS) remaining within 100 m and behavioural disturbances reaching about 400 m for both types of fish.

For sea turtles, predicted zones for potential auditory injury and TTS consistently remain within 100 m of both wells for both VSP and drilling activities. Potential behavioural impact zones for sea turtles are also confined to 100 m, although responses may still occur.

4.3.2 POTENTIAL MARINE BIODIVERSITY IMPACTS

4.3.2.1 PHYSICAL DISTURBANCE OF SEABED SEDIMENTS AND ASSOCIATED COMMUNITIES

Impact Description

The table below summarises the project activities that may physically disturb the seabed.

Activity phase	Activity
Pre-drilling Survey	Pre-drilling seabed sediment sampling
Mobilisation	n/a
Operation	Pre-drilling ROV seabed survey
	Drilling and spudding of the exploration well
	Removal of BOP
Demobilisation	n/a
Unplanned Activities	Accidental loss of equipment to the seafloor

These activities and their associated aspects are described further below:

- During pre-drilling surveys, a ROV is deployed to obtain video footage of the seabed at the proposed well location. Although the standard operating procedure is not to land or rest the ROV on the seabed, the ROVs thrusters can stir up the soft or silty sediments when operating close to the seabed. This resuspension of fine sediments would result in localised increased turbidity and potentially disturb seabed communities temporarily.

- The current well-design parameter is to have a wellbore diameter of 36 inch (91 cm) during spudding. The penetration of the seabed by the drill bit would physically disturb a surface area of 0.650 m^2 and displace deeper sediments into a conical cuttings pile around the wellhead. The drilling footprint for ten wells amounts to 6.57 m^2. Additionally, the installation of casings, wellheads and blowout preventers (BOP) would occupy approximately 78.54 m^2 per site, resulting in a total area of 785.40 m^2 for all wells.
- The removal of the BOP, which would include the use of a ROV, may also result in the localised disturbance of the seabed.

Project Controls

The proposed drilling operation will be undertaken in a manner consistent with good international industry practice.

Impact Assessment

DISTURBANCE OF SEDIMENTS DUE TO ROV SURVEYS

Resuspension of seabed sediments by ROV thrusters during pre-drilling ROV surveys may result in increased turbidity of the near-bottom water layers. This may place transient stress on sessile and mobile benthic organisms, by negatively affecting filter-feeding efficiency of suspension feeders or through disorientation of mobile species due to reduced visibility (reviewed by Clarke and Wilber 2000). However, in most cases sub-lethal or lethal responses occur only at concentrations well in excess of those anticipated due to resuspension of sediments by ROV thrusters. As marine communities in the Benguela are frequently exposed to naturally elevated suspended-sediment levels, they can be expected to have behavioural and physiological mechanisms for coping with this feature of their habitat.

The potential impact of increased turbidity and elevated suspended sediment concentrations on benthic communities due to disturbance of seabed sediments by ROV thrusters would be of negligible intensity, persist only temporarily (hours), and would be extremely localised (a few metres around the ROV and/or ROV flight track). Although disturbance of seabed sediments by thrusters is highly likely when the ROV is operating close to the seabed, the likelihood of an impact to benthic organisms occurring is considered remote and any potential adverse effects on sessile benthos would be negligible, with no loss of resources expected. With similar unconsolidated habitats nearby, receptor sensitivity is rated as low. The potential impact is considered to be fully reversible and can thus confidently be rated as being INCIDENTAL without mitigation.

Mitigation

No mitigation measures are proposed or deemed necessary over and above the standard operating procedure of not landing or resting the ROV on the seabed (Abate on site).

Residual Impact

This potential impact cannot be eliminated due to the necessity for pre-drilling ROV surveys. Thus the impact remains INCIDENTAL.

Seabed disturbance by ROVs during pre-drilling surveys		
	Without Mitigation	Assuming Mitigation
Type	Direct	
Extent	Local: limited to the operational area around the ROV	No mitigation is proposed
Duration	Short-term (Temporary): for duration of pre-drilling surveys	
Intensity	Negligible	
Significance	Incidental	
Likelihood	Remote	
Receptor Sensitivity	Low	
Reversibility	Fully reversible	
Loss of Resources	Low	
Mitigation Potential	None	

DISTURBANCE OF SEDIMENTS DUE TO DRILLING

The immediate effect of the physical disturbance and removal of seabed sediments on the benthos depends on their degree of mobility, with sedentary and relatively immobile species likely to be physically damaged or destroyed during the disturbances associated with well drilling or the accidental loss of irretrievable equipment6. Deep-water benthic fauna in unconsolidated sediments are expected to be relatively ubiquitous, usually comprising fast-growing species able to rapidly recruit into areas that have suffered environmental disturbance. Epifauna living on the sediment may, however, be longer-lived and, therefore,

[6] The rig/drillship will be dynamically positioned but equipment such as casings, pieces of drill string etc may be lost during operations. Loss of anchors may occur if the support vessels need to anchor.

more sensitive to disturbance. No rare or endangered species are known to occur in deep-water unconsolidated sediments. Overall, receptor sensitivity is therefore considered medium. In contrast, the benthos associated with hard substrata is typically vulnerable to disturbance due to their long generation times and sensitivity is thus considered high. However, considering the available area of similar habitat on and off the edge of the continental shelf in the Central Namib and Namib biozones, this disturbance of, and reduction in, benthic biodiversity can be considered negligible, and no cumulative effects on higher order consumers are expected.

Further loss or disturbance of the benthos due to smothering under the spoil mounds generated by disposal of drilling muds and cuttings are discussed below.

The low-intensity negative impact of physical disturbance and/or removal of benthic macrofaunal communities in unconsolidated seabed as part of well drilling would be extremely localised and persist only over the short term as recolonisation from adjacent areas will be rapid. The recovery of communities to functional similarity would however only occur over the long term. The removal and disturbance of sediments during drilling and spudding is unavoidable. The potential impact is, however, fully reversible and the loss of resources would be low. The potential impact can confidently be rated as being INCIDENTAL without mitigation.

Mitigation

In addition to the project controls, specifically avoiding spudding on any potential hardgrounds (using ROV footage and other survey data), the following measures will be implemented to mitigate the potential seabed disturbance impact:

No.	Mitigation measure	Classification
1	Establish clear operational procedures for ROVs to avoid seabed contact.	Abate on site
2	Conduct careful design of pre-drilling site surveys to collect sufficient information on seabed habitats, including mapping of sensitive and potentially vulnerable habitats within 500 m of a proposed well site., aiming to select level areas for spudding and well head installation..	Avoid
3	If sensitive habitats (such as hard grounds), sensitive species (e.g., cold-water corals, sponges), or significant structural features are detected, adjust the well position to beyond 500 m, or implement technologies, procedures, and monitoring to reduce risks and assess potential damage.	Avoid/ reduce at source

No.	Mitigation measure	Classification
4	Limit the area physically affected by infrastructure to the minimum required..	Avoid/ reduce at source

Disturbance of benthic macrofauna of unconsolidated sediments from drilling		
	Without Mitigation	Assuming Mitigation
Type	Direct	
Extent	Local: limited to the well site (s)	Local
Duration	Short-term: recolonisation from adjacent areas will be rapid	Short-term
Intensity	Negligible	Negligible
Significance	Incidental	Incidental
Likelihood	Likely	Likely
Receptor Sensitivity	Medium (unconsolidated sediments) to High (hard grounds)	
Reversibility	Fully reversible	
Loss of Resources	Low	
Mitigation Potential	None	

Residual impact

This potential impact cannot be eliminated due to the nature of the drilling approach. Thus the residual impact remains of INCIDENTAL significance.

4.4.2.2 ACCUMULATION OF CEMENT AND DISPOSED DRILL CUTTINGS ON THE SEABED

Description of the potential impact

The table below summarises the project activities that will result in accumulation of cement and drill cuttings on the seabed.

Activity phase	Activity
Pre-drilling Survey	n/a
Mobilisation	n/a
Operation	Discharge of drill cuttings at the well bore during the riserless stage
	Discharge of residual cement during the riserless stage
	Discharge of drill cuttings and NADFs below sea surface during the risered drilling phase
	Discharge of excess fluids and residual cement during plugging of well
Demobilisation	n/a

These activities and their associated aspects are described further below:

- The current well-design parameter is to have a wellbore diameter of 36 inch (91 cm) during spudding. The cuttings from the top-hole sections of the well (drilled with WBMs) are discharged onto the seafloor where they would accumulate in a conical cuttings pile around the wellhead. In the order of 1,487 MT of cuttings will be generated at the well bore. In addition to the cuttings, approximately 10,431 MT of WBM (discharged mineral mass) will be discharged onto the seafloor.
- After the first surface casing string is set in a well, specially designed cement slurries are pumped into the annular space between the outside of the casing and the borehole wall. To conduct effective cementing, an excess of cement is usually used. This excess (100 m3 in the worst case) emerges out of the top of the well onto the cuttings pile, where, due to the low temperatures and high pressures at the proposed well depth, it will dissolve slowly into the surrounding seawater.
- During the risered drilling stage, the primary discharge from the drilling unit would be the drill cuttings. For the current project, these are expected to comprise muds and sands ranging in size from 1 µm to 200 µm. The chemistry and mineralogy of the rock particles reflect the types of sedimentary rocks penetrated by the bit. Cuttings from lower hole sections (drilled with WBMs and/or NADFs) are lifted up the marine riser to the drilling unit and separated from the drilling fluid by the on-board solid control systems. The solids waste stream is fluidised with seawater and discharged overboard through the cutting chute, which is typically located >5 m below the sea surface. Cuttings released from the drillship would be dispersed more widely around the drill site by prevailing currents. In the order of 1,164 MT of cuttings and 139 MT of residual NADF will be discharged from the drill unit.

- Before demobilisation, the well(s) would be plugged, tested for integrity and abandoned, irrespective of whether hydrocarbons have been discovered in the reserve sections. Cement plugs would be set inside the well bore and across any reserve sections.

The potential impacts associated with the discharge of drill cuttings include:

- Direct disturbance, smothering or crushing of invertebrate benthic communities living on the seabed or within the sediments by the discharge of cuttings onto the seabed from the top-hole section of the well, the discharge of residual cement and the discharge of treated cuttings from the drill ship;
- Increased water turbidity and reduced light penetration through discard of treated cuttings from the drill ship resulting in indirect physiological effects on marine fauna or indirect effects on primary productivity (phytoplankton) in surface waters, and pelagic fish and invertebrate communities in the water column; and
- Physiological effects on marine fauna due to toxicity and/or bioaccumulation.

Project Controls

The Operator would monitor cement returns and would terminate pumping if returns are observed on the seafloor. Furthermore, it is the intention of the Operator to make sure that cementing operations are undertaken in a manner consistent with good international industry practice.

Project specifications for discharge of drill cuttings includes:

- Discharge of risered cuttings *via* a caisson at 10 m below surface to reduce dispersion of the cuttings in surface currents.
- Discharge of cuttings only in water >30 m depth;
- Should high-performance WBMs not be able to provide the necessary characteristics for drilling during the risered stage, a low toxicity Group III NADF will be used (PAH of <0.001 and < 1 mg/kg Hg and <3 mg/kg Cd);
- Treatment of cuttings offshore to reduce the oil content to <6.9% or less of dry cutting weight (offshore treatment and disposal" strategy).

Impact assessment

The discharge of cuttings at the seabed would have both direct and indirect effects on benthic faunal communities in the vicinity of the wellhead and within the fall-out footprint of the cuttings plume discharged from the drill rig.

SMOTHERING OF SEABED HABITAT AND ASSOCIATED BENTHIC FAUNA

The benthic fauna inhabiting unconsolidated sediments of the outer shelf and continental slope are very poorly known, but at the depths of the proposed well are expected to be relatively ubiquitous, varying only with sediment grain size, organic carbon content of the sediments and/or near-bottom oxygen concentrations. Considering the available area of similar habitat on and off the edge of the continental shelf in the Namib and Central Namib biozones, the disturbance of and reduction in benthic biodiversity due to cementing or the discard of cuttings can be considered negligible, and no cumulative effects on higher order consumers is expected.

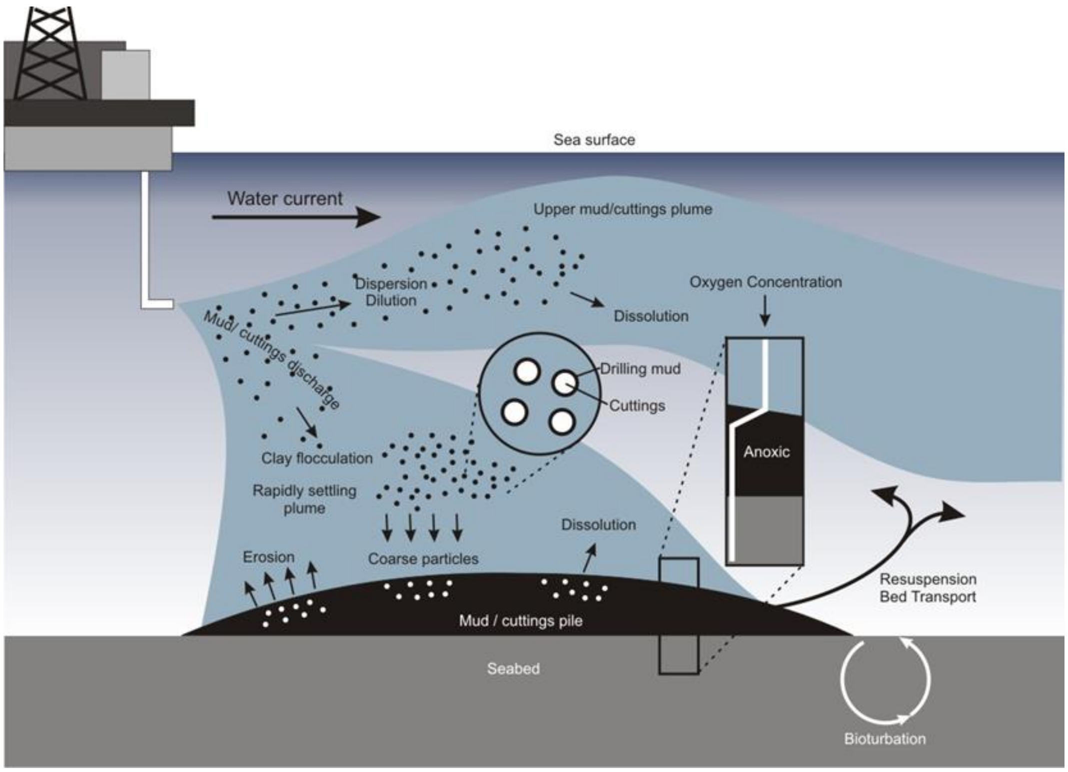
The effects of drilling mud and cuttings discharges on the benthic environment are related to the total mass of drilling solids discharged, whether these are discharged at the seabed or off the drilling unit, and the relative energy of the water column and benthic boundary layer at the discharge site. The total volume of cuttings discharged during the drilling of a well would be dependent upon the well depth and the drilling conditions encountered. With increasing well depth and concomitant decrease in both penetration rate and wellbore diameter, the rate of cuttings discharge decreases.

The cuttings discharged at the seabed during the spudding of a well would form a highly localised mound around the wellbore, thinning outwards. In contrast, the cuttings discharged from the drilling unit form two plumes as they are discharged. The heavier cuttings and flocculated clay/barite particles (>0.2 mm), which constitute 74% of the discharge, settle to the seabed near the wellbore while the fine-grained unflocculated solids and dissolved components of the mud (26% of the discharge) are dispersed in the water column at increasing distances from the drill unit (FIGURE 4-3). The dispersion pattern and degree of accumulation depends on water depth, current strength and the frequency of storm surges (Buchanan et al. 2003).

In high energy environments, accumulation of drilling waste on the seabed is minimal as the drilling solids are rapidly dispersed and redistributed. Under such conditions adverse effects of the discharges on benthic community composition are difficult to detect above the natural variability (Lees and Houghton 1980; Houghton et al. 1980; Bothner et al. 1985; Neff et al. 1989; Daan and Mulder 1993, 1996). Where changes in abundance and diversity of macrofaunal communities were detected, these were typically restricted to within about 100 m of the discharge, but did not persist much beyond 6 months after drilling operations had ceased (Chapman et al. 1991; Carr et al. 1996; Currie and Isaacs 2005).

In low-energy, deep-water environments, however, the effects of drilling waste discharges on benthic ecosystems are more severe and long-lasting. Typically, the coarse cuttings accumulate within 200 m of the drilling unit, although depending on the strength of prevailing current, some may disperse as far as 800 m from the drilling unit. Some authors report that cuttings piles near a rig can be 1-2 m high (Hinwood et al. 1994; Hartley et al. 2003; Neff 2005), but these were usually associated either with the disposal of NADF cuttings, which tend to aggregate once discharged and thus disperse less readily resulting in a smaller area but thicker deposition on the seabed, or with cuttings shunted to and discharged near the seabed. The results of recent international modelling studies and physical sampling exercises have indicated that the majority of discharges would have a maximum accumulated height of less than 8 cm, with a fine cover of less than 2 mm thickness likely to extend to ~0.5 km from the discharge point (Perry 2005).

FIGURE 4-3 HYPOTHETICAL DISPERSION AND FATES OF CUTTINGS FOLLOWING DISCHARGE TO THE OCEAN, IRRESPECTIVE OF DRILLING UNIT USED



The solids undergo dispersion, dilution, dissolution, flocculation, and settling in the water column. If the discharge contains a high concentration of organic matter, the cuttings pile may become anaerobic near the surface, before being altered by redox cycling, bioturbation, and bed transport (adapted from Neff 2005).

Studies have found that changes in abundance and diversity of macrofaunal communities in response to depositing cuttings were typically detected within a few 100 m of the discharge (Neff et al. 1992; Ranger 1993; Montagna and Harper 1996; Schaanning et al. 2008), with recovery of the benthos observed to take from several months to several years (most likely within 1 year) after drilling operations had ceased (Husky 2000, 2001a, 2001b; Buchanan et al. 2003; Neff 2005; Currie and Isaacs 2005). The potential environmental effects of drilling solids discharges have been discussed in several studies (Morant 1999; Husky 2000, 2001a; CAPP 2001; Hurley and Ellis 2004), all of which concluded that exploratory drilling has no measureable environmental effect on the marine environment.

The main potential impacts associated with the disposal of drilling solids would be smothering of sessile benthic fauna, physical alteration of the benthic habitat (changes in sediment properties) in the immediate vicinity (<200 m) of the well. The effects of smothering on the receiving benthic macrofauna are determined by 1) the depth of burial; 2) the nature of the depositing sediments; and 3) the tolerance of species (life habitats, escape potential, tolerance to hypoxia etc.) (Kranz 1974; Maurer et al. 1981a, 1981b, 1982, 1986; Bijkerk 1988; Hall 1994; Baan et al. 1998; Harvey et al. 1998; Essink 1999; Schratzberger et al. 2000b; Baptist et al. 2009).

Many benthic infaunal species are able to burrow or move through the sediment matrix, and some infaunal species are able to actively migrate vertically through overlying deposited sediment thereby significantly affecting the recolonisation and subsequent recovery of impacted areas (Maurer et al. 1979, 1981a, 1981b, 1982, 1986; Ellis 2000; Schratzberger et al. 2000a; but see Harvey et al. 1998; Blanchard and Feder 2003). Maurer et al. (1979) reported that some animals are capable of migrating upwards through 30 cm of deposited sediment. In contrast, consistent faunal declines were noted during deposition of mine tailings from a copper mine in British Columbia when the thickness of tailings exceeded 15-20 cm (Burd 2002), and Schaffner (1993) recorded a major reduction in benthic macrofaunal densities, biomass, and species richness in shallow areas in lower Chesapeake Bay subjected to heavy disposal (>15 cm) of dredged sediments. Similarly, Roberts et al. (1998) and Smith and Rule (2001) found differences in species composition detectable only if the layer of instantaneous applied overburden exceeded 15 cm. In general, mortality tends to increase with increasing depth of deposited sediments, and with speed and frequency of burial.

The survival potential of benthic infauna, however, also depends on the nature of the deposited non-native sediments (Turk and Risk 1981; Chandrasekara and Frid 1998; Schratzberger et al. 2000a). Although there is considerable variability in species response to specific sediment characteristics (Smit et al. 2006), higher mortalities were typically recorded when the deposited sediments have a different grain-size composition from that of the receiving environment (Cantelmo et al. 1979; Maurer et al. 1981a, 1981b, 1982, 1986; Smit et al. 2006; Smit et al. 2008), which would be the case in the discharge of drill cuttings. Migration ability and survival rates of organisms are generally lower in silty sediments than in coarser sediments (Hylleberg et al. 1985; Ellis and Heim 1985; Maurer et al. 1986; Romey and Leiseboer 1989, cited in Schratzberger et al. 2000a; Schratzberger et al. 2000b). Some studies indicate that changes to the geomorphology and sediment characteristics may in fact have a greater influence on the recovery rate of invertebrates than direct burial or mortality (USDOI/FWS 2000). The availability of food in the depositional sediment is, however, also influential.

The duration of burial would also determine the effects on the benthos. Here a distinction must be made between incidental deposition, where species are buried by deposited material within a short period of time (as would occur during drilling solids disposal), and continuous deposition, where species are exposed to an elevated sedimentation rate over a long period of time (e.g. in the vicinity of river mouths). Provided the sedimentation rate of incidental deposition is not higher than the velocity at which the organisms can move or grow upwards, such deposition need not necessarily have negative effects. The sensitivity to short-term incidental deposition is species dependent and also dependent on the sediment type, with deposition of silt being more lethal than a deposition of sand.

The nature of the receiving community is also of importance. In areas where sedimentation is naturally high (e.g. wave-disturbed shallow waters) the ability of taxa to migrate through layers of deposited sediment is likely to be well developed (Roberts et al. 1998). The life-strategies of organisms is a further aspect influencing the susceptibility of the fauna to mortality. Benthic and demersal species that spawn, lay eggs or have juvenile life stages dependent on the seafloor habitat (e.g. hake) may be negatively affected by the smothering effects of drill cuttings. Studies on the burrowing habits of 30 species of bivalves showed that mucous-tube feeders and labial palp deposit-feeders were most susceptible to sediment deposition, followed by epifaunal suspension feeders, boring species and deep-burrowing siphonate suspension-feeders, none of which could cope with more than 1 cm of sediment overburden. Infaunal non-siphonate suspension feeders were able to escape 5 cm of burial by their native sediment, but normally no more than 10 cm (Kranz 1972, cited in Hall 1994). The most resistant species were deep-burrowing siphonate suspension-feeders, which could escape from up to 50 cm of overburden. Meiofaunal species appear to be less susceptible to burial than macrofauna (Menn 2002).

There has recently been increasing focus on the impacts of drilling solids disposal on vulnerable deep-water coral communities in the Northeast Atlantic (Rogers 1999; Colman et al. 2005; www.coralreef.noaa.gov/deepseacorals/threats). As deep-water corals tend to occur in areas with low sedimentation rates (Mortensen et al. 2001), these benthic suspension-feeders and their associated faunal communities are likely to show particular sensitivity to increased turbidity and sediment deposition associated with cuttings discharges. Exposure of corals to drilling solids can result in mortality of the colony due to smothering, alteration of feeding behaviour and consequently growth rate, disruption of polyp expansion and retraction, physiological and morphological changes, and disruption of calcification. While tolerances to increased suspended sediment concentrations will be species specific, drilling mud concentrations as low as 100 mg/L have been shown to have noticeable effects on coral function (Roger 1999). Lepland and Mortensen (2008) identified that deep-water corals on the Norwegian shelf, downcurrent of a test well discharge, did not show clear differences in health status, although barite crystals derived from the drilling mud were present among trapped sediments in the skeleton cavities of dead coral polyps older than six years, with highest barite concentration found in a polyp older than 13 years. The impacts of drilling discharges on more fragile ecosystems such as cold-water corals are thought to persist for longer than recorded for soft-sediment communities (Fisher *et al.* 2014a, 2014b; Cordes *et al.* 2016). The potential occurrence of such sensitive deep-water ecosystems in the Walvis Basin area cannot be excluded. In addition, sensitive communities may also be expected on the seamounts associated with the Walvis Ridge, which is located approximately 300 km northwest and west of PEL 82. International best practice recommends that pre-drilling site surveys be carefully designed to provide sufficient information on seabed habitats on and in the vicinity of the proposed drill sites, and appropriate technologies and monitoring surveys implemented to reduce the risks of, and assess the damage to, vulnerable seabed habitats and communities should they occur in the target area (Jødestøl & Furuholt 2010; Purser & Thomsen 2012; Purser 2015). In this regard, a set-back distance of 610 m (2,000 ft) for sea surface discharge of drilling discharges from sensitive deep-water communities is mandated in US territorial waters.

The results of the cuttings dispersion modelling studies undertaken as part of this project (ERM 2025a) largely confirm the reports of international studies that predicted that the effects of discharged cuttings are localised (see Perry 2005). For the current project, ~2,650 MT of rock cuttings would be generated, of which 1,487 MT of uncontaminated cuttings would be discharged at the seafloor (~56% of the total volume of cuttings generated), with the remaining 1,164 MT discharged off the drill rig to the water column. In addition, approximately 10,431 MT of WBM (excluding the seawater portion) will be discharged onto the seafloor and 139 MT of residual NADF will be discharged from the drilling unit.

The cuttings discharged at the seabed during the riserless drilling stage during June and March were predicted to create a cone of >10 cm thick close to the wellbore, thinning outwards to a thickness of >6.3 mm over a maximum total area 33,948 m^2 (June) and 15,869 m^2 (March). Deposition exceeding 10 cm was generally confined to within a 50 m radius of the Gemsbok well (917 m depth). At the second modelled well site in 1,166 m depth, the cone at the wellhead was similarly predicted to be confined to within a 500 m radius of the well, thinning outwards to a thickness of >6.3 mm over a maximum total area of 364,244 m^2 (March). The maximum total predicted area affected by the seabed discharges (>6.3 mm) for 10 wells would thus be in the order of 36.4 km^2.

Once the marine riser has been set, cuttings would be released continuously near the sea surface from the drilling platform. These discharges would continue throughout the entirety of the drilling campaign and would experience greater dispersion as they settle through the water column resulting in a broad, deposit that extends from the wellhead in the direction of the prevailing current. Although the variation in current direction between the March and September scenarios modelled result in different directional spread of the particles, the overall maximum footprint for deposition of >50 mm for all four scenarios is confined to up to a maximum of ~150 m from the wellhead (potential second well location). The differences are mainly seen for the deposit thicknesses of <25 mm, which would constitute the finer fractions that remain in the water column for longer. The comparatively deep depths at the simulated well sites in combination with the low current speeds at the well location(s) therefore result in a high dispersion of the discharged drill cuttings, with deposition thicknesses <10 mm predicted for distances beyond ~1,000 m from the well location. Relatively rapid recolonisation of benthic fauna can thus be expected (see for example Kingston 1987, 1992; Trefry et al. 2013), with subsequent bioturbation playing an important role in the physical recovery of the seabed (Munro et al. 1997).

Although information on benthic communities beyond the shelf break is lacking, those on the shelf in the region show a high natural variability (Environmental Evaluation Unit 1996; Parkins and Field 1997, 1998; Pulfrich and Penney 1999; Goosen et al. 2000; Steffani and Pulfrich 2004a, 2007; Steffani 2007a, 2007b, 2009a, 2009b, 2009c, 2010a, 2010b, 2010c). The structure of the recovering communities beyond the shelf will thus likely be highly spatially and temporally variable. The community developing after an impact depends on (1) the nature of the impacted substrate, (2) environmental factors such as bedload transport, near-bottom dissolved oxygen concentrations etc., and (3) differential re-settlement of larvae into the area, migration of mobile species into the area and from burrowing species migrating upwards back to the surface. Indications of significant recruitments and natural mortalities in recovering succession communities on the southern African West Coast following marine diamond mining has provided evidence of natural disturbances (Pulfrich and Penney 1999; see also Savage et al. 2001). Short-term physical disturbance resulting from activities such as exploration well drilling, mining or dredging will thus be no more stressful than the regular naturally occurring anoxic events typical of the West Coast continental shelf areas.

Disturbance and smothering of benthic macrofauna due to the release of excess cement around the wellbore is of negligible intensity as the cement will be discharged in an area already affected by drill cuttings, extremely localised (i.e. confined to the wellbore footprint) and would persist only over the short term as excess cement will dissolve into the surrounding water. The potential impact is fully reversible, and the likelihood of the impact occurring would depend on the amount of excess cement released and is thus considered ‘occasional. The direct potential impact of smothering benthic communities can thus confidently be rated as being INCIDENTAL without mitigation.

The smothering effects resulting from the discharge of drilling solids at the wellbore is assessed to have an potential impact of medium intensity on the benthic macrofauna of unconsolidated sediments in the cuttings footprint, whereas discharges from the drilling unit would have a low intensity impact. In both cases, the potential impact is localised and recovery of benthic communities is expected over the short term as recolonisation from adjacent areas will be rapid. The recovery of communities to functional similarity would however only occur over the long term. Whereas smothering of benthos due to cuttings discharges at the wellbore is likely, the likelihood of smothering impacts due to discharges from the drilling unit is considered ‘occasional. Deep-water benthic fauna in unconsolidated sediments are expected to be relatively ubiquitous, usually comprising fast-growing species able to rapidly recruit into areas that have suffered environmental disturbance. Epifauna living on the sediment may, however, be longer-lived and, therefore, more sensitive to disturbance. No rare or endangered species are known to occur in deep-water unconsolidated sediments. Overall, receptor sensitivity is therefore considered medium. In contrast, the benthos associated with hard substrata is typically vulnerable to disturbance due to their long generation times and sensitivity is thus considered high. As the potential impact is fully reversible, it can thus be considered to be of MINOR significance without mitigation for discharges at the wellbore. For discharges from the drilling unit, the potential impact is fully reversible and can be considered INCIDENTAL. Although the well will be located in unconsolidated sediments, with known sensitive hard substrata associated with the Walvis Ridge some 300 km to the northwest of PEL 82, there is a possibility that hardgrounds occur in the license area. Should the cuttings footprint overlap with vulnerable communities on hard ground, the smothering effects would potentially have an impact of high intensity, and recovery would only be expected over the long-term due to their long generation times. In the unlikely event of the potential impact on vulnerable communities on hard ground occurring, it would be partially reversible and can thus be considered to be of MODERATE significance before mitigation.

Mitigation

No.	Mitigation measure	Classification
1	Conduct careful design of pre-drilling site surveys to collect sufficient information on seabed habitats, including mapping of sensitive and potentially vulnerable habitats within 500 m of a proposed well site., aiming to select level areas for spudding and well head installation.	Avoid / reduce at source

No.	Mitigation measure	Classification
2	Pre-drilling site surveys should be carefully designed to make sure that drilling locations are positioned at least 500 meters away from any vulnerable habitats (e.g., hard grounds), sensitive species (e.g., cold-water corals, sponges), or significant structural features.	Avoid / reduce at source
3	If sensitive and potentially vulnerable habitats are detected, adjust the well position accordingly or implement appropriate technologies, operational procedures and monitoring surveys to reduce the risks of, and assess the damage to, vulnerable seabed habitats and communities.	Avoid / reduce at source
4	Limit excess cement slurry during riserless drilling operations	Avoid / reduce at source
5	Monitor cement returns with an ROV and stop cement pumping if significant discharges are detected on the seafloor.	Reduce at source
6	Monitor (using ROV) hole wash out to reduce discharge of fluids, as far as possible.	Reduce at source

Residual impact

This potential impact cannot be eliminated due to the nature of the drilling approach, the necessity for cementing, and the need for and nature of the cuttings discharge. As no mitigation is proposed for communities in unconsolidated sediments (except for monitoring and the minimising discharge of cement), the significance of residual impacts would not change. For vulnerable seabed communities, however, the implementation of the above-mentioned mitigation measures would lower the intensity and probability of the potential impacts being realised, and the residual impact would drop to INCIDENTAL significance.

Smothering effects of residual cement and drilling solids discharge onto the seabed at the wellbore on soft sediment macrofauna		
	Without Mitigation	Assuming Mitigation
Type	Direct, Indirect	
Extent	Local: limited to within a 500 m radius of the well bore.	No further mitigation is proposed
Duration	Short-term: recovery is expected within a few years	
Intensity	Low (cementing) to Medium (cuttings)	
Significance	Minor	
Probability	Likely	
Receptor Sensitivity	Medium (unconsolidated sediments) to High (hard grounds)	
Reversibility	Fully reversible	
Loss of Resources	Low	
Mitigation Potential	None	

Smothering effects of drilling solids discharged at the surface on soft sediment macrofauna		
	Without Mitigation	Assuming Mitigation
Type	Direct, Indirect	
Extent	Local: limited to within a 2,000 m radius of the well site.	Local
Duration	Short-term: recolonisation is expected within a few years	Short-term
Intensity	Low: some biota will be smothered, but many will be capable of burying up through the deposited drilling solids	Low
Significance	Incidental	Incidental
Probability	Likely	Likely
Receptor Sensitivity	Medium	
Reversibility	Fully reversible	
Loss of Resources	Low	

Mitigation Potential	None

Smothering effects of drilling solids discharge at the surface on vulnerable seabed communities		
	Without Mitigation	Assuming Mitigation
Type	Direct, Indirect	
Extent	Local: limited to within a maximum radius of 2,000 m around the well bore.	Local
Duration	Medium to Long-term	Short-term
Intensity	High	Medium
Significance	Moderate	Incidental
Probability	Unlikely	Unlikely
Receptor Sensitivity	High	
Reversibility	Partially reversible	
Loss of Resources	Low	
Mitigation Potential	Medium	

TOXICITY AND BIOACCUMULATION EFFECTS ON MARINE FAUNA

The disposal of cuttings at the wellbore and from the drilling unit would have various direct and indirect biochemical effects on the receiving environment. The direct effects are associated with the contaminants contained in the drilling muds and cements used during drilling operations. The indirect effects result from changes to water and sediment quality and are discussed separately below. The cuttings themselves are generally considered to be relatively inert, but may contribute small amounts of trace metals and/or hydrocarbons to receiving waters (Neff et al. 1987). However, most of the metals associated with cuttings are in immobile forms in minerals from the geologic strata, and their composition will thus resemble that of natural marine sediments. The drilling muds on the other hand, are a specially formulated mixture of natural clays, polymers, weighting agents and/or other materials suspended in a fluid medium. The constituents and additives of the discharged muds may potentially have ecotoxicological effects on the water column and sediments. These are discussed further below.

Toxicity and bioaccumulation effects of residual cement

Various chemical additives are used in the cementing programme to control its properties, include setting retarders and accelerators, surfactants, stabilisers and defoamers. The formulations are adapted to meet the requirements of a particular well. Their concentrations, however, typically make up <10% of the overall cement used. There is potential for the leaching of the additives into the surrounding water column, where they would potentially have toxic effects on benthic communities, or the potential for bioaccumulation but dilution in the surrounding water column would be rapid. Furthermore, the additives have a low toxicity to marine life (Ranger 1993; Chevron 1994) and the organic additives are partially biodegradable.

Toxicity and bioaccumulation effects of Water-Based Muds (WBMs)

WBMs would be used to drill the first two sections of the well. These would be discharged at the seabed together with the drill cuttings. For the current project, it is estimated that the discharged mineral mass of WBMs will amount to 10,182 MT. This would be discharged at the seabed affecting a maximum area of some 15,814 m^2 around the wellhead. The primary issues related to the discharge of WBMs include bioaccumulation. Low concentrations of other typically biodegradable organic compounds are added to gain the desired density and drilling properties. Effects on the benthos is thus primarily physical, through accumulation of fine particles (disruption of filter feeding) or burial of epi- and in-faunal benthic organisms (Paine *et al.* 2014) as discussed above. However, some WBMs, particularly those containing glycols or organic long chain screen binding polymers, have been found to cause temporary organic enrichment of sediments, resulting in a reduction in abundance, biomass and diversity of sensitive macrofaunal species (Schaanning *et al.* 2008; Trannum *et al.* 2010, 2011), although enrichment effects on tolerant species have also been reported (Paine *et al.* 2014). Other sub-lethal effects of metals contained in barite (Edge *et al.* 2016) may play an additional role (see below), with lagged responses three to five years after drilling started suggesting chronic or indirect effects (Paine *et al.* 2014). Toxicity effects of WBMs are thus negligible.

Toxicity and bioaccumulation effects of residual Non-Aqueous Drilling Fluids (NADFs) on drill cuttings

WBMs are, however, not well suited for use in demanding drilling operations, such as highly deviated and horizontal wells, or for drilling the deeper sections of offshore wells. For the current project, should the WBMs not be able to provide the necessary characteristics, a low toxicity NADF will be used for the deeper sections of the well. NADF composition comprises barite, calcium chloride, a synthetic base oil, lime, and a mixture of surfactants, emulsifiers, thinners and viscosifiers. The drilling fluid and cuttings would be isolated from the marine environment by the marine riser and would be circulated back to the drilling unit between the well casing and riser pipe. Although most of the drilling fluids would be mechanically separated from the drilling cuttings, some NADF would remain adhered to the cuttings and would therefore reach the ocean. It is estimated that the discharged cuttings may contain up to 6.9% by weight of drilling fluid solids. During drilling of the deeper sections of the well, in the order of 139 MT of mud may be discharged to the sea with treated cuttings, with deposition to >6.3 mm affecting a maximum area of 364,244 m^2.

The fate of these drilling fluids in the marine environment differs from that of the WBMs used in the initial section of the well. Such cuttings do not clump when discharged, but disperse and settle over a wide area, preventing development of significant cuttings mounds and speeding biodegradation (Getliff et al. 1997). The heavier cuttings and particles settle near the wellbore where a localised smothering effect can be expected (see previous Section). The fines generate a plume in the upper water column, which is dispersed away from the drilling unit by prevailing currents, diluting rapidly to background levels at increasing distances from the drill unit. Despite the widespread dispersion of the cuttings, minor toxicity effects may occur in the water column and in the seabed sediments from the potential solution of the constituents and additives of the discharged muds.

The primary issues related to the discharge of NADFs thus include bioaccumulation and toxicity. The disposal of mud into the marine environment and its subsequent fate has been extensively investigated through field and laboratory studies (reviewed by Neff 2005). In general, it has been found that the impacts are insignificant in the open marine environment (Thomson et al. 2000; Hurley and Ellis 2004). The results of the studies are summarised below, focussing primarily on the constituents of WBMs as these would form the bulk of the discharge at the seabed (10,182 MT), with anticipated loss of NADFs in the cuttings discharged at the surface amounting to 139 MT.

Bioaccessibility of Metals

Several metals typically occur in significantly higher concentrations in drilling muds discharges than background concentrations in uncontaminated marine sediments. Barium (from drilling mud barite) is usually the most abundant metal in WBMs and NADFs, and is thus used most frequently as an indicator of drilling muds in sediments (Neff 2005). Increased levels of barium in the sediments surrounding wells have been recorded up to 65 km from drill sites (Neff et al. 1989) and persisting in the sediments for up to 1.5 years post-drilling (Steinhauer et al. 1994). Other metals, most of them associated with barite, often present at substantially higher concentrations in drilling muds than in natural marine sediments are chromium, lead, and zinc (Neff et al. 1989; Neff 2005 and references therein), with elevated concentrations of cadmium, arsenic, copper and mercury in near-field sediments (<500 m) also being recorded in some cases (Buchanan et al. 2003). However, due to the low solubility of barite in seawater and in anoxic marine sediments, these metals do not dissolve from the barite and leach into sediment pore water and are thus not bioavailable to benthic fauna and do not bioaccumulate in the marine food chain (Neff 2005 and references therein). Lead appears to be the only metal that is bioavailable in some cuttings piles.

Bioaccessibility of Drilling Mud Ingredients

The requirements for toxicity testing differ worldwide, with some countries requiring testing on whole muds, whereas others require testing of the individual mud components. The overall conclusion drawn from these tests is that the majority of the components of WBMs currently used in offshore drilling operations constitute a low risk of chemical toxicity to marine communities.

As the most abundant solid ingredient in both WBMs and NADFs particulate barite is almost insoluble and non-biodegradable, and thus essentially inert toxicologically to marine organisms. In chronic exposure studies with benthic shrimp *Palaemonetes pugio* barite accumulated in the exoskeleton, hepatopancreas, and muscle tissue, with ingestion damaging the epithelial tissue of the gut (Neff 2005). Tagatz and Tobia (1978) reported that although barite-rich sediments did not prevent recruitment of several planktonic larvae of polychaetes and mussels, fewer individuals and species colonised sediments covered by a thin layer of barite. No adverse effects on faecal production, growth, and adults tube production were observed in the polychaete *Mediomastus ambiseta* living in barite-covered sediments, although migration out of patches of 100 % barite was observed (Starczak et al. 1992). Olsgard and Gray (1995) suggested that the effects of barite are more likely to be detected at a community level than at individual species levels.

Most toxicological studies have determined that sensitivity to barite was related to physical interactions with gills, the gastrointestinal tract, and integument due to elevated concentrations of particulate barite in suspension, rather than to direct chemical toxicity (see for example Barlow and Kingston 2001). Dilute suspensions have been shown to inhibit gonad development (Cranford et al. 1999), and food ingestion rates in the scallop *Placopecten magellanicus* leading to reduced growth rates and increased mortality (Muschenheim and Milligan 1996). In contrast, Cranford et al. (1998) reported no significant effect on survivorship or growth following acute and chronic exposure of scallops to 100 mg/l water-based drilling mud. At concentrations >1 000 mg/L, Barium (as barite) was toxic to embryos of the crab *Cancer anthonyi* (MacDonald et al. 1988). Most bioassays have produced effects at median lethal concentrations >7,000 mg/L suspended barite (National Research Council 1983, in Neff 2005).

Bentonite, the second most abundant ingredient of WBMs, is a naturally occurring, insoluble and non-biodegradable clay added to drilling muds to provide viscosity. When in suspension, the clay-sized bentonite solids have smothering effects through burial and clogging of the gills, ultimately leading to mortality (Cabrera 1971; Sprague and Logan 1979). It may cause physical damage through abrasion and erosion (Sprague and Logan 1979), or shading effects reducing photosynthesis in the alga (Neff 2005). In particular, clay additives have been found to induce changes in respiratory and cardiac activities in cod, haddock, salmon and rays exposed to concentrations up to 40 mg/L for 2-5 minutes (Shparkovski et al 1989) with reduced survival in cod and flounder at 5 mg/L for exposures of 10-30 days (Kozak and Shparkovski 1991). Dethlefsen et al. (1996) also reported some indications of effects of WBMs on fish embryos and larvae. However, once the clay settles to the bottom, no further effects were observed (Carls and Rice 1984). Most 96-h acute toxicity studies have thus found bentonite to be non-toxic, with LC_{50}s ranging from 22,000 to >100,000 ppm for various organisms.

In modern WBMs, bentonite has been supplemented or replaced by organic polymers (e.g. carboxymethyl cellulose, hydroxyethyl cellulose, guar gum), which are primarily used in shallow parts of a well due to their poor thermal stability. These organic polymers are similarly non-toxic to aquatic organisms, but being highly biodegradable, require a biocide to control bacterial growth. The biocide most frequently used is gluteraldehyde (a liquid derivative of glutaric acid), which is a toxic irritant. However, when discharged to the marine environment, it is rapidly destroyed by biological degradation and reduction by oxidation of organic matter. Gluteraldehyde is moderately toxic to non-toxic to various freshwater and marine animals with LC_{50}s ranging from >6-2,200 ppm for several crustaceans. If used in excess in polymer muds, sufficient gluteraldehyde could persist in the mud/cuttings plume to be toxic to pelagic organisms.

Some of the inorganic salts added to WBM for alkalinity/pH or shale control are slightly toxic to freshwater plants and animals due to their ionic or pH effects. Caustic soda is corrosive. Because of the high ionic strength and buffer capacity of seawater, it is unlikely that these salts would be toxic to marine organisms at the concentrations at which they occur in drilling muds.

Some chrome and ferrochrome lignosulfonate thinners used in WBMs are slightly toxic to marine organisms (Neff 2005). Chronic toxicity testing identified that their effects include alterations in feeding behaviour of lobsters; cessation of swimming by crab and mysid larvae, inhibition of shell formation, reduced rate of shell regeneration, and damage to gills in various molluscs; reduction in calcification, respiration, and growth rates of corals; and a decrease in growth rate, depressed heart rate, developmental abnormalities, and reduced survival of several marine fish species. Whether these effects would be manifested under conditions of exposure to discharged drilling muds and cuttings is uncertain, as field studies have generally failed to find evidence of the long-lasting ecological impacts of lignosulfonate muds near WBM and cuttings discharges. Nonetheless, chrome lignosulfonates have to some extent been replaced with less-toxic chrome-free lignosulfonate salts. Other clay thinners, such as lignites and tannins, are not toxic.

Of the minor additives (based on volumes discharged) sometimes used in WBMs, the most toxic include diesel fuel, corrosion inhibitors, detergents, defoamers, and emulsion breakers. Toxicity of whole drilling mud was attributed primarily to chrome, in cases where chromate and chrome lignosulfonate concentrations in the mud were very high (Conklin et al. 1983). Other additives such as zinc-based H_2S scavengers, tributyl phosphate surfactant defoamers, and fatty acid high-temperature lubricants are also toxic, but are usually not present in concentrations high enough to contribute significantly to whole mud toxicity. Where hydrocarbons are added to the mud to aid in lubricating the drill string or to free stuck pipes, the toxicity of WBM to water column and benthic marine animals increases significantly (Breteler et al. 1988). Although common in the past, this practice is seldom implemented today. Drilling fluids containing a high-sulfur diesel fuel (Group I NADFs containing 25% total aromatic hydrocarbons) are the most toxic, followed by those containing a low-sulfur diesel (containing 8.7% total aromatics); drilling fluids containing a low-aromatic mineral (Group III NADFs) oil were the least toxic.

In addition to the multitude of ecotoxicological studies undertaken to date, many field monitoring studies have been performed since the 1970s to determine short- and long-term impacts of drilling discharges on the marine environment (e.g. Neff et al. 1989; Daan et al. 1992; Steinhauer et al. 1994; Hyland et al. 1994; Olsgard and Gray 1995, amongst others). Most of the monitoring conducted prior to 1993, focused on the impacts of OBMs cuttings discharges. Some of these earlier studies (e.g. Neff et al. 1989; Steinhauer et al. 1994; Hyland et al. 1994) reported no detectable changes in benthic communities that could be attributed to oil and gas extraction, possibly due to dispersal of drilling mud solids over a wide area in the high-energy environment in which the drilling occurred (Neff et al. 1989). Many monitoring studies, however, showed a clear chemical contamination gradient of sediment within a few hundred metres of the well, decreasing beyond 750 m (Daan et al. 1992; Hernandez Arana et al. 2005), but in some cases still being detectable at distances of several kilometres from the well (Olsgard and Gray 1995), and persisting over the long term (>15 years) (OSPAR 2008). These contamination gradients manifested themselves as reduced abundance and biomass of dominant faunal species that serve as food for demersal fish, declines in diversity and loss of sensitive macrofaunal species, with an increase in abundance of opportunistic species (IOGP 2003, 2016). The effects were shown to be predominantly linked to the presence of total hydrocarbons, barium and strontium. Although taint studies on fish caught near North Sea platforms discharging OBM cuttings where unable to determine an off taste (reviewed in Davies et al. 1983), Husky (2001b) reported external lesions (indicative of contaminant stress) in fish in the vicinity of drilling sites. Similarly, cod and haddock from a Norwegian oil field were found to have different lipid content or lipid composition of the cell membranes, possibly due to the fish feeding on old NADF cuttings piles (OSPAR 2008). The physical and physiological impacts to benthic fauna, were found to be greater at depths of <600 m, whereas at depths >600 m impacts tend to be lower as increased water depths allow small particles to disperse over greater distances, thereby lessening the effects on the benthos (IOGP 2016).

Table 4-4 below provides a summary of acute toxicities of the ingredients of WBMs and NADFs to marine algae and animals. Neff (2005) notes that the requirements for toxicity testing of drilling mud and drilling mud ingredients differ in different regions of the world. In the U.S., a mysid (crustacean), *Americamysis [Mysidopsis] bahia*, is used for toxicity tests with dispersions of used whole drilling muds. In contrast, the North Sea countries test the individual drilling mud components with at least three organisms from different taxonomic levels: alga, crustacean, fish. In Russia, toxicity testing is undertaken with several species on individual drilling mud components.

Biological effects associated with the use of NADFs are not typically found beyond 250 – 500 m from the drilling unit (Husky 2000, 2001a; Buchanan et al. 2003; OGP 2003). The potential for significant bioaccumulation of NADFs in aquatic species is unlikely due to their extremely low water solubility and consequent low bioavailability (OGP 2003). However, certain hydrocarbons are known to have tainting effects on fish and shellfish. Sediment toxicity tests for NADFs have shown that these base fluids have relatively low toxicity to sessile organisms with LC_{50} >1,000 mg/L. Esters are the least toxic and impacts to benthic community structure did not persist beyond 2 years (reviewed by OGP 2003). This was followed by internal olefin and polymerised olefin, where complete recovery of impacted communities was anticipated within 3 – 5 years (Neff et al. 2000). The differences in toxicity may be due to differences in molecular size and polarity, which affects water solubility and bioavailability (OGP 2003).

With changes to the use of WBMs and low-toxicity NADFs, field results have clearly indicated "a reduction in environmental contamination and biological impact, compared to effects reported … for OBM drill cuttings" (Olsgard and Gray 1995). Due to the low acute and chronic toxicities of WBMs and NADFs to marine life, and as a result of the high dilution and wide dispersal of the dissolved and particulate components following discharge, the effects of these muds are restricted primarily to the seabed in the immediate vicinity of the drilling unit and for a short distance downcurrent from the discharge (OSPAR 2008). Rather than direct chemical toxicity, impacts to sessile marine organisms arise primarily through smothering effects (see previous Section) and oxygen depletion due to rapid biodegradation of the base fluid in the sediment (see Section below).

TABLE 4-4 ACUTE TOXICITIES, MEASURED AS MEDIAN LETHAL CONCENTRATION (LC50) AFTER 48 – 96 HOURS, AND EXPRESSED AS MG/L (PPM) OF THE INGREDIENT OR ITS SUSPENDED PARTICULATE PHASE (SUMMARIZED FROM NEFF 2005).

Ingredient	Range of LC_{50} for different species (mg/L)
Weighting Materials	
Barite (barium sulfate: $BaSO_4$)	385[a] - >100,000
Hematite (iron oxide: $Fe2O_3$)	>100,000
Siderite (iron carbonate: $FeCO_3$)	>100,000
Viscosifiers	
Bentonite (montmorillonite clay)	9,600[a] - >100,000
Hydroxyethyl cellulose (HEC) polymer/viscosifier	7,800 – 29,000
Sodium carboxymethyl cellulose (CMC)	500[a] - >100,000
Polyanionic cellulose	60,000 – 100,000
Organic polymers	7,800 - >100,000
Xanthan gum	420
Salts for pH and Shale Control	
Potassium chloride (KCl: muriate of potash)	2,100[b]
Lime (CaO)	70 – 450[b]
Calcite (calcium carbonate: $CaCO_3$)	>100,000
Sodium hydroxide (NaOH: caustic soda)	105 – 110[b]
Lost Circulation Materials	
Mica	>7,500
Jellflake® shredded cellophane	>7,500
Thinners, Clay Dispersants	
Ferrochrome lignosulfonate	12 – 1,500
Chrome lignosulfonate	12,200 – 100,000
Chrome-treated lignosulfonate	465 – 12,200
Chrome-free lignosulfonate	31,000 – 100,000
Iron lignosulfonate	2,100
Modified chrome lignite	20,100
Potassium lignite	>100,000

Ingredient	Range of LC_{50} for different species (mg/L)
Carbonox® lignitic material	6,500 - >7,500
Generic lignite	>15,000
Sulfomethylated tannin	33,900 - >100,000
Sodium acid pyrophosphate ($Na_4P_2O_7$)	870[b] - >100,000
Lubricants	
Diesel fuel	0.1 – 1 112
Fatty acid high pressure lubricant	3,500 - >100,000
Blended organic ester lubricant	10,400 – 49,400
Graphite	86,500
Other Additives	
Corrosion inhibitors (several types)	2.0 – 7,000
Ammonium bisulfite corrosion inhibitor	75,000
H_2S scavengers (zinc salts)	235 – 7,800
Low MW polyacrylate reverse breaker	3,500
Polyacrylate scale inhibitor	77,300
Scale inhibitors	>10,000
Glutaraldehyde (biocide) (25 %)	41 – 465
Flocculant WT-40	5,300
Surfactants	40 – 429
Detergents	0.4 – 340
Defoamers	5.4 – 84
Tributyl phosphate surfactant defoamer	5,100
Emulsion breakers	3.6 - 930
Oxygen scavenger (sodium bisulfite)	175 – 185

LC_{50} median lethal concentration; measure of toxicity that will kill 50 % of a given population of organisms in a specified period.

[a] microalgal test; effects probably caused by turbidity.

[b] Freshwater species used in test; marine species expected to be more tolerant due to high ionic strength and buffer capacity of seawater

In summary, although several metals typically occur in significantly higher concentrations in drilling muds than in uncontaminated marine sediments, most of these are not bioavailable to benthic fauna and thus do not bioaccumulate in the marine food chain. Toxicity testing of WBMs and NADFs in use today has indicated that they constitute a low risk of chemical toxicity to marine communities. The two most abundant ingredients in WBMs, barite and bentonite, are insoluble and non-biodegradable. Other additives such as gluteraldehyde, inorganic salts and lignosulfonate thinners are only mildly toxic to marine life, but are present in such low concentrations that evidence of long-lasting ecological impacts are lacking. The most toxic additives include diesel fuel, corrosion inhibitors, detergents, defoamers, and emulsion breakers, but are usually not present in concentrations high enough to contribute significantly to whole mud toxicity. Similarly, the potential for significant bioaccumulation of SBMs in the marine environment is unlikely due to their extremely low water solubility and consequent low bioavailability. Due to the high dilution and wide dispersal of the dissolved and particulate components of NADFs, the biological effects associated with their use typically do not extend beyond 250 – 500 m from the drilling unit, with complete recovery of impacted communities being predicted within 3 – 5 years.

For the current project, the total maximum predicted area affected by seabed discharges of >50 mm thickness of WBMs would be in the order of 15,814 m^2, whereas cumulative deposition of >6.3 mm thickness following surface discharges of NADF cuttings were anticipated to cover a maximum area of 364,244 m^2. The larger footprint of the surface-discharged cuttings was, however, offset by the relatively low deposition thicknesses (<6.3 mm) predicted for distances beyond ~500 m from the well location.

Assuming that the WBMs to be used in drilling the initial sections of the well do not contain spotting fluids or lubricating hydrocarbons, the impacts of discharges of these drilling fluids to both the water column and the sediments are considered of low intensity. The area affected by discharged drilling fluids of seabed thickness >6.3 mm would be extremely localised, with impacts persisting only over the short term. The likelihood of impacts occurring is considered 'likely', but as these would be partially reversible any potential adverse effects on sessile benthos of WBMs would be of MINOR significance before mitigation, depending on the sensitivity of the biota affected. In the case of residual NADFs on the drill cuttings, the impacts of discharges are considered of medium intensity. The total area affected by discharged drilling fluids would be larger, but by definition still localised, persisting over the short term. As NADFs are not discharged under normal operating procedures the likelihood of adverse effects on sessile benthos, or on the feeding, spawning and recruitment of mobile predators can be considered 'seldom. As these would be partially reversible any potential adverse effects on sessile benthos of NADFs can similarly be rated as being of MINOR to MODERATE significance before mitigation, depending on the sensitivity of the biota affected.

The indirect potential impact of leaching of cement additives into the surrounding water column and their potential toxic effects on benthic communities, or the potential for bioaccumulation is of low intensity and extremely localised (i.e. confined to the wellbore footprint) and would likely persist only temporarily as dilution would be rapid. The likelihood of the impact occurring would depend on the nature of the cement additives and their potential for leaching out of the residual cement and is thus considered ‘occasional’. As physiological effects would be fully reversible, the biochemical potential impacts can thus be rated as being of INCIDENTAL significance before mitigation.

<u>Mitigation</u>

No.	Mitigation measure	
1	Use WBM where possible or switch to low-toxicity Group III NADF with offshore treatment to reduce oil content in cuttings (<6.9%) before discharge.	Avoid / reduce at source
2	Conduct careful design of pre-drilling site surveys to collect sufficient information on seabed habitats, including mapping of sensitive and potentially vulnerable habitats within 500 m of a proposed well site., aiming to select level areas for spudding and well head installation.	Avoid / reduce at source
3	If sensitive habitats (such as hard grounds), sensitive species (e.g., cold-water corals, sponges), or significant structural features are detected, adjust the well position to beyond 500 m, or implement technologies, procedures, and monitoring to reduce risks and assess potential damage.	Avoid / reduce at source
4	Careful selection of drilling fluid additives taking into account their concentration, toxicity, bioavailability and bioaccumulation potential; Use only, PLONOR (Pose Little Or No Risk) chemicals, low-toxicity, low bioaccumulation potential and partially biodegradable additives are used, where practicable. Maintain a full register of Safety Data Sheets (SDSs) for all chemical used, as well as a precise log file of their use and discharge	Avoid / reduce at source
5	Employ high-efficiency solids control equipment to reduce liquid content in cuttings, maximise reuse and recycling of drilling mud, limit fluid change-outs and minimise residual spent mud.	Avoid / reduce at source
6	If NADFs are used for drilling the risered sections, conduct regular maintenance of the onboard solids control package and avoid inappropriate discharge of NADF cuttings	Abate on site

No.	Mitigation measure	
7	Arrange for unused cement remaining onboard the drilling unit to be shipped to shore for reuse, storage, or disposal.	Abate on site
8	Monitoring requirements: • Test drill cuttings daily for retained oil content to check specified discharge standards are maintained (average residual oil on cuttings <6.9%) at the end of the well. • Test barite for heavy impurities prior to mixing barite on location. • Test any other discharged fluids for visible oil contamination (static sheen). • Where practical, monitor sediment deposition and hydrocarbon concentrations. • Monitor cement returns with an ROV and stop cement pumping if significant discharges are detected on the seafloor. • Monitor (using ROV) hole wash out to reduce discharge of fluids, as far as possible.	Reduce at source/Abate on site

Residual impact

This potential impact cannot be eliminated due to the nature of the drilling approach and the necessity for cementing and the use of WBMs and NADFs in the drilling process. With the implementation of the above-mentioned mitigation measures, the residual impact on marine fauna, would have a lower intensity and likelihood, and the level would drop to INCIDENTAL for the effects of cement leachates and WBMs and MINOR significance for NADFs.

Monitoring

Drilling fluids to be discharged to sea (including residual material on drilled cuttings) must be subject to tests for toxicity, barite contamination, and oil content.

Potential Biochemical Impacts of Water-based Drilling muds and Cement leachates on marine organisms		
	Without Mitigation	Assuming Mitigation
Type	Direct, Indirect	
Extent	Local: >50 mm thickness limited to 15,814 m^2.	Local
Duration	Temporary (leachates) to Short-term (WBMs)	Short-term
Intensity	Low	Low
Significance	Minor	Incidental
Probability	Likely	Occasional
Receptor Sensitivity	Medium (soft sediments) to High (hard grounds)	
Reversibility	Partially reversible	
Loss of Resources	Low	
Mitigation Potential	Low	

Potential Biochemical Impacts of residual Non-Aqueous Drilling Fluids on drill cuttings on marine organisms		
	Without Mitigation	Assuming Mitigation
Type	Direct, Indirect	
Extent	Local: NABF concentrations >10 g/m^2 limited to maximum area of 7.2 m^2	Local
Duration	Medium-term: recovery is expected within a year	Short-term
Intensity	Medium	Low
Significance	Minor to Moderate	Minor
Probability	Occasional	Seldom
Receptor Sensitivity	Medium (soft sediments) to High (hard grounds)	
Reversibility	Partially reversible	
Loss of Resources	Low	
Mitigation Potential	Very Low	

INCREASED WATER TURBIDITY AND REDUCED LIGHT PENETRATION

Apart from the main biophysical (smothering and alteration in sediment characteristics) and biochemical (ecotoxicological effects of drilling mud constituents) potential impacts of the dispersed and settling cuttings on the marine environment, indirect impacts (i.e. impacts arising indirectly from biochemical effects on the water column) associated with cuttings disposal include changes in water turbidity in the vicinity of the discharge point.

The heavier cuttings and particles discharged at the seabed or from the drilling unit would settle near the wellbore where a localised smothering effect can be expected (see previous Section). The finer components of the surface discharge generate a plume in the upper water column, which is dispersed away from the drilling unit by prevailing currents, diluting rapidly to background levels at increasing distances from the drill unit. Several studies have shown that in areas where current speeds are high, cuttings discharges are diluted rapidly (within an hour) to very low concentrations, within 1,000 – 2,000 m down-current of the drilling unit (see Neff 2005 for references). Morant (1999) reported that a typical near-surface plume is 30-40 m in vertical height, 40-60 m wide and can extend in excess of 10 km from the drilling unit.

The results of the cuttings dispersion modelling studies undertaken as part of this project (ERM 2025a) largely confirm the reports of international studies that predicted that the effects of elevated TSS resulting from the riserless and risered drilling phases are localised (see Perry 2005). The model results identified that threshold TSS concentration of 35 mg/L in turbidity plumes generated at the seabed can extend up to a maximum area of 0.291 km^2 around the discharge location. The variation in current direction between the scenarios modelled, however result in different directional spreads of the turbidity plume.

One of the more apparent effects of increased concentrations of suspended sediments and consequent increase in turbidity, is a reduction in light penetration through the water column with potential adverse effects on the photosynthetic capability of phytoplankton (Poopetch 1982; Kirk 1985; Parsons et al. 1986a, 1986b; Monteiro 1998; O'Toole 1997) and the foraging efficiency of visual predators (Simmons 2005; Braby 2009; Peterson et al. 2001). However, due to the rapid dilution and widespread dispersion of settling particles, any adverse effects in the water column would be ephemeral and highly localised. Any biological effects on nectonic and planktonic communities would thus be negligible (Aldredge et al. 1986). The modelling study (ERM 2025a) identified that TSS concentration near the water surface did not exceed the 35 mg/L threshold during any of the four scenarios for either well location. The risk in the water column is pulsed, corresponding to the various drilling stages and ceases once drilling operations have been completed.

Turbid water is a natural occurrence along the southern African west coast, resulting from aeolian and riverine inputs, resuspension of seabed sediments in the wave-influenced nearshore areas and seasonal phytoplankton production in the upwelling zones. Further offshore where the potential well(s) would be located, surface waters, however, tend to be clearer and less productive as they are beyond the influence of coastal upwelling (see

Figure 3-9). Consequently, the major spawning areas are all located on the continental shelf, well inshore of the potential well sites(s) (see Figure 3-15). Any potential effects of turbid water plumes generated during cutting disposal on phytoplankton and ichthyoplankton production, fish migration routes and spawning areas, or on benthic and demersal species in the area would thus be negligible. Increased turbidity of near-bottom waters through disposal of WBMs and cuttings at the wellbore, may place transient stress on sessile and mobile benthic organisms, by negatively affecting filter-feeding efficiency of suspension feeders or through disorientation due to reduced visibility (reviewed by Clarke and Wilber 2000). However, in most cases sub-lethal or lethal responses occur only at concentrations well in excess of those anticipated at the wellbore. Furthermore, as marine communities in the Benguela are frequently exposed to naturally elevated suspended-sediment levels, they can be expected to have behavioural and physiological mechanisms for coping with this feature of their habitat.

The potential impact of increased turbidity in the water column and elevated suspended sediment concentrations >35 mg/L around the wellbore would thus be of negligible intensity, persisting only over the very short term (days), and would be localised (<0.3 km^2 around the well site at the seabed). Any possible adverse effects on sessile benthos, or on the feeding, spawning and recruitment of mobile predators, will be fully reversible. The potential biochemical impact of reduced water quality through increased turbidity can thus confidently be rated as being INCIDENTAL without mitigation.

<u>Mitigation</u>

No mitigation measures for potential indirect impacts on the water column are proposed or deemed necessary.

<u>Residual impact</u>

This potential impact cannot be eliminated due to the necessity of disposal of drill cuttings. Thus the impact remains INCIDENTAL.

Potential impacts of drill cuttings discharge on water column and bottom-water biochemistry (turbidity and light)		
	Without Mitigation	Assuming Mitigation
Type	Direct, Indirect	
Extent	Local: limited to within 0.3 km^2 around the well site at the seabed).	No mitigation is proposed
Duration	Short-term: intermittently for duration of drilling operations	
Intensity	Low: rapid dispersion and dilution	
Significance	Incidental	
Probability	Occasional	
Receptor Sensitivity	Low	
Reversibility	Fully reversible	
Loss of Resources	Low	
Mitigation Potential	None	

REDUCED PHYSIOLOGICAL FUNCTIONING OF MARINE ORGANISMS DUE TO INDIRECT BIOCHEMICAL EFFECTS

A further indirect potential impact (i.e. impacts arising indirectly from biochemical effects on the sediments) associated with cuttings disposal is the potential development of hypoxic conditions in the near-surface sediment layers through bacterial decomposition of organic matter. Biodegradable organic matter in cuttings piles on the seabed often has a greater effect than sediment texture, deposition rate or, in some cases, chemical toxicity on the structure and function of benthic communities (Hartley et al. 2003). Bacterial decomposition of organic matter may deplete oxygen in the near-surface sediment layers, thereby changing the chemical properties of the sediments by generating potentially toxic concentrations of sulfide and ammonia (Wang and Chapman 1999; Gray et al. 2002; Wu 2002). The rapid biodegradation of drilling solids (particularly those containing NADFs) may therefore lead indirectly yet rapidly to sediment toxicity, particularly in fine-grained sediments (Munro et al. 1998; Jensen et al. 1999; Trannum et al. 2010). Organically enriched sediments are often hypoxic or anoxic, and consequently harbour markedly different benthic communities to oxygenated sediments (Pearson and Rosenberg 1978; Gray et al. 2002). Organic matter concentration in the sediments would decrease in response to microbial degradation, resulting in increases in oxygen concentration in the surface-sediment layers leading to succession in the benthic community structure toward a more stable state. Such biochemical effects in the sediments can have substantial effects on the structure and function of benthic communities.

WBM cuttings piles typically contain low concentrations of biodegradable organic matter and do not support large populations of bacteria (Dow et al. 1990). As most of the organic chemicals in WBMs are biodegradable under aerobic conditions, sediments containing WBM cuttings show only slight and short-term reductions in redox potential. However, organic chemicals in settled solids from mineral oil- and diesel fuel-contaminated WBMs have a high chemical and biological oxygen demand (Breteler et al. 1988). Therefore, if cuttings piles contain WBMs contaminated with petroleum hydrocarbons, the sediments may experience the ecological effects of organic enrichment, particularly if the cuttings pile is large. Similarly, the synthetic fluids in NADFs typically degrade rapidly and can cause localised hypoxia in underlying sediments (EPA 2000; OGP 2003). In the case of sediments containing OBM cuttings, the anoxic conditions that developed not only persisted over the long term (>1 year), but stimulated production of hydrogen sulphide by anaerobic sulphate-reducing bacteria (Dow et al. 1990).

Oxygen depletion in the sediments around a well site may also develop in response to organic enrichment following fall-out of fouling organisms off submerged platform structures.

Marine organisms respond to hypoxia by first attempting to maintain oxygen delivery (e.g. increases in respiration rate, number of red blood cells, or oxygen binding capacity of haemoglobin), then by conserving energy (e.g. metabolic depression, down regulation of protein synthesis and down regulation/modification of certain regulatory enzymes), and upon exposure to prolonged hypoxia, organisms eventually resort to anaerobic respiration (Wu 2002). Hypoxia reduces growth and feeding, which may eventually affect individual fitness. The effects of hypoxia on reproduction and development of marine animals remains almost unknown. Many fish and marine organisms can detect, and actively avoid hypoxia. Some macrobenthos may leave their burrows and move to the sediment surface during hypoxic conditions, rendering them more vulnerable to predation. Hypoxia may eliminate sensitive species, thereby causing changes in species composition of benthic, fish and phytoplankton communities. Decreases in species diversity and species richness are well documented, and changes in trophodynamics and functional groups have also been reported. Under hypoxic conditions, there is a general tendency for suspension feeders to be replaced by deposit feeders, demersal fish by pelagic fish and macrobenthos by meiobenthos (see Wu 2002 for references). Further anaerobic degradation of organic matter by sulphate-reducing bacteria may additionally result in the production of hydrogen sulphide, which is detrimental to marine organisms (Brüchert et al. 2003).

The bulk of the seawater in the area comprises South Atlantic Central Water (SACW), which has depressed oxygen concentrations (~80% saturation value), with lower oxygen concentrations (<40% saturation) occurring frequently due to nutrient remineralisation in bottom waters. The benthic communities will therefore be adapted to low oxygen conditions and will be characterised either by species able to survive chronic hypoxia, or colonising and fast-growing species able to rapidly recruit into areas that have suffered oxygen depletion.

Development of anoxic conditions beneath re-deposited cuttings is highly unlikely due to the low deposition thicknesses predicted in the cuttings fallout footprint for distances beyond ~500 m from the well location. Should anoxic conditions develop, these are likely to be limited to within the >50 mm thickness WBMs cuttings pile deposited on the seabed around the wellbore (maximum area 15,814 m^2), where they would have an impact of low intensity on the benthic macrofauna, with recovery expected within a few months. The likelihood of the impact occurring is considered ‘occasional’ with any potential effects being fully reversible. The potential impact is thus considered to be INCIDENTAL without mitigation.

As part of the drill cuttings dispersion modelling, seabed accumulation of hydrocarbons due to the retained Non-Aqueous Base Fluid (NABF) mass on drill cuttings from both wells were predicted as a part of the computation of the thickness deposited on the seabed due to the material discharged during the drilling of Section 3 and Section 4 using NADFs. The hydrocarbon deposits identified by the modelling are locations where there are varying degrees of likelihood of impact proportional to the concentrations, but clear determination of potential impacts cannot be made. Deposits of NABF adhere to cuttings scattered across the seabed and would eventually mix into the sediments through bioturbation, with the composition of the hydrocarbons changing over time as the compounds degrade. Hydrocarbon deposition exceeding the 10 g/m^2 threshold (not a value related any environmental threshold) was observed, suggesting potential accumulation zones that may require further investigation. It was predicted that hypoxic zones from cuttings may affect up to a maximum area of 7.2 km^2 around the well site, with potential impacts lasting over the medium term depending on season and location (Appendix D). The potential impact is thus considered to be MINOR without mitigation.

Mitigation

No mitigation measures for potential indirect biochemical effects in seabed sediments are proposed or deemed necessary. Thus the potential impact remains MINOR.

Residual impact

This potential impact cannot be eliminated due to the necessity of disposal of drill cuttings.

Indirect Potential impacts of Cuttings Discharges: development of anoxic sediments around the wellbore		
	Without Mitigation	Assuming Mitigation
Type	Indirect	
Extent	Local: maximum area of 7.2 km² around the well site.	No mitigation is proposed
Duration	Medium-term: erosion and dispersal of cuttings and bioturbation of cuttings piles should occur within a year	
Intensity	Low: West Coast biota are naturally adapted to low oxygen conditions	
Significance	Minor	
Probability	Possible	
Receptor Sensitivity	Low	
Reversibility	Fully reversible	
Loss of Resources	Low	
Mitigation Potential	None	

4.4.2.3 INCREASED HARD SUBSTRATA ON THE SEABED

Description of the potential impact

The table below summarises the project activities that will result in an increase in hard substrata on the seabed.

Activity phase	Activity
Pre-drilling Survey	n/a
Mobilisation	n/a
Operation	Placement of wellhead on the seabed
	Discharge of residual cement during riserless stage
Demobilisation	Abandonment of wellhead on seabed

These activities and their associated aspects are described further below:

- Once the wellhead has been installed a BOP is lowered to the seabed and installed onto the wellhead. The BOP stack extends ~10 m above the seabed into the water column, thereby providing a pillar of hard substrate in an area of otherwise unconsolidated sediments.
- During initial cementing of the well, excess cement emerges out of the top of the well onto the cuttings pile or is discarded on the seabed, where (depending on its mix) it may set and remain in a pile to subsequently be colonised by epifauna and attract fish and other mobile predators (Buchanan *et al*. 2003). Excess cement may therefore act as an artificial reef.
- The risered drilling stage commences with the installation of a wellhead onto of the 20-inch casing. Once the wellhead has been installed a BOP is lowered to the seabed and installed onto the wellhead. The BOP stack extends ~10 m above the seabed into the water column, thereby providing a pillar of hard substrate in an area of otherwise unconsolidated sediments. The BOP will be removed during decommissioning.
- After the exploration well(s) have been sealed, tested for integrity and abandoned, the wellhead (with a maximum height of ~4 m and a diameter of 1 m) would be left on the seafloor, thereby providing an island of hard substrate in an area of otherwise unconsolidated sediments. If deemed unsafe, the wellheads will be removed.
- If the abandoned wellheads are located within the footprint of the demersal trawl fishery, over-trawlable abandonment caps would be installed. These are estimated to measure approximately 5.2 m x 5.2 m, with a height of 4.4 m, and would add structural complexity to otherwise uniform unconsolidated seabed habitats thereby creating areas of higher biological diversity.
- The accidental loss of equipment onto the seafloor would similarly provide a localised area of hard substrate (see unplanned events).

The availability of hard substrata on the seabed provides opportunity for colonisation by sessile benthic organisms and provides shelter for demersal fish and mobile invertebrates thereby potentially increasing the benthic biodiversity and biomass in the continental slope region. The benthic fauna inhabiting islands of hard substrata in otherwise unconsolidated sediments of the outer shelf and continental slope are, however, very poorly known.

Project Controls

The Operator would monitor cement returns and would terminate pumping if returns are observed on the seafloor. The contractors will make sure that the proposed drilling campaign is undertaken in a manner consistent with good international industry practice and BAT. Based on pre-drilling ROV survey(s), the well(s) will specifically be sited to avoid sensitive hardgrounds, as the preference will be to have a level surface area to facilitate spudding and installation of the wellhead.

Impact assessment

Many studies have reported on the rich biodiversity of marine species associated with the infrastructure provided by oil platforms (Hall 2001; Love et al. 2005; Love and York 2006), or the increase in abundance of macroepibenthic invertebrates and demersal fish near the rig site (Wolfson et al. 1979; Bull and Kendall 1994; Ellis et al. 1996; Fechhelm et al. 2001; EG&G, Environmental Consultants 1982, in Neff 2005). These changes in biodiversity were, however, associated with permanent production rigs. For the current project, the exploration drilling unit will be on site for only a three-month period, and the establishment of alternative communities on drilling infrastructure is thus not expected.

The presence of wellheads left on the seabed can, however, alter the community structure in an area, and effectively increase the availability of hard substrate for colonisation by sessile benthic organisms in an area dominated by unconsolidated sediments, thereby locally altering and increasing biodiversity and biomass. Similarly, but to a lesser extent, solidified excess cement discarded during cementing of the casings, as well as equipment accidentally lost to the seabed would provide hard substratum for benthic organisms to colonise in an environment otherwise dominated by unconsolidated sediments. These alterations to community structure would occur at a much smaller scale than that reported on production infrastructure. While this may have positive implications to certain fish species (e.g. kingklip *Genypterus capensis* and jacopever *Helicolenus dactylopterus*, which show a preference for structural seabed features), it may enhance colonisation by non-indigenous species. Due to the water depths in the license area, colonisation by invasive species is unlikely to pose a significant threat to natural biodiversity in the deep sea habitats.

The increase in biodiversity (neutral impact status) due to the presence of subsea structures would be considered a secondary impact of low intensity, but potentially with additive cumulative effects if the well proves feasible for production in the future. The potential impact is highly localised and due to the depth of the well the establishment of alternative communities is considered possible. As CNEL has indicated that the wellhead would be abandoned, the impact is irreversible but is considered to be of INCIDENTAL significance without mitigation. For the establishment of communities on residual cement and irretrievable objects, the potential impact would similarly be of INCIDENTAL significance without mitigation.

Mitigation

In addition to the measures recommended to avoid vulnerable hardground habitats, the following measures will be implemented:

No.	Mitigation measure	Classification
1	Monitor cement returns with an ROV and stop cement pumping if significant discharges are detected on the seafloor.	Reduce at source/Abate on site
2	Monitor (using ROV) hole wash out to reduce discharge of fluids, as far as possible.	
3	Undertake a post drilling ROV survey to scan seafloor for any dropped equipment and other removable features (e.g. excess cement) around the well site. Retrieve these objects, where practicable, after assessing the safety and metocean conditions.	Repair / restore
4	Ship unused cement onboard to shore for reuse, storage, or disposal..	Reduce at source
5	The location of abandoned wellheads must be registered and distributed via "Notice to Mariners" and "Notice to Fishers".	Reduce at source

Residual impact

This potential impact cannot be eliminated due to the abandonment of the wellhead on the seafloor.

Potential impacts of petroleum infrastructure on marine biodiversity		
	Without Mitigation	Assuming Mitigation
Type	Indirect	
Extent	Local: limited to well site(s)	Local: limited to well site(s)
Duration	Permanent	Short-term (retrieved equipment) to Permanent (wellhead)
Intensity	Negligible	Negligible
Significance	Incidental	Incidental
Probability	Likely	Likely

Receptor Sensitivity	Low
Reversibility	Irreversible
Loss of Resources	Low
Mitigation Potential	None

4.4.2.4 INTRODUCTION OF INVASIVE SPECIES

Description of the potential impact

The table below summarises the project activities that will potentially result in the introduction of invasive alien species.

Activity phase	Activity
Pre-drilling Survey	n/a
Mobilisation	Transit of drilling units and support vessels to the drill site
	Discharge of ballast water by drill rig and/or support vessels
Operation	n/a
Demobilisation	n/a

These activities and their associated aspects are described further below:

- Larvae, cysts, eggs and adult marine organisms are frequently firmly attached to artificial structures such as vessel hulls and infrastructure that have been in the sea for any length of time. Vessels and the transportation of infrastructure from one place to another in the ocean also provide the potential for translocation of introduced or alien species.
- De-ballasting of the drill unit once at the drill site could introduce non-native species into the area.

Artificial structures deployed at sea serve as a substrate for a wide variety of larvae, cysts, eggs and adult marine organisms. The transportation of equipment from one part of the ocean to another would therefore also facilitate the transfer of the associated marine organisms. Drill units, drilling equipment and support vessels are used and relocated all around the world. Similarly, the ballasting and de-ballasting of these vessels may lead to the introduction of exotic species and harmful aquatic pathogens to the marine ecosystems (Bax et al. 2003).

The marine invertebrates that colonize the surface of drilling units and vessels can easily be introduced to a new region, where they may become invasive by outcompeting and displacing native species. Marine invasive species are considered primary drivers of ecological change in that they create and modify habitat, consume and outcompete native fauna, act as disease agents or vectors, and threaten biodiversity. Once established, an invasive species is likely to remain in perpetuity (Bax et al. 2003).

Project Controls

Ballast water is discharged subject to the requirements of the International Maritime Organisation’s (IMO) 2004 International Convention for the Control and Management of Ships’ Ballast Water and Sediments. The Convention aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediments. The Convention stipulates that all ships are required to implement a Ballast Water Management Plan and that all ships using ballast water exchange will do so at least 200 nautical miles from nearest land in waters of at least 200 m deep; the absolute minimum being 50 nautical miles from the nearest land. Project vessels would be required to comply with this requirement.

Although the Operator follows IMO requirements, de-ballasting is limited to biologically compatible receiving environments. The project would therefore follow the requirements of the IFC Project Standard 6, through the implementation of the 2004 Ballast Water Management Convention, and its guidelines, as regards ballast water management. Good industry practice would include:

- The development of a ballast water management plan;
- Ensuring all infrastructure (e.g. wellheads, BOPs and guide bases) that has been used in other regions is thoroughly cleaned prior to deployment.

Other precautionary guidelines suggested by the IMO include:

- During the loading of ballast, every effort should be made to avoid the uptake of potentially harmful aquatic organisms, pathogens and sediment that may contain such organisms, through adequate filtration procedures;
- Where practicable, routine cleaning of the ballast tank to remove sediments should be carried out in mid-ocean or under controlled arrangements in port or dry dock, in accordance with the provisions of the ship's ballast water management plan;
- Avoidance of unnecessary discharge of ballast water.

Impact assessment

Numerous studies have investigated the potential for petroleum infrastructure to serve as vectors of potential invasive species (Foster and Willan 1979; Page et al. 2006; Hewitt et al. 2009). Foster and Willan (1979) identified 12 barnacle species, a grapsid crab (*Plagusia depressa tubuculata*), sergeant-major fish (*Abedefduf sexetilis*), a species of hydroid (*Orthopyxis* sp.) and two algal species in the succession community that developed over a two-month period on an oil rig towed from Japan to New Zealand. Of these, six species of barnacles and the sergeant-major fish had never previously been recorded in New Zealand.

Similarly Page et al. (2006) documented three exotic invertebrate species (a bryozoan, anemone and amphipod) inhabiting offshore platforms on the Pacific offshore continental shelf of California, of which the bryozoan and anemone appeared to be outcompeting indigenous organisms for primary space. Underwater footage of existing petroleum infrastructure on the Agulhas Bank has shown dense abundances of an exotic anemone species *Metridium senile* most likely introduced from the North West Atlantic (K. Sink pers. comm.). Four non-indigenous marine species are currently known to be invasive in southern African waters, namely the Mediterranean mussel *Mytilus galloprovincialis*, the Chilean bisexual mussel *Semimytilus algosus*, European shore crab *Carcinus meanas* and the Pacific barnacle *Balanus glandula*. Although many more non-native species have been documented, the difficulty in detection, identification and the cryptic nature of some species suggests that there may be many more (C.L. Griffiths pers. comm.).

The introduction of non-native, potentially invasive species would have an indirect impact of medium intensity on marine biodiversity. The potential impact may extend regionally or even nationally, and established species could persist to perpetuity, with impacts being irreversible. With the implementation of IMO standards, and considering the depth of the well(s) and their offshore location, the likelihood of introductions is considered ‘unlikely’, and the potential impact is thus considered to be of MINOR significance without mitigation. It must be pointed out, however, that this potential impact is not unique to the potential project, but rather a threat common to the Southern African offshore environment from the numerous vessels that pass through southern African coastal waters daily.

Mitigation

The following mitigation measures are proposed:

- Develop a ballast water management plan that considers all IMO requirements (Avoid / reduce at source);
- Check all infrastructure (e.g. wellheads, BOPs and guide bases) that has been used in other regions is thoroughly cleaned prior to deployment (Avoid / reduce at source).

Residual impact

This potential impact cannot be eliminated due to the necessity of bringing vessels and rigs to the drill site from other parts of the world, and the need for de-ballasting these once on site.

With the implementation of the above-mentioned mitigation measures, the potential residual impact on marine fauna, would have a lower intensity and probability, and the level would drop to INCIDENTAL.

Introduction of invasive species on petroleum infrastructure		
	Without Mitigation	Assuming Mitigation
Type	Indirect	
Extent	Regional to National	Regional
Duration	Long-term: once established an invasive species could remain to perpetuity	Long-term
Intensity	Small	Small
Significance	Minor	Incidental
Probability	Unlikely	Unlikely
Receptor Sensitivity	Medium	
Reversibility	Irreversible	
Loss of Resources	Medium	
Mitigation Potential	Low	

4.4.2.5 GENERATION OF NOISE

Description of the potential impact

The table below summarises the project activities that will result in noise.

Activity phase	Activity
Pre-drilling Survey	Presence and operation of Survey Vessel
Mobilisation	Transit of drilling units and support vessels to the drill site
Operation	Operation of drilling unit and support vessels
	Operation of helicopters
	Vertical seismic profiling of the well(s)
Demobilisation	Drilling unit / support vessels leave drill site and transit to port or next destination

These activities and their associated aspects are described further below:

- The presence and operation of the drillship and support vessels during transit to the drill site, during the potential drilling activities and during demobilisation will introduce a range of underwater noises into the surrounding water column that may potentially contribute to and/or exceed ambient noise levels in the area. The drillship and associated offshore support vessel are expected to generate noise levels of 188 – 198.8 dB re 1µPa @ 1 m (SLR Consulting Canada 2023).

- Crew transfers by helicopter from Walvis Bay to the drill unit will generate noise in the atmosphere that may disturb coastal species such as seabirds and seals. Noise source levels from helicopters flying at an altitude of 150 m or more above sea level are expected to be around 109 dB re 1µPa at the most noise-affected point (SLR Consulting Canada 2023).
- Vertical seismic profiling (VSP) is a standard method used during well logging and can generate noise that could exceed ambient noise levels. VSP source generates a pulse peak sound pressure level around 245.5 dB re 1 µPa @ 1 m, the root-mean-square sound pressure level (RMS SPL) 231.5 re 1 µPa @ 1 m, and the sound exposure level (SEL) 223.7 dB re $\mu Pa^2 \cdot s$ @ 1 m, decreasing rapidly with distance from the source. VSP uses a small airgun array; volumes and the energy released into the marine environment are significantly smaller than what is required or generated during conventional seismic surveys. The airgun array would be discharged approximately five times at 20 second intervals. This process is repeated, as required, for different sections of the well. A VSP is expected to take approximately 9 hours and ~250 shots per well to complete, depending on the well's depth and number of stations being profiled. VSP is unlikely to be undertaken during operations but has been included in the assessment as a conservative scenario.

Description of the potential impact

Elevated underwater noise can affect marine fauna, including cetaceans, by:

- causing direct physical injury to hearing;
- masking or interfering with other biologically important sounds (e.g. communication, echolocation, signals and sounds produced by predators or prey);
- causing disturbance to the receptor resulting in behavioural changes or displacement from important feeding or breeding areas.

This assessment focuses on physiological injury and behavioural disturbance only.

The ocean is a naturally noisy place and marine animals are continually subjected to both physically produced sounds from sources such as wind, rainfall, breaking waves and natural seismic noise, or biologically produced sounds generated during reproductive displays, territorial defence, feeding, or in echolocation (see references in McCauley 1994). Such acoustic cues are thought to be important to many marine animals in the perception of their environment as well as for navigation purposes, predator avoidance, and in mediating social and reproductive behaviour. Anthropogenic sound sources in the ocean can thus be expected to interfere directly or indirectly with such activities thereby affecting the physiology and behaviour of marine organisms (NRC 2003). Natural ambient noise will vary considerably with weather and sea state, ranging from about 80 to 120 dB re 1 µPa for the frequency range 10 – 10k Hz (Croft and Li 2017). Of all human-generated sound sources, the most persistent in the ocean is the noise of shipping. Depending on size and speed, the sound levels radiating from vessels range from 160 to 220 dB re 1 µPa at 1 m (McCauley 1994; NRC 2003). Especially at low frequencies between 5 to 100 Hz, vessel traffic is a major contributor to noise in the world's oceans, and under the right conditions, these sounds can propagate 100s of kilometres thereby affecting very large geographic areas (Coley 1994, 1995; NRC 2003; Pidcock et al. 2003; Duarte *et al.* 2021).

As PEL 82 is located between the main offshore shipping routes that pass around southern Africa and the high density of inshore fishing vessel traffic, the shipping noise component of the ambient noise environment is expected to be significant within and around the license area. Given the significant local shipping traffic and relatively strong metocean conditions specific to the area surrounding PEL 82, the underwater noise modelling study for Chevron's Block 2813B to the south of PEL 82 estimated that the ambient noise levels were expected to be 90 - 120 dB re 1 µPa for the frequency range 10 Hz – 10 kHz (SLR Consulting Canada 2024). Other forms of anthropogenic noise include 1) aircraft flyovers, 2) multi-beam sonar systems, 3) seismic acquisition, 4) hydrocarbon and mineral exploration and recovery, and 5) noise associated with underwater blasting, pile driving, and construction (

Figure 4-4).

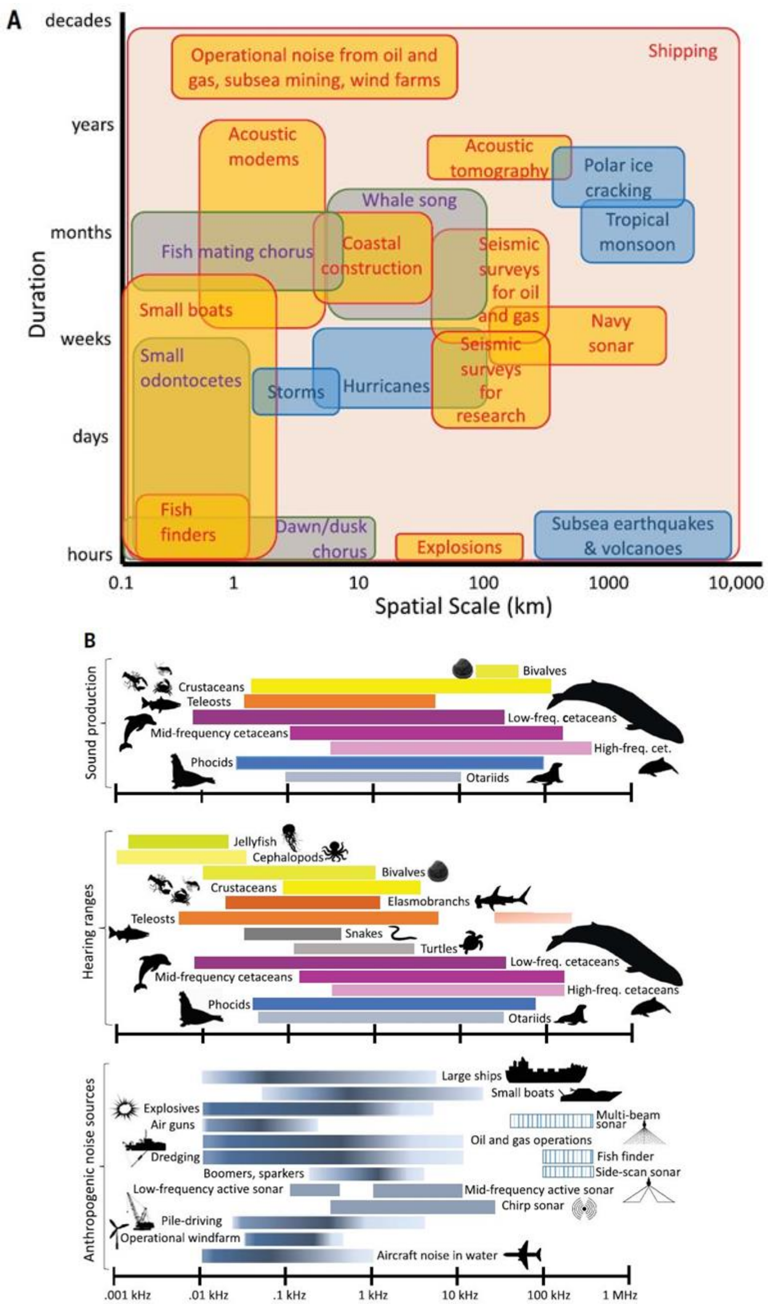
Noise propagation represents energy travelling either as a wave or a pressure pulse through a gas or a liquid. Due to the physical differences between air and water (density and the speed at which sound travels), the decibel units used to describe noise underwater are different from those describing noise in air. Furthermore, hearing sensitivities vary between species and taxonomic groups. Underwater noise generated by drilling activities is therefore treated separately from noise generated in the air.

The cumulative impact of increased background anthropogenic noise levels in the marine environment is an on-going and widespread issue of concern (Koper and Plön 2012), as such sound sources interfere directly or indirectly with the animals' biological activities. Reactions of marine mammals to anthropogenic sounds have been reviewed by McCauley (1994), Richardson et al. (1995), Gordon and Moscrop (1996) and Perry (1998).

Exposure to high sound levels can result in physiological injury to marine fauna through a number of avenues, including shifts of hearing thresholds (as either permanent (PTS) or temporary threshold shifts (TTS)), tissue damage, acoustically induced decompression sickness (particularly in beaked whales), and non-auditory physiological effects. Both PTS and TTS represent actual changes in the ability of an animal to hear, usually at a particular frequency, whereby it is less sensitive at one or more frequencies as a result of exposure to sound. In assessing injury from noise, a dual criterion is adopted based on the peak sound

FIGURE 4-4 SOURCES AND ANIMAL RECEIVERS OF SOUND IN THE OCEAN

A) Spatial extent and duration of selected sound producing events, and B) Approximate sound production and hearing ranges of marine taxa and frequency ranges of selected anthropogenic sound sources. (Source: Duarte et al. 2021).



pressure level (SPL) and sound exposure level (SEL) (a measure of injury that incorporates the sound pressure level and duration), with the one that is exceeded first used as the operative injury criterion. PTS-onset and TTS-onset thresholds differ between impulsive and non-impulsive noise, with ranges for marine mammals provided in Southall et al. (2019). Peak sound pressure levels for impulsive noise resulting in mortality or potential mortal injury for fish eggs and larvae, turtles and fish range from 207 - 213 dB re 1 µPa, with TTS in fish occurring at cumulative sound exposure levels of above 186 dB re 1 µPa2·s. The risk of TTS close to continuous shipping sounds is generally low, although masking and behavioural changes would be likely.

The sound level generated by survey and support vessels fall within the 180-190 dB re 1 µPa range close to the vessel, with main frequencies from 10 Hz - 10 kHz. The sound level generated by drilling operations and support vessels fall within the 145 to 190 dB re 1 µPa rms range at the drilling unit, with thrusters used for dynamic positioning of the drill unit being responsible for the noise at the higher end of the range. The VSP airgun array would generate peak sound pressure levels of around 235 dB re 1µPa @ 1 m with sound exposure levels of 210 dB re1µPa2·S @ 1 m. For a similar deepwater drilling operation in southern Namibia, a number of noise sources were identified (e.g. heavy lift vessel, drill ship in transit and operational, semi-submersible drill rig, support vessels, helicopters and drill ship maintenance), with noise levels to ranging from 170 – 190 dB re 1 µPa depending on the drill unit and support vessels used (Croft and Li 2017). The noise generated by vessels and well-drilling operations in general, thus falls within the hearing range of most fish and marine mammals, and would be audible for considerable ranges before attenuating to below threshold levels. The received level of noise (and risk of physiological injury or behavioural changes) would depend on the animal's proximity to the sound source.

The extent of the noise impacts would, however, also depend on the variation in the background noise level with weather and with the proximity of other vessel traffic (not associated with the project), the depth of the drill site and the marine mammal hearing group, with low frequency cetaceans (i.e. mysticetes: southern right, humpback, sei, fin, blue, Bryde's, minke) showing the highest sensitivity.

Project Controls

The drilling contractor will make sure that the potential exploration activities are undertaken in a manner consistent with good international industry practice and BAT.

Although the regulations under the Namibian Marine Resources Act, 2000 (No. 27 of 2000) state that no whales or dolphins may be harassed, killed or fished, there are no specific regulations governing the permissible approach distance to marine mammals.

The operation of helicopters and fixed-wing aircraft is governed by the Civil Aviation Act (No. 6 of 2016) and associated regulations.

Impact assessment

PHYSIOLOGICAL INJURY IN MARINE FAUNA DUE TO UNDERWATER NOISE ASSOCIATED WITH WELL-DRILLING

Well-Drilling

The emission of underwater noise from drilling operations and associated drill unit and tender vessel activity is not considered to be of sufficient amplitude to cause direct physical injury or mortality to marine life, even at close range.

The impact zones for auditory injury (AUD INJ) and temporary threshold shift (TTS) from drilling noise predicted by the noise modelling study (ERM 2025b) were within 100 m of the source for all marine mammal hearing groups. Therefore, if marine mammals only pass through the site near the noise sources over a very short period of time, their noise exposure is not expected to attain thresholds resulting in auditory injury. Among fish species sensitive to sound, especially those with swim bladders used in hearing, non-impulsive sources were expected to create recoverable injury zones within 100 m and TTS zones within 400 m of the source. For sea turtles, predicted zones for auditory injury and TTS consistently remain within 100 m of the well for drilling activities. The non-impulsive drilling operation noise therefore has low physiological impacts (both mortality and recovery injury) on fish and sea turtle species. Furthermore, as most pelagic species likely to be encountered within the license area are highly mobile, they would be expected to move away from the sound source before trauma could occur. With a decreased exposure period, the zones of impact would be significantly reduced.

For a similar deepwater drilling operation in southern Namibia it was estimated that noise from well-drilling activities would decrease to below the estimated median ambient background level (100 dB re 1µPa) within a distance of 14 - 32 km from the drill site, depending on the specific vessels used, the number of support vessels operating and the scenario. Maintenance activities represented the worst-case scenario for noise, although this would be expected to occur only for relatively short periods of time (Croft and Li 2017).

The effects of underwater noise generated during well-drilling and by the drilling unit and survey and support vessels on marine fauna is therefore considered to be of small magnitude in the drilling area and for the duration of the drilling campaign. It is unlikely that the noise generated during well-drilling will cause physiological injury or mortality of marine fauna. Should injury occur, impacts would be fully reversible once drilling operations are completed. The impact of vessel and drilling noise is thus considered INCIDENTAL without mitigation.

Vertical Seismic Profiling

The peak pressure levels from VSP seismic pulses, are likely to cause both PTS and TTS on-set in marine mammals, and potential mortal injury in fish and turtles. The animals would, however, need to be directly adjacent to or below the VSP source (marine mammals : <20 m; fish and turtles : <25 m) to be affected. An exception are the very high-frequency cetaceans, which are predicted to experience PTS-onset within 45 m from the VSP source, and TTS-onset within 90 m from the VSP source.

As most pelagic species likely to be encountered within the license area are highly mobile, they would be expected to flee and move away from the sound source before trauma could occur. Assuming the animal does not move away from the noise source, the cumulative maximum threshold distances would apply. Considering the cumulative impact (250 discharges over 24-hours) on marine mammals, the maximum threshold distances will be in the order of up to 800 m for PTS onset and up to 8 000 m for TTS onset. For fish and turtles, the cumulative impact (250 discharges over 24-hours) will result in distances in the order of 200 m for recovery injury and 2,000 m for TTS-onset.

In reality though, marine fauna would not stay in the same location for the entire period. Therefore, the zones of impact represent the worst-case consideration and will reduce logarithmically with decreased exposure time period.

Potential physiological effects on marine fauna of pulsed VSP sounds is considered to be of medium intensity, but restricted to within a few 10s of metres of the sound source (assuming animals move away from the sound source before trauma could occur). It is thus unlikely that the pulsed seismic noise generated by the VSP will cause physiological injury or mortality of marine fauna. Should injury occur, impacts would be fully reversible once VSP operations are completed. The impact of VSP pulses is thus considered MINOR without mitigation.

BEHAVIOURAL CHANGES AND MASKING OF BIOLOGICALLY-RELEVANT SOUNDS IN MARINE FAUNA DUE TO UNDERWATER NOISE ASSOCIATED WITH WELL-DRILLING AND VSP

The underwater noise from the well-drilling operations and VSP may induce localised behavioural changes or masking of biologically relevant sounds in some marine fauna, but there is no evidence of significant behavioural changes that may impact on the wider ecosystem (Perry 2005).

The noise impact study undertaken for this project (ERM 2025b) predicted that potential behavioural disturbance from the non-impulsive noise emissions from drilling operations may occur at between 9.6 km and 11 km from the source for marine mammals of all hearing groups. Among fish species sensitive to sound, behavioural responses were predicted to extend up to 1 km, with potential behavioural impact zones for sea turtles confined to 100 m, although responses may still occur.

In a study evaluating the potential effects of vessel-based diamond mining on the marine mammals community off the southern African West Coast, Findlay (1996) concluded that the significance of the impact is likely to be minimal based on the assumption that the radius of elevated noise level would be restricted to ~20 km around the mining vessel. The responses of cetaceans to noise sources are often also dependent on the perceived motion of the sound source as well as the nature of the sound itself. For example, many whales are more likely to tolerate a stationary source than they are one that is approaching them (Watkins 1986; Leung-Ng and Leung 2003), or are more likely to respond to a stimulus with a sudden onset than to one that is continuously present (Malme et al. 1985).

Underwater noise from drilling operations are unlikely to mask biologically significant sounds, but disturbance and behavioural changes are seldom. Impacts are considered of medium intensity persisting over the short-term only, with impacts being fully reversible once drilling operations are completed. The impact of underwater noise from drilling operations potentially resulting in behavioural changes of masking biologically significant sounds is considered of MINOR significance without mitigation.

Potential behavioural disturbance from the VSP seismic pulses for low-frequency cetaceans may reach up to 400 m under a 250-pulse scenario and up to 200 m under a 50-pulse scenario at both wells (ERM 2025b). For other hearing groups, potential behavioural impact zones stay within 100 m of the source. Under the general 160 dB re 1 µPa RMS criterion for all marine mammals, potential behavioural impact zones are estimated to extend up to 300 m from the Gemsbok well and up to 400 m from the second well.

In the case of pulsed sounds generated during VSP, the effects on the behaviour of marine fauna are considered to be of medium intensity, but restricted to within 10 km of the source and for the very short duration (8-12 hours) of the VSP activities. The noise generated by VSP may occasionally mask biologically significant sounds, and cause disturbance and behavioural changes in the receptors, but impacts are fully reversible once VSP operations are completed. Potential behavioural impacts of underwater noise generated during VSP is thus considered of MINOR significance without mitigation.

<u>Mitigation</u>

Although not legislated in Namibia, no vessel or aircraft should approach closer than 500 m to any whale and a vessel or aircraft should move to a minimum distance of 500 m from any whales if a whale surfaces closer than 500 m from a vessel or aircraft.

The generation of vessel noise and drilling noise cannot be eliminated due to the nature of the drilling operations. The following measures are proposed to reduce noise at the source:

No.	Mitigation measure	Classification
1	• Implement a maintenance plan to check all diesel motors and generators receive adequate maintenance to minimise noise emissions.	Avoid/reduce at source
2	Limit vessel transit speeds to ≤12 knots (22 km/h) between the drilling area and port and ≤10 knots (18 km/h) within 25 km of the coastline	Avoid/reduce at source

For VSP, recommendations for mitigation include:

No.	Mitigation measure	Classification
1	Key personnel and equipment	
1.1	Appoint a minimum of two dedicated Marine Mammal Observer (MMO), with a recognised MMO training course, on board for marine fauna observation (360 degrees around drilling unit), distance estimation and reporting. One MMO should also have Passive Acoustic Monitoring (PAM) training should a risk assessment, undertaken ahead of the VSP operation, indicate that the PAM equipment can be safely deployed considering the metocean conditions (specifically current).	Abate on site
1.2	Check drilling unit vessel is fitted with PAM technology (one or more hydrophones), which detects animals through their vocalisations, should it be possible to safely deploy PAM equipment.	Abate on site
2	Pre-start Protocols for airgun testing and profiling	
2.1	VSP profiling should, as far as possible, only commence during daylight hours with good visibility. However, if this is not possible due to prolonged periods of poor visibility (e.g. thick fog) or unforeseen technical issue which results in a night-time start, refer to "periods of low visibility" below.	Avoid / Abate on site
2.2	Undertake a 1-hr (as water depths > 200 m) pre-shoot visual and possible acoustic scan (prior to soft-starts / airgun tests) within the 500 m radius mitigation zone in order to confirm there are no cetaceans, turtles, penguins and shoaling large pelagic fish activity close to the source.	Abate on site

No.	Mitigation measure	Classification
2.3	Implement a "soft-start" procedure of a minimum of 20 minutes' duration when initiating the acoustic source (except if testing a single airgun on lowest power). This requires that the sound source be ramped from low to full power rather than initiated at full power, thus allowing a flight response by marine fauna to outside the zone of injury or avoidance. Delay "soft-starts" if cetaceans, turtles and shoaling large pelagic fish are observed / detected within the mitigation zone during the pre-shoot visual / acoustic scan. A "soft-start" should not begin until 20 minutes after cetaceans depart the mitigation zone or 20 minutes after they are last seen or acoustically detected by PAM in the mitigation zone. In the case of penguins, shoaling large pelagic fish and turtles, delay the "soft-start" until animals move outside the 500 m mitigation zone.	Abate on site
2.4	Maintain visual and possibly acoustic observations within the 500 m mitigation zone continuously during VSP operation to identify if there are any cetaceans present.	Abate on site
2.5	Keep VSP operations under 250 pulses to remain within the 500 m exclusion zone for cetaceans.	Abate on site
3	Shut-Downs	
3.1	Shut down the acoustic source if cetaceans, penguins, shoaling large pelagic fish or turtles are sighted within 500 m mitigation zone until such time as the mitigation zone is clear of cetaceans for 20 minutes or in the case of penguins, shoaling large pelagic fish or turtles, the animals move outside the 500 m mitigation zone before the soft-start procedure and production may commence.	Abate on site
4	Breaks in Airgun Firing	
4.1	Breaks of less than 20 minutes: • there is no requirement for a soft-start and firing can recommence at the same power level as at prior to the break (or lower), provided that continuous monitoring was ongoing during the silent period and no cetaceans, penguins, shoaling large pelagic fish or turtles were detected in the mitigation zone during the breakdown period. • If cetaceans are detected in the mitigation zone during the breakdown period, there must be a minimum of a 20-minute delay from the time of the last detection within the mitigation zone and a soft-start must then be undertaken. In the case of penguins, shoaling large pelagic fish or turtles,	Abate on site

No.	Mitigation measure	Classification
	the animals move outside the 500 m mitigation zone within the 20 minute period.	
4.2	Breaks of longer than 20 minutes: • If it takes longer than 20 minutes to restart the airguns, a full pre-watch and soft-start process should be carried out before the survey re-commences. If an MMO/PAM operator has been monitoring during the breakdown period, this time can contribute to the 60-minute pre-watch time.	Abate on site
5	Period of low visibility	
5.1	During periods of low visibility (where the mitigation zone cannot be clearly viewed out to 500 m), including night-time, the VSP source is only used if PAM technology is in place to detect vocalisations (subject to a risk assessment indicating that the PAM equipment can be safely deployed considering the metocean conditions) or: • there have not been three or more occasions where cetaceans, penguins, shoaling large pelagic fish or turtles have been sighted within the 500 m mitigation zone during the preceding 24-hour period; and • a two-hour period of continual observation of the mitigation zone was undertaken (during a period of good visibility) prior to the period of low visibility and no cetaceans, penguins, shoaling large pelagic fish or turtles were sighted within the 500 m mitigation zone.	Abate on site

<u>Residual impact</u>

The generation of noise from the drillship and support vessels cannot be eliminated due to the operating requirements of dynamic positioning. With the implementation of the above-mentioned mitigation measures specifically for sonar and VSP operations, the residual impact on marine fauna, would have a lower intensity and probability, and the level would drop to INCIDENTAL.

Physiological Injury or mortality in Marine Fauna due to impulsive and non-impulsive noise associated with well-drilling operations		
	Without Mitigation	Assuming Mitigation
Type	Direct	
Extent	Local: limited to well site area	Local
Duration	Temporary (VSP) to Short-term (drilling)	Temporary (VSP) to Short-term (drilling)
Intensity	Low (drilling) to Medium (VSP)	Low
Significance	Incidental (drilling) to Minor (VSP)	Incidental
Probability	Occasional (VSP) to Unlikely (drilling)	Unlikely
Receptor Sensitivity	Medium to High	
Reversibility	Fully reversible	
Loss of Resources	Low	
Mitigation Potential	Low	

Behavioural changes and masking of biologically significant sounds in Marine Fauna due to impulsive and non-impulsive noise associated with well-drilling operations		
	Without Mitigation	Assuming Mitigation
Extent	Local: limited to within 11 km of the well site	No mitigation is proposed
Duration	Temporary (VSP) to Short-term (drilling)	
Intensity	Medium	
Significance	Minor	
Probability	Seldom (drilling) to occasional (VSP)	
Receptor Sensitivity	Medium to High	
Reversibility	Fully reversible	
Loss of Resources	Low	

Mitigation Potential	None

DISTURBANCE AND BEHAVIOURAL CHANGES IN MARINE FAUNA IN RESPONSE TO AIRCRAFT / HELICOPTER NOISE

The dominant low-frequency components of aircraft engine noise (10-550 Hz) penetrate the water only in a narrow (26° for a smooth water surface) sound cone directly beneath the aircraft, with the angle of the cone increasing in Beaufort wind force >2 (Richardson et al. 1995). The peak sound level received underwater is inversely related to the altitude of the aircraft.

Available data indicate that the expected frequency range and dominant tones of sound produced by fixed-wing aircraft and helicopters overlap with the hearing capabilities of most odontocetes and mysticetes (Richardson et al. 1995; Ketten 1998). Determining the reactions of cetaceans to over flights is difficult, however, since most observations are made from either the disturbing aircraft itself (Richardson and Würsig 1997), or from a small nearby vessel. Reactions to aircraft flyovers vary both within and between species, and range from no or minimal observable behavioural response (Belugas: Stewart et al. 1982, Richardson et al. 1991; Sperm: Clarke 1956, Gambell 1968, Green et al. 1992), to avoidance by diving, changes in direction or increased speed of movement away from the noise source (Gray: Withrow 1983; Belugas: Richardson et al. 1991, Patenaude et al. 2002; Sperm: Clarke 1956; Fritts et al. 1983, Mullin et al. 1991, Würsig et al. 1998; Minke: Leatherwood et al. 1982; Bowhead: Patenaude et al. 2002; Humpbacks: Smultea et al. 1995), separation of cow-calf pairs (Gray: Withrow 1983), increased surface intervals (Belugas: Awbrey and Stewart 1983; Stewart et al. 1982; Patenaude et al. 2002), changes in vocalisation (Sperm whales: Watkins and Schevill 1977, Richter et al. 2003, 2006) and dramatic behavioural changes including breaching and lobtailing (Minke: Leatherwood et al. 1982; Sperm: Fritts et al. 1983; Bowhead: Patenaude et al. 2002; Beluga: Patenaude et al. 2002), and active and tight clustering behaviour at the surface (Sperm: Smultea et al. 2008).

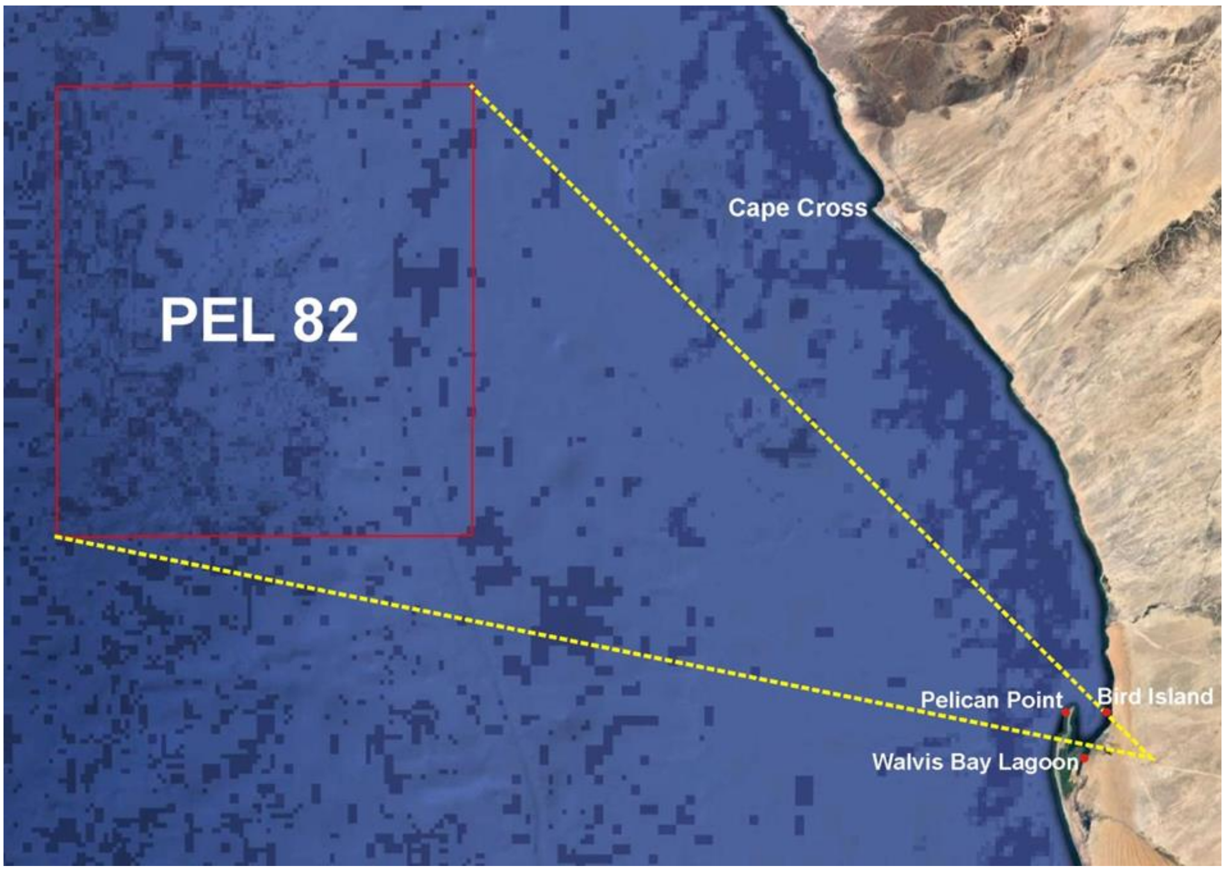
Most authors established that the reactions resulted from the animals presumably receiving both acoustic and visual cues (the aircraft and/or its shadow). As would be expected, sensitivity of whales to disturbance by an aircraft generally lessened with increasing distance, or if the flight path was off to the side and downwind, and if its shadow did not pass directly over the animals (Watkins 1981; Smultea et al. 2008). Smultea et al. (2008) concluded that the observed reactions of whales to brief over flights were short-term and isolated occurrences were probably of no long-term biological significance and Stewart et al. (1982) suggested that disturbance could be largely eliminated or minimised by avoiding flying directly over whales and by maintaining a flight altitude of at least 300 m. However, repeated or prolonged exposures to aircraft over flights have the potential to result in significant disturbance of biological functions, especially in important nursery, breeding or feeding areas (Richardson et al. 1995). Southern right whales were completely displaced from Namibian waters during historical whaling activities and have only recently returned to the Namibian coast to calve. Calving and nursing activities are known to occur in Elizabeth Bay and Hottentot Bay (over 450 km southeast of PEL 82) (Currie et al. 2009). The months of main calving and nursing activities include June to September. The level of disturbance would also depend on the distance and altitude of the aircraft from the animals (particularly the angle of incidence to the water surface) and the prevailing sea conditions.

The reactions of pinnipeds to aircraft noise was reviewed by Richardson et al. (1995). As the frequency of aircraft engine noise overlaps with the hearing ranges of seals, these will likely similarly receive both acoustic and visual cues from aircraft flyovers. Richardson et al. (1995), however, point out that in very few cases was it determined that responses were specifically to aircraft noise as opposed to visual cues. Furthermore, most reported observations relate to pinnipeds on land or ice, with few data specifically on the reactions of pinnipeds in water to either airborne or waterborne sounds from aircraft. Reactions to flyovers vary between species, ranging from stampeding into the water, through temporary abandonment of pupping beaches to alertness at passing aircraft. When in the water, seals have been observed diving when the aircraft passes overhead. Pinnipeds thus exhibit varying intensities of a startle response to airborne noise, most appearing moderately tolerant to flyovers and habituating over time (Richardson et al. 1995; Laws 2009). The rates of habituation also varies with species, populations, and demographics (age, sex). Any reactions to over flights would thus be short-term and isolated occurrences would unlikely be of any long-term biological significance. The seal colony at Cape Cross north of Walvis Bay and inshore of PEL 82 represents the largest colony in the project area, with a smaller colony on Hollamsbird Island south of Sandwich Harbour. The colony at Pelican Point in Walvis Bay is primarily a haul-out site. As the Walvis Bay airport (or a suitable airport nearby, e.g. Swakopmund) would be used as the logistics base for fixed-wing and rotary-wing operations as part of the potential well drilling project, flight paths would need to be planned to avoid these colonies, particularly the one at Pelican Point, which falls into the direct flight path from the airport to the centre of PEL 82 (

Figure 4-5).

The hazards of aircraft activity to birds include direct strikes as well as disturbance, the degree of which varies greatly. The negative effects of disturbance of birds by aircraft were reviewed by Drewitt (1999) and include loss of usable habitat, increased energy expenditure, reduced food intake and resting time and consequently impaired body condition, decreased breeding success and physiological changes. Nesting birds may also take flight and leave eggs and chicks unattended, thus affecting hatching success and recruitment success (Zonfrillo 1992). Differences in response to different types of aircraft have also been identified, with the disturbance effect of helicopters typically being higher than for fixed-wing aeroplanes. Results from a study of small aircraft flying over wader roosts in the German Wadden Sea showed that helicopters disturbed most often (in 100 % of all potentially disturbing situations), followed by jets (84 %), small civil aircraft (56 %) and motor-gliders (50 %) (Drewitt 1999).

FIGURE 4-5 AREA OF POTENTIAL FLIGHT PATHS (WITHIN DASHED YELLOW LINES) FROM WALVIS BAY AIRPORT TO THE NORTHEASTERN AND SOUTHWESTERN EXTREMES OF PEL 82, INDICATING LOCATION OF SEAL AND BIRD COLONIES (SEE TEXT FOR DETAILS).



Sensitivity of birds to aircraft disturbance are not only species specific, but generally lessened with increasing distance, or if the flight path was off to the side and downwind. However, the vertical and lateral distances that invoke a disturbance response vary widely, with habituation to the frequent loud noises of landing and departing aircraft without ill effects being reported for species such as gulls, lapwings, ospreys and starlings, amongst others (reviewed in Drewitt 1999). Further work is needed to examine the combined effects of visual and acoustic stimuli, as evidence suggests that in situations where background noise from natural sources (e.g. wind and surf) is continually high, the visual stimulus may have the greater effect.

The nearest seabird colonies to Walvis Bay airport are at Walvis Bay lagoon and the man-made Bird Island guano platform in Walvis Bay, both of which are important bird areas and provide a vital breeding habitat. These colonies potentially fall within the flight path between the airport and the license area, although they are all located far enough away to not be influenced by aircraft landing at or taking off from the Walvis Bay airport (or a suitable airport nearby, e.g. Swakopmund). The nearest colony to a direct flight path to the area of interest would be the Bird Island guano platform, on the edge of the direct flight path from the airport to the northeastern point of PEL 82 (

Figure 4-5).

Indiscriminate low altitude flights over whales, seals, seabird colonies and turtles by helicopters used to support the drilling unit could thus have an impact on behaviour and breeding success. The level of disturbance would depend on the distance and altitude of the aircraft from the animals (particularly the angle of incidence to the water surface) and the prevailing sea conditions and could range from low to medium intensity for individuals but of small intensity for the populations as a whole. Impacts would be regional (although temporary in nature a few minutes in every week while the helicopter passes overhead). As impacts will seldom occur and be fully reversible, the significance of the potential impact is considered to be of MINOR significance without mitigation.

<u>Mitigation</u>

Recommendations for mitigation include:

No.	Mitigation measure	Classification
1	Avoid flying over sensitive areas near Walvis Bay, including Namib-Skeleton Coast National Park and Ramsar sites like the Walvis Bay Wetlands and Sandwich Harbour. These zones are essential for conserving birds, turtles, fish and marine mammals, some of which are threatened. Low-altitude flights can disturb breeding colonies, causing nest abandonment and higher predation risks. Key habitats like Walvis Bay Wetlands and Bird Island guano platform may overlap with flight paths but are distant from airport zones	Avoid / abate on site

No.	Mitigation measure	Classification
2	Avoid extensive low-altitude coastal flights.	Avoid/ abate on site
3	Maintain a flight altitude >1,000 m over the Walvis Bay coastline, which includes protected areas like Namib-Skeleton Coast National Park and Ramsar sites such as the Walvis Bay Wetlands and Sandwich Harbour. These regions support diverse bird and wildlife species, some at risk or endangered. Low-altitude flights can disrupt breeding colonies, increasing predation risks. Important Bird Areas near the airport include Walvis Bay Wetlands and Bird Island guano platform, which may intersect helicopter routes though are not close to main flight zones. Exceptions: take-off/landing, medical emergencies and Diaz Point (approach only from the north).	Avoid/ abate on site
4	Comply fully with aviation and authority guidelines and rules.	Avoid/ abate on site
5	Brief all pilots on the ecological risks associated with flying at a low level along the coast or above marine mammals.	Avoid

Residual impact

The generation of noise from helicopters cannot be eliminated if helicopters are required for crew changes. With the implementation of the mitigation measures above, the residual impact would reduce to INCIDENTAL significance.

Disturbance and behavioural changes in seabirds, seals, turtles and cetaceans due to support aircraft		
	Without Mitigation	Assuming Mitigation
Type	Direct, Indirect	
Extent	Regional	Regional
Duration	Temporary	Temporary
Intensity	Small	Small
Significance	Minor	Incidental
Probability	Seldom	Unlikely
Receptor Sensitivity	Medium	

Reversibility	Fully reversible
Loss of Resources	Low
Mitigation Potential	Medium

4.4.2.5 DISCHARGE OF WASTE TO SEA (E.G. DECK AND MACHINERY SPACE DRAINAGE, SEWAGE AND GALLEY WASTES, PRODUCED WATER) AND LOCAL REDUCTION IN WATER QUALITY

<u>Description of the potential impact</u>

The table below summarises the project activities that will result in discharges of wastes to the sea.

Activity phase	Activity
Pre-drilling survey	Operation of survey vessel
Mobilisation	Transit of drilling units and support vessels to the drill site
Operation	Operation of drilling unit and support vessels
	Opening and closing of BOP
	Possible discharge of produced water during well testing
Demobilisation	Drilling unit / support vessels leave drill site and transit to port or next destination

These activities and their associated aspects are described further below:

- Deck drainage: all deck drainage from work spaces is collected and piped into a sump tank on board the drilling unit inline with MARPOL compliance (15 ppm oil in water). The fluid would be analysed and any hydrocarbons skimmed off the top prior to discharge. The oily substances would be added to the waste (oil) lubricants and disposed of at a suitable facility onshore.
- Sewage: sewage discharges will be comminuted and disinfected. In accordance with MARPOL Annex IV, the effluent must not produce visible floating solids in, nor causes discolouration of, the surrounding water. The treatment system must provide primary settling, chlorination and dechlorination before the treated effluent can be discharged into the sea. The discharge depth is variable, depending upon the draught of the drilling unit / support vessel at the time, but would be in accordance with MARPOL Annex IV.

- Vessel machinery spaces, mud pit wash residue and ballast water: the concentration of oil in discharge water from vessel machinery space or ballast tanks may not exceed 15 ppm oil in water (MARPOL Annex I). If the vessel intends to discharge bilge or ballast water at sea, this is achieved through use of an oily-water separation system. Oily waste substances must be shipped to land for treatment and disposal.
- Food (galley) wastes: food wastes may be discharged after they have been passed through a comminuter or grinder, and when the drilling unit is located more than 3 nautical miles from land. Discharge of food wastes not comminuted is permitted beyond 12 nautical miles. The ground wastes must be capable of passing through a screen with openings <25 mm. The daily volume of discharge from a standard drilling unit is expected to be <0.2 m^3.
- Detergents: detergents used for washing exposed marine deck spaces are discharged overboard. The toxicity of detergents varies greatly depending on their composition, but low-toxicity, biodegradable detergents are preferentially used. Those used on work deck spaces would be collected with the deck drainage and treated as described above.
- Cooling Water: electrical generation on drilling units is typically provided by large diesel-fired engines and generators, which are cooled by pumping water through a set of heat exchangers. The cooling water is then discharged overboard. Other equipment is cooled through a closed loop system, which may use chlorine as a disinfectant. Such water would be tested prior to discharge and would comply with relevant Water Quality Guidelines.
- Opening and closing of BOP: A further operational discharge is associated with routine well opening and closing operations. As part of these operations, the subsea BOP stack elements will vent between 500 to 1 000 litres per month of oil-based hydraulic fluid into the ocean at the seafloor. Concentrated BOP fluids, which are usually mineral oil- or glycol-water mixes are mildly toxic to crustaceans and algae (96 h LC_{50} 102-117 ppm) but are completely biodegradable within 28 days.
- Well (flow) testing: is undertaken to determine the economic potential of any discovery before the well is abandoned or suspended. If produced water arises during well flow testing, it would be separated from the oily components and treated onboard to reduce the remaining hydrocarbons in these produced waters and discharged overboard, or be shipped to shore for disposal. Discharged treated water may retain trace hydrocarbons, representing possible toxicity risks to marine organisms. Incomplete hydrocarbon combustion during flaring can result in unburnt material reaching the sea surface and forming observable oil slicks.

The potential impact of such operational discharges from the drilling unit and resultant local reductions in water quality would include reduced physiological functioning of marine organisms due to the biochemical effects on the water column, increased food source for marine fauna due to discharge of galley wastes potentially leading to fish aggregation around drilling units and increased predator-prey interactions.

If water flows during well testing, the hydrocarbon component will be separated and piped to a flare boom where it would be incinerated, while the water will be treated and possibly discharged. This product water contains hydrocarbons, which if released overboard without treatment would have toxic effects on marine fauna (indirect negative impact).

Inefficient combustion of hydrocarbons can result in the release of unburnt hydrocarbons, which ‘drop-out’ onto the sea surface and may form a visible slick of oil (indirect negative impact).

Project Controls

The potential drilling operation will be undertaken in a manner consistent with good international industry practice.

Contractors will make sure that the potential exploration campaign is undertaken in compliance with the applicable requirements in MARPOL 73/78, as summarised below.

- The discharge of biodegradable food wastes (excluding cooking oils and grease) from vessels is regulated by MARPOL 73/78 Annex V, which stipulates that:
    - No disposal to occur within 3 nm (± 5.5 km) of the coast.
    - Disposal between 3 nm (± 5.5 km) and 12 nm (± 22 km) needs to be comminuted to particle sizes smaller than 25 mm.
    - Disposal overboard without macerating can occur greater than 12 nm from the coast. As the drilling unit will be stationary, food waste will need to be comminuted prior to discharge at the drilling site.
- Discharges of oily water (deck drainage, bilge and mud pit wash residue) to the marine environment are regulated by MARPOL 73/78 Annex I, which stipulates that vessels must have:
    - A Shipboard Oil Pollution Emergency Plan (SOPEP).
    - A valid International Oil Pollution Prevention Certificate, as required by vessel class.
    - Equipment for the control of oil discharge from machinery space bilges and oil fuel tanks, e.g. oil separating/filtering equipment and oil content meter. Oil in water concentration must be less than 15 ppm prior to discharge overboard.
    - Oil residue holding tanks.

  - Oil discharge monitoring and control system. The system will make sure that any discharge of oily mixtures is stopped when the oil content of the effluent exceeds 15 ppm.
- Sewage and grey water discharges from vessels are regulated by MARPOL 73/78 Annex IV, which specifies the following:
  - Vessels must have a valid International Sewage Pollution Prevention Certificate (ISPPC).
  - Vessels must have an onboard sewage treatment plant providing primary settling, chlorination and dechlorination before discharge of treated effluent.
  - The discharge depth is variable, depending upon the draught of the drill rig / semi-submersible at the time, but will be in accordance with MARPOL 73/78 Annex IV.
  - Discharge of sewage beyond 12 nm requires no treatment. However, sewage effluent must not produce visible floating solids in, nor cause the discolouration of, the surrounding water.
  - Sewage must be comminuted and disinfected for discharges between 3 nm (± 6 km) and 12 nm (± 22 km) from the coast. This will require an onboard sewage treatment plant or a sewage comminuting and disinfecting system.
  - Disposal of sewage originating from holding tanks must be discharged at a moderate rate while the ship is proceding on route at a speed not less than 4 knots.
- Sewage will be treated using a marine sanitation device to produce an effluent with:
  - A biological oxygen demand (BOD) of <25 mg/L (if the treatment plant was installed after 1/1/2010) or <50 mg/L (if installed before this date).
  - Minimal residual chlorine concentration of 0.5 mg/L.
  - No visible floating solids or oil and grease.
- Cooling water and freshwater surplus would be tested prior to discharge and would comply with relevant South African Water Quality Guidelines for residual chlorine, salinity and temperature relative to the receiving environment.

Contractors will be required to develop a Waste and Discharge Management Plan for all wastes generated at the various sites and a Chemical Management Plan detailing the storage and handling of chemicals, as well as measures to minimise potential pollution. These plans will include / address the following:

- Environmental awareness to make sure wastes are reduced and managed as far as possible.
- Avoidance of waste generation, adopting the Waste Management Hierarchy (reduce, reuse, recycle, recover, residue disposal), and use of BAT.

- Treatment of wastes at source (including maceration of food wastes, compaction, incineration, treatment of sewage and oily water separation).
- Development of a waste inventory that classifies (hazardous, non-hazardous or inert) and quantifies waste, and identifies treatment and disposal methods.
- Waste collection and temporary storage, which is designed to minimise the risk of escape to the environment (for example by particulates, infiltration, runoff or odours).
- On-site waste storage, which is limited in time and volume.
- Provision of dedicated, clearly labelled, containers (bins, skips, etc.) in quantities adequate to handle anticipated waste streams and removal frequency.
- Chemicals will be appropriately stored onboard the project vessels (segregation, temperature, ventilation, retention, etc.).

During well testing, once the produced water has been separated from the hydrocarbon component, the hydrocarbon component will be burned off via the flare booms, while the water will be temporarily collected in a slop tank. The product water is then either directed to:

- a settling tank prior to transfer to supply vessel for onshore treatment and disposal; or
- a dedicated treatment unit where, after treatment, it is either:
  - (i) if hydrocarbon content is < 30 mg/L, discharged overboard; or
  - (ii) if hydrocarbon content is > 30 mg/L, subject to a 2nd treatment or directed to tank prior to transfer to supply vessel for onshore treatment and disposal.

Impact assessment

Impact on Marine Fauna from Operational Discharges

The potential impact of such operational discharges from the drilling unit would include reduced physiological functioning of marine organisms due to the biochemical effects on the water column, increased food source for marine fauna due to discharge of galley wastes potentially leading to fish aggregation around drilling units and increased predator-prey interactions. Given the offshore location of the license area, waste discharges are expected to disperse rapidly and there is no potential for accumulation of wastes leading to any detectable long-term impact.

The majority of the discharged wastes are not unique to the project vessels, but rather common to the numerous vessels that operate in or pass through Namibian coastal waters daily. As volumes discharged would be low, any associated impacts would be of low intensity and limited to the drilling location over the short-term.

For support vessels travelling from Walvis Bay operational discharges would likewise be restricted to the immediate vicinity of the vessel over the short-term. Although waste discharges would definitely occur as a result of the operation of the drilling unit and support vessels, the likelihood of impacts occurring is considered to be ‘occasional’ due to the far offshore location of the license area away from any sensitive coastal receptors. This impact is considered to be fully reversible as waste discharges and their potential impacts would cease after demobilisation. The significance of the potential impacts is therefore considered to be MINOR without mitigation.

Impact on Marine Fauna from Discharge of Produced water

Some produced water is expected per well. PEL 82 is located 72 km from the coast at its closest point and is thus far removed from any coastal receptors. The dominant wind and current direction will also make sure that any discharges will disperse rapidly mainly in a north-westerly direction away from coast.

The overboard discharge of treated product water would be of small magnitude and temporary (7 days of flaring over a period of up to 14 days), and limited to the area in the immediate vicinity of the drill rig (local). The potential for toxic effects on marine fauna would be fully reversible once operations are completed and with a low probability (unlikely) of the impact occurring and is thus considered of MINOR significance without mitigation.

Impacts on Marine Fauna from Hydrocarbon 'drop-out' during flaring:

The PEL 82 is located 72 km from the coast at its closest point and is thus far removed from any coastal receptors. The dominant wind and current direction will also make sure that any discharges move mainly in a north-westerly direction away from coast. Given the offshore location of the drill area(s), hydrocarbon 'drop-out' is expected to disperse rapidly and is unlikely to have an impact on sensitive coastal receptors. Due to the distance offshore, it is only likely to be pelagic species of fish, birds, turtles and cetaceans that may be affected by potential hydrocarbon 'drop-out', some of which are species of conservation concern, but they are unlikely to respond to the minor changes in water quality.

The impact of hydrocarbon 'drop-out' during flaring would be of low intensity, limited to the drilling location (local) and be temporary (7 days of flaring over a period of up to 14 days). Impacts of 'drop-out' would be fully reversible once flaring is completed, with a low probability of the impact being realised. The impact of well testing is therefore considered of MINOR significance without mitigation.

<u>Mitigation</u>

The following mitigation measures are proposed to avoid and reduce at source:

In addition to compliance with MARPOL 73/78 standard, the other project controls and their monitoring, the following measures will be implemented to reduce wastes at the source:

No.	Mitigation measure	Classification
1	Prohibit operational discharges when transiting through the MPAs and EBSAs during transit to and from the drill site.	Avoid/reduce at source
2	Implement an awareness programme that addresses reduced water usage and waste generation at the various sites, shore-based and marine.	Reduce at Source

3	Use drip trays to collect run-off from equipment that is not contained within a bunded area and route contents to the closed drainage system.	Avoid / Reduce at Source
4	Implement leak detection and repair programmes for valves, flanges, fittings, seals, etc.	Avoid/Reduce at Source
5	Use a low-toxicity biodegradable detergent for the cleaning of the deck and any spillages.	Reduce at Source

The following measures are recommended to reduce and manage 'drop-out' onto the sea surface during flaring[7]:

No.	Mitigation measure	Classification
6	Use high efficiency burners for flaring to optimise combustion of the hydrocarbons in order to minimise emissions and hydrocarbon 'drop-out' during well testing.	Avoid / reduce at source
7	Optimise well test programme to reduce flaring as much as possible during the test.	Reduce at source/Abate on site

Residual impact

The potential impacts of discharged wastes cannot be eliminated because the drilling unit and support vessels are needed to undertake the drilling programme and will generate wastes during routine operations.

Should flow-testing be required, the need for flaring and discharge of treated product water (if not shipped to shore) cannot be eliminated.

With the implementation of the above-mentioned mitigation measures, the residual impact would have a lower likelihood, and would therefore decrease to being INCIDENTAL.

[7] Based on the International Finance Corporation's (IFC) Environmental, Health and Safety Guidelines for offshore oil and gas development, April 2007

Impacts of operational discharges to the sea from drilling units and support vessels		
	Without Mitigation	Assuming Mitigation
Type	Direct (wastes), Indirect (produced water, drop-out)	
Extent	Local: limited to immediate area around drill unit or support vessel	Local
Duration	Temporary (produced water) to Short-term (wastes)	Temporary
Intensity	Small	Negligible
Significance	Minor	Incidental
Probability	Occasional (flaring) to Likely (wastes)	Seldom
Receptor Sensitivity	Medium	
Reversibility	Fully reversible	
Loss of Resources	Low	
Mitigation Potential	Low	

4.4.2.6 IMPACT OF SURVEY VESSEL, DRILL UNIT LIGHTING AND FLARING ON MARINE MAMMALS, BIRDS AND FISH

Description of the potential impact

The table below summarises the project activities that will result in an increase in ambient lighting.

Activity phase	Activity
Pre-drilling Survey	Operation of survey vessel
Mobilisation	Transit of drilling units and support vessels to the drill site
Operation	Operation of drill rig at the drill site, operation of survey vessels and support vessels between the drilling unit and port
	Flaring during well tests
Demobilisation	Drilling unit / support vessels leave drill site and transit to port or next destination

These activities and their associated aspects are described further below.

- Transit and operation of the survey vessel, drilling unit and support vessels. The operational lighting of drilling unit and survey/support vessels during transit and installation can be a significant source of artificial light in the offshore environment increasing the ambient lighting in offshore areas.
- Well (flow) testing is undertaken to determine the economic potential of any discovery before the well is abandoned or suspended. During well testing it may be necessary to flare off some of the oil and gas brought to the surface. Flaring produces a flame of intense light at the drill unit. One test would be undertaken per exploration well if a resource is discovered and up to two tests per appraisal well. Each test would take up to 7 days to complete (5 days of build-up and 2 days of flowing and flaring) and involves burning hydrocarbons at the well site. A high-efficiency flare is used to maximise combustion of the hydrocarbons. The amount of hydrocarbons produced would depend on the quality of the reservoir but is kept to a minimum to minimise the impact on the environment and avoid wasting potentially marketable oil and/or gas. However, an estimated 100 to 1,000 bbl oil could be flared per day but only for a maximum duration of 4 hours, i.e. up to 2,000 bbl over the two tests associated with an appraisal well.

The drilling activities would be located in the offshore marine environment, more than 70 km offshore, far removed from any sensitive coastal receptors (e.g. bird or seal colonies), but could still directly affect migratory pelagic species (pelagic seabirds, marine mammals and fish) transiting through the license area. The taxa most vulnerable to ambient lighting are pelagic seabirds, although turtles, large migratory pelagic fish, and both migratory and resident cetaceans may also be attracted by the lights. The strong operational lighting used to illuminate the offshore installations at night and the intense light generated during flaring may disturb and disorientate pelagic seabirds feeding in the area.

<u>Project Controls</u>

The potential drilling operation will be undertaken in a manner consistent with good international industry practice.

<u>Impact assessment</u>

Impacts on Marine Fauna from Drill-rig and Vessel Lighting

Offshore platform structures are known to concentrate both seabirds and their prey due to structural stimuli, food concentrations, oceanographic processes and lights and flares (Wiese *et al*. 2001). Potential attraction may increase during fog when greater illumination is caused by refraction of light by moisture droplets. The strong operational lighting used to illuminate drilling units or vessels at night have been reported to attract primarily passerines

(Hüppop *et al*. 2016), but also Little Auks, Storm-petrels and Shearwaters (Wiese *et al*. 2001), with documented mortalities being higher during migration periods. However, in relation to the huge numbers of migrant birds overflying the seas, collisions with man-made structures seem to be rare, although sometimes several thousand birds may be affected in a single event, particularly during adverse weather conditions (Hüppop *et al*. 2016). Operational lights may also result in physiological and behavioural effects on fish and cephalopods, as these may be drawn to the lights at night where they may be more easily preyed upon by other fish, marine mammals and seabirds. This would be more of an issue for a stationary drilling unit than for a support vessel, which would be constantly moving. It is expected, however, that seabirds and marine mammals in the area would become accustomed to the presence of the project vessels and drill rig within a few days. Since the drilling area is located within the main traffic routes that pass around southern Africa, which experience high vessel traffic, animals in the area should be accustomed to vessel traffic and associated lighting.

Although little can be done at the offshore installation to prevent seabird collisions, reports of collisions or death of seabirds on drilling units are rare. Should they occur, the light impacts would primarily take place at the well location and along the route taken by the support vessels between the drilling unit and Walvis Bay. Most of the seabird species breeding in Namibia feed relatively close inshore (10-30 km), with African Penguins recorded as far as 60 km offshore and Cape Gannets up to 140 km offshore. It is expected, however, that seabirds and marine mammals in the area become accustomed to the presence of the installations within a few days, thereby making the significance of the overall impact on these populations negligible. The significance to the populations of fish and squid of increased predation as result of being attracted to an installation’s lights is deemed to be insignificant.

The increase in ambient lighting in the offshore environment would be of negligible intensity and limited to the drilling location over the short-term. For support vessels travelling from Walvis Bay increase in ambient lighting would likewise be restricted to the immediate vicinity of the vessel over the short-term. Although an increase in ambient lighting would definitely occur as a result of the operation of the drilling unit and support vessels, the likelihood of impacts occurring is considered to be ‘occasional’ due to the offshore location of the area of interest away from most sensitive receptors. This impact is considered to be fully reversible. The significance of the potential impacts is therefore considered to be INCIDENTAL without mitigation.

Impacts on Marine Fauna from Lighting from Flare

Flaring during well testing produces a flame of intense light and heat at the drill unit. The intense light generated during flaring at night may disturb and disorientate pelagic seabirds feeding in the area. Flare lighting may also result in indirect physiological and behavioural effects on fish and cephalopods, as these maybe drawn to the lights at night where they maybe more easily preyed upon by other fish and seabirds (indirect negative impact).

Drilling activities would be undertaken in the offshore marine environment, over 72 km from the shore at its closest points and thus far removed from any sensitive coastal receptors (e.g. bird or seal colonies) and range of most coastal seabirds (10-30 km), but could still directly affect some migratory pelagic species (pelagic seabirds, marine mammals and fish) transiting through the license area. Odontocetes are also highly mobile, supporting the notion that various species are likely to occur in the license area and thus potentially be attracted to bright lights in the license area.

The increase in ambient lighting in the offshore environment due to flaring would be of low intensity and temporary, limited to the area in the immediate vicinity of the drill rig (local). The potential for behavioural disturbance as a result of flaring would be fully reversible once operations are completed and with a low probability of the impact occurring and is thus considered to be INCIDENTAL without mitigation.

Mitigation

The use of lighting on the project vessels and drill rig cannot be eliminated due to safety, navigational and operational requirements. Recommendations for mitigation include:

No.	Mitigation measure	Classification
1	The lighting on the support vessels, and drill rig, should be reduced to a minimum compatible with safe operations whenever and wherever possible.	Avoid/Reduce at Source
2	Light sources should, if possible and consistent with safe working practices, be positioned in places where emissions to the surrounding environment can be minimised	Avoid/Reduce at Source
3	Keep disorientated, but otherwise unharmed, seabirds in dark containers (e.g. cardboard boxes) for subsequent release during daylight hours. Capturing and transportation of seabirds must be undertaken according to specific protocols as outlined by wildlife response specialists.	Repair or Restore
4	Report ringed/banded birds to the appropriate ringing/banding scheme (details are provided on the ring).	Repair or restore
5	Optimise well test programme to reduce flaring as much as possible during the test.	Reduce at source/Abate on site

No.	Mitigation measure	Classification
6	Commence with well testing during daylight hours, as far as possible.	Reduce at source/ Abate on site
7	Monitor flare (continuous) for any malfunctioning, etc. (including any drop-out).	Avoid/reduce at source

Residual impact

The use of lighting on the drilling unit cannot be eliminated due to safety, navigational and operational requirements. With the implementation of the above-mentioned mitigation measures, the residual impact remains INCIDENTAL.

Impacts of increased ambient lighting from drilling units and support vessels		
	Without Mitigation	Assuming Mitigation
Type	Direct	
Extent	Local: limited to immediate area around drill unit or support vessel	Local
Duration	Temporary (flaring) to Short-term (vessel/rig lighting)	Short-term
Intensity	Negligible	Negligible
Significance	Incidental	Incidental
Probability	Occasional	Occasional
Receptor Sensitivity	Medium	
Reversibility	Fully reversible	
Loss of Resources	Low	
Mitigation Potential	None	

4.3.3 IMPACT SUMMARY FOR PLANNED EVENTS

The residual impacts on marine habitats and communities associated with the proposed drilling of up to 10 exploration wells in PEL 82 are summarised in the Table below, and the main mitigation measures are listed. The total area to be impacted by the proposed exploration drilling can be considered negligible with respect to the total area of the Central Namib and Namib ecozone.

For the sake of completeness, impacts deemed Incidental have been included in the assessment above but have subsequently been excluded from the assessment in the ESIA report. These are highlighted below.

<table>
<tr><th colspan="3">IMPACT ASSESSMENT SUMMARY</th></tr>
<tr><th>Main Impacts</th><th>Main Mitigations</th><th>Main residual impact</th></tr>
<tr><td colspan="3">Biological component</td></tr>
<tr><td>Disturbance of Seabed Sediments and Associated Biota by ROV Surveys and Drilling</td><td>• Do not land ROVs on the seabed as part of normal operations.
• Design of pre-drilling site surveys to collect sufficient information on seabed habitats, including the mapping potentially sensitive and vulnerable habitats within 500 m of a proposed well site thereby preventing potential conflict with the well site.
• If sensitive and potentially vulnerable habitats are detected, adjust the well position accordingly to beyond 500 m or implement appropriate technologies, operational procedures and monitoring surveys to reduce the risks of, and assess the damage to, vulnerable seabed habitats and communities.
• Limit the area directly affected by physical contact with infrastructure to the smallest area required.</td><td>Incidental</td></tr>
<tr><td>Disturbance and/or smothering of soft sediment communities due to residual cement and drilling solids discharge at the seabed</td><td rowspan="3">• Pre-drilling site surveys should be carefully designed to make sure that drilling locations are positioned at least 500 meters away from any vulnerable habitats (e.g., hard grounds), sensitive species (e.g., cold-water corals, sponges), or significant structural features.
• If sensitive and potentially vulnerable habitats are detected, adjust the well position accordingly to beyond 500 m or implement appropriate technologies, operational procedures and monitoring surveys to reduce the risks of, and assess the damage to, vulnerable seabed habitats and communities..</td><td>Incidental</td></tr>
<tr><td>Disturbance and/or smothering of soft sediment communities due to residual cement and drilling solids discharge at the surface</td><td>Incidental</td></tr>
<tr><td>Disturbance and/or smothering of deep-water reef communities due to drilling solids discharge at the surface</td><td>Incidental</td></tr>
</table>

IMPACT ASSESSMENT SUMMARY		
Main Impacts	Main Mitigations	Main residual impact
Biochemical Impacts of WBS and cement leachates	• Use only low-toxicity and partially biodegradable additives. • Use high efficiency solids control equipment • Conduct regular maintenance of the onboard solids control equipment.	Incidental
Biochemical Impacts of residual NADFs on marine organisms	• Test drilling fluids for toxicity (LC50) prior to start of drilling, barite contamination and oil content to check the specified discharge standards are maintained. • Test drill cuttings daily for retained oil content to check specified discharge standards are maintained (average residual oil on cuttings <6.9%) before discharge. ° • Monitor cement returns with an ROV and stop cement pumping if significant discharges are detected on the seafloor. • Monitor (using ROV) hole wash out to reduce discharge of fluids, as far as possible.	Minor
Impacts of drill cuttings discharge on water column (turbidity & light) and seabed (turbidity)	None	Incidental
Impacts of Cuttings Discharges: development of anoxic sediments around the wellbore during drilling of the riseless sections	None	Minor

IMPACT ASSESSMENT SUMMARY		
Main Impacts	Main Mitigations	Main residual impact
Impacts of petroleum infrastructure and residual cement on marine biodiversity (Wellhead Abandonment)	• Monitor cement returns with an ROV and stop cement pumping if significant discharges are detected on the seafloor. • Monitor (using ROV) hole wash out to reduce discharge of fluids, as far as possible. • Undertake a post drilling ROV survey to scan seafloor for any dropped equipment and other removable features (e.g. excess cement) around the well site. • Ship any excess cement onboard the drilling unit to shore for storage or disposal.. • The location of abandoned wellheads must be registered and distributed via "Notice to Mariners" and "Notice to Fishers". • In the event that equipment is lost to the seabed during the operational stage, assess safety and metocean conditions before performing any retrieval operations	Incidental
Introduction of Invasive species on petroleum infrastructure	• Develop a ballast water management plan that considers all IMO requirements (Avoid / reduce at source) • Use filtration procedures during loading. • Conduct routine cleaning of ballast tanks. • Checkall infrastructure is thoroughly cleaned prior to deployment.	Incidental
Disturbance, behavioural changes and avoidance of feeding and/or breeding areas in shoaling large pelagic fish, seabirds, seals, turtles and cetaceans due to drilling and vessel noise	• Implement a maintenance plan to make sure all diesel motors and generators receive adequate maintenance to minimise noise emissions. • Make sure vessel transit speed between the Area of Interest and port is a maximum of 12 kts (22 km/h), except within 25 km of the coast where it is reduced further to 10 knots (18 km/h).	Incidental

IMPACT ASSESSMENT SUMMARY		
Main Impacts	Main Mitigations	Main residual impact
Disturbance and behavioural changes in shoaling large pelagic fish, seabirds, seals, turtles and cetaceans due to VSP	• Appoint a minimum of two dedicated Marine Mammal Observer (MMO), with a recognised MMO training course, on board for marine fauna observation (360 degrees around drilling unit), distance estimation and reporting. One MMO should also have Passive Acoustic Monitoring (PAM) training should a risk assessment, undertaken ahead of the VSP operation, indicate that the PAM equipment can be safely deployed considering the metocean conditions (specifically current). • Make sure drilling unit vessel is fitted with PAM technology (one or more hydrophones), which detects animals through their vocalisations, should it be possible to safely deploy PAM equipment. • VSP profiling should, as far as possible, only commence during daylight hours with good visibility. However, if this is not possible due to prolonged periods of poor visibility (e.g. thick fog) or unforeseen technical issue which results in a night-time start, refer to "periods of low visibility" below.	Incidental

IMPACT ASSESSMENT SUMMARY		
Main Impacts	Main Mitigations	Main residual impact
Disturbance and behavioural changes in shoaling large pelagic fish, seabirds, seals, turtles and cetaceans due to VSP (cont.)	• Undertake a 1-hr (as water depths >200 m) pre-shoot visual and possible acoustic scan (prior to soft-starts / airgun tests) within the 500 m radius mitigation zone in order to confirm there are no cetaceans, turtles, penguins and shoaling large pelagic fish activity close to the source. Implement a “soft-start” procedure of a minimum of 20 minutes’ duration when initiating the acoustic source (except if testing a single airgun on lowest power). This requires that the sound source be ramped from low to full power rather than initiated at full power, thus allowing a flight response by marine fauna to outside the zone of injury or avoidance. • Delay “soft-starts” if cetaceans, turtles and shoaling large pelagic fish are observed / detected within the mitigation zone during the pre-shoot visual / acoustic scan. A “soft-start” should not begin until 20 minutes after cetaceans depart the mitigation zone or 20 minutes after they are last seen or acoustically detected by PAM in the mitigation zone. In the case of penguins, shoaling large pelagic fish and turtles, delay the “soft-start” until animals move outside the 500 m mitigation zone. • Maintain visual and possibly acoustic observations within the 500 m mitigation zone continuously during VSP operation to identify if there are any cetaceans present. • Keep VSP operations under 250 pulses to remain within the 500 m exclusion zone for cetaceans.	Incidental

IMPACT ASSESSMENT SUMMARY		
Main Impacts	Main Mitigations	Main residual impact
Disturbance and behavioural changes in shoaling large pelagic fish, seabirds, seals, turtles and cetaceans due to VSP (cont.)	• Shut down the acoustic source if cetaceans, penguins, shoaling large pelagic fish or turtles are sighted within 500 m mitigation zone until such time as the mitigation zone is clear of cetaceans for 20 minutes or in the case of penguins, shoaling large pelagic fish or turtles, the animals move outside the 500 m mitigation zone before the soft-start procedure and production may commence. Breaks of less than 20 minutes: • there is no requirement for a soft-start and firing can recommence at the same power level as at prior to the break (or lower), provided that continuous monitoring was ongoing during the silent period and no cetaceans, penguins, shoaling large pelagic fish or turtles were detected in the mitigation zone during the breakdown period. • If cetaceans are detected in the mitigation zone during the breakdown period, there must be a minimum of a 20-minute delay from the time of the last detection within the mitigation zone and a soft-start must then be undertaken. In the case of penguins, shoaling large pelagic fish or turtles, the animals move outside the 500 m mitigation zone within the 20 minute period.	Incidental

IMPACT ASSESSMENT SUMMARY		
Main Impacts	Main Mitigations	Main residual impact
	Breaks of longer than 20 minutes: • If it takes longer than 20 minutes to restart the airguns, a full pre-watch and soft-start process should be carried out before the survey re-commences. If an MMO/PAM operator has been monitoring during the breakdown period, this time can contribute to the 60-minute pre-watch time.	
Disturbance and behavioural changes in shoaling large pelagic fish, seabirds, seals, turtles and cetaceans due to VSP (cont.)	Make sure that during periods of low visibility (where the mitigation zone cannot be clearly viewed out to 500 m), including night-time, the VSP source is only used if PAM technology is in place to detect vocalisations (subject to a risk assessment indicating that the PAM equipment can be safely deployed considering the metocean conditions) or: • there have not been three or more occasions where cetaceans, penguins, shoaling large pelagic fish or turtles have been sighted within the 500 m mitigation zone during the preceding 24-h period; and • a two-hour period of continual observation of the mitigation zone was undertaken (during a period of good visibility) prior to the period of low visibility and no cetaceans, penguins, shoaling large pelagic fish or turtles were sighted within the 500 m mitigation zone.	Incidental
Disturbance of marine fauna due to helicopter noise	• Pre-plan flight paths to make sure that no flying occurs over sensitive areas near Walvis Bay. • Avoid extensive low-altitude coastal flights • Maintain a flight altitude >1 000 m over the Walvis Bay coastline at all times,	Incidental

IMPACT ASSESSMENT SUMMARY		
Main Impacts	Main Mitigations	Main residual impact
	except when taking off and landing or in a medical emergency. • Comply fully with aviation and authority guidelines and rules. • Brief all pilots on the ecological risks associated with flying at a low level along the coast or above marine mammals	

IMPACT ASSESSMENT SUMMARY		
Main Impacts	Main Mitigations	Main residual impact
Reduction in water quality due to normal vessel discharges	• Prohibit operational discharges when transiting through the MPAs and EBSAs during transit to and from the drill site. • Implement an awareness programme that addresses reduced water usage and waste generation at the various sites, shore-based and marine. • Use drip trays to collect run-off from equipment that is not contained within a bunded area and route contents to the closed drainage system. • Implement leak detection and repair programmes for valves, flanges, fittings, seals, etc. • Use a low-toxicity biodegradable detergent for the cleaning of the deck and any spillages.	Incidental
Reduction in water quality due to discharge of produced water	• Use high efficiency burners for flaring to optimise combustion of the hydrocarbons in order to minimise emissions and hydrocarbon 'drop-out' during well testing. • Optimise well test programme to reduce flaring as much as possible during the test	Incidental
Disturbance of marine fauna due to vessel lighting and flaring	• The lighting on the support vessels, and drill rig, should be reduced to a minimum compatible with safe operations whenever and wherever possible. • Light sources should, if possible and consistent with safe working practices, be positioned in places where emissions to the surrounding environment can be minimised. • Keep disorientated, but otherwise unharmed, seabirds in dark containers (e.g. cardboard boxes) for subsequent release during daylight hours. Capturing and transportation of seabirds must be undertaken according to specific protocols	Incidental

IMPACT ASSESSMENT SUMMARY		
Main Impacts	Main Mitigations	Main residual impact
	as outlined by wildlife response specialists. • Ringed/banded birds should be reported to the appropriate ringing/banding scheme (details are provided on the ring). • Optimise well test programme to reduce flaring as much as possible during the test. • Commence with well testing during daylight hours, as far as possible. • Monitor flare (continuous) for any malfunctioning, etc. (including any drop-out).	

4.4 ASSESSMENT OF UNPLANNED EVENTS

4.4.1 SUMMARY OF OIL SPILL MODELLING RESULTS

Using OILMAP/SIMAP oil spill modelling system to evaluate the probable spill effects under varying environmental conditions in the near-field and the far-field, representative “worst-case” events were analysed to assess the potential impact of a Light Crude Oil release from subsurface well loss of containment events at three sites within PEL 82 on the nearby waters and shorelines (Tetra Tech 2025). Each scenario was simulated for two seasons: Summer (November – April) and Winter (May – October). Each scenario simulated a continuous release of light crude oil over a 30-day period, with the modelling extended to 60 days to assess long-term dispersion. Modelling assumed a continuous release rate per day of 18,668 barrels, with the total release volume of 560,040 barrels.

The modelling approach involved two tools. OILMAPDeep was used for near-field analysis, focusing on the vertical transport of oil and gas plumes immediately following release. OILMAP/SIMAP was applied for far-field analysis, which assessed the horizontal transport and weathering of oil over time.

Stochastic Results

Stochastic modelling was used to assess the probability and spatial extent of oil exposure across the sea surface, shoreline and water column.

Key findings include:

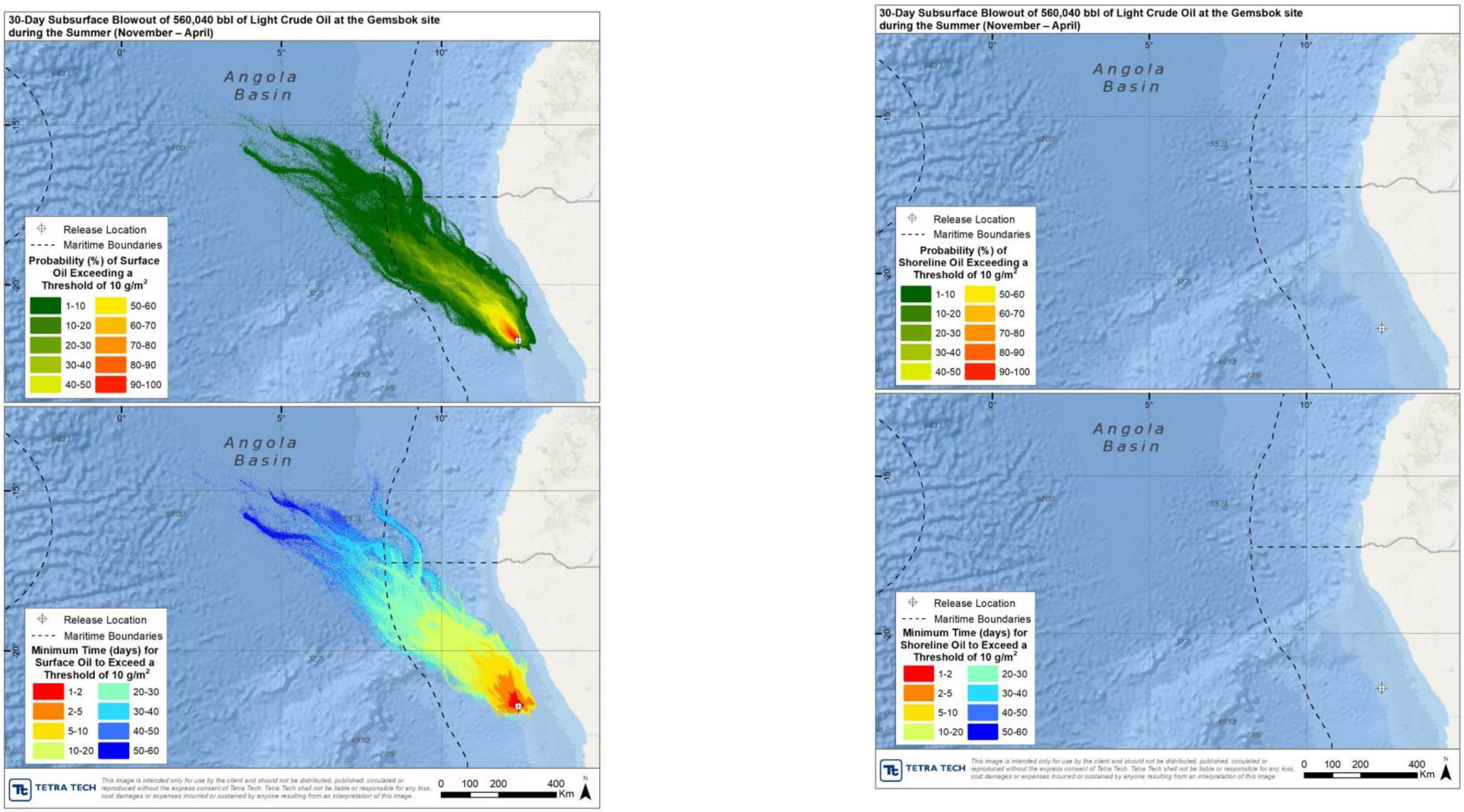
- Surface oiling above the 10 g/m^2 threshold was consistently transported northwest due to prevailing offshore currents.
- Summer scenarios produced larger surface oiling footprints, extending up to 1,500 km from the release site. Figure 4-6 illustrates the worst-case scenario during summer at the Gemsbok site.
- No shoreline oiling above threshold levels was predicted.

TABLE 4-5 SUMMARY OF WORST-CASE DETERMINISTIC MODELLING RESULTS

ID	Location	Season	Total Oil Released (bbl)	Fate Summary	Trajectory	Shoreline Impacts
1	Gemsbok	Summer	560,040	~37% evaporated, ~21% degraded, ~30% remained on surface	Surface oil transported ~350 km NW; water column oil within 50 km NW	None
2	Gemsbok	Winter	560,040	~34% evaporated, ~28% degraded, ~24% remained on surface	Surface oil transported ~175 km NW; water column oil within 50 km NW	None
3	Potential second Well/ Sable	Summer	560,040	~40% evaporated, ~18% degraded, ~35% remained on surface	Surface oil transported ~500 km NW; water column oil within 25 km NW	None
4	Potential second Well/ Sable	Winter	560,040	~35% evaporated, ~28% degraded, ~20% remained on surface	Surface oil transported ~175 km WNW; water column oil within 50 km NW	None
5	Shallow Well	Summer	560,040	~50% evaporated, ~10% degraded, ~27% remained on surface	Surface oil transported ~350 km NW; water column oil within 25 km N	None
6	Shallow Well	Winter	560,040	~50% evaporated, ~15% degraded, ~13% remained on surface	Surface oil transported ~300 km NW/W; water column oil within 15 km W	None

Note: These results reflect the final distribution of oil at the end of the 60-day simulation and do not represent peak concentrations during the simulation period.
Source: RPS Ocean Science, 2025

FIGURE 4-6 SURFACE OILING PROBABILITIES (TOP LEFT) AND MINIMUM TRAVEL TIMES (BOTTOM LEFT), AND SHORELINE OILING PROBABILITIES (TOP RIGHT) AND MINIMUM TRAVEL TIMES (BOTTOM RIGHT) DURING SUMMER AT THE GEMSBOK SITE.



- Water column oiling above 1,000 µg/L remained within 10 km of the release locations. Total hydrocarbons in the water column thus remained concentrated near the release location.

Deterministic Results

Deterministic modelling provided detailed insights into the maximum concentrations and environmental fate of hydrocarbons under defined worst-case conditions (TABLE 4-5). Outputs included:

- Maximum surface oil concentration.
- Maximum total hydrocarbon concentration (THC) in the water column.
- Mass balance of oil fate.
- Vertical cross-section views of subsurface oiling.

The mass balance analysis tracked the transformation of oil into various environmental compartments, including surface oil, evaporated oil, entrained oil, degraded oil and shoreline deposition. Notably, no shoreline oiling was predicted in any scenario.

The table below summarises the fate, trajectory and shoreline impact predictions for six worst-case scenarios. Key findings across all scenarios include:

- Evaporation was the dominant fate mechanism, accounting for 34% to 50% of the released oil.
- Degradation via photo-oxidation and biodegradation ranged from 10% to 28%.
- Surface oil remaining at the end of the 60-day simulation ranged from approximately 13% to 35%, influenced by seasonal and wind conditions.
- No shoreline oiling was predicted in any scenario.
- Oil exhibited dynamic movement between surface and subsurface compartments throughout the simulation period.

These results indicate low risk of shoreline contamination and widespread ecological impact, assuming appropriate spill response actions are taken.

4.4.2 VESSEL STRIKES COLLISION OF VESSELS WITH MARINE FAUNA

Source of Impact

Activities that could result in faunal strikes are indicated below:

Project phase	Activity
Mobilisation	Transit of drilling unit and support vessels to drill site
Operation	Transit of support /supply vessels between the drilling unit and port
Demobilisation	Transit of drilling unit and support vessels from drill site

These activities and their associated aspects are described further below.

- During the passage of the drill rig and support vessels to and from the Area of Interest for drilling collisions with turtles or marine mammals basking or resting on the sea surface may occur.

Impact Description

The potential effects of vessel presence on marine fauna (especially turtles and cetaceans) include physiological injury or mortality due to the drill rig or support vessels colliding with animals basking or resting at the sea surface (direct negative impact).

Project Controls

Contractors will make sure that the potential drilling campaign is undertaken in a manner consistent with good international industry practice and BAT.

All whales and dolphins are given protection under the Namibian Law. The regulations under the Namibian Marine Resources Act, 2000 (No. 27 of 2000) states that no whales or dolphins may be harassed, killed or fished. Although not legislated in Namibia, no vessel or aircraft should approach closer than 300 m to any whale and a vessel or aircraft should move to a minimum distance of 300 m from any whales if a whale surfaces closer than 300 m from a vessel or aircraft. This control has been considered in the pre-mitigation assessment.

Impact assessment

Ship strikes are globally the biggest threat to large whales, having direct, long-term and population-level consequences (Schoeman *et al.* 2020). Although most scientific publications to date have focussed on collisions between vessel and whales and manatees, there is growing evidence that at least 75 marine species, including smaller whales, dolphins, porpoises, dugongs, manatees, whale sharks, sharks, seals, sea otters, turtles, penguins, and fish are at risk of collision, especially within coastal areas frequented by smaller vessels (reviewed by Schoeman *et al.* 2020). As the Area of Interest for drilling is located in a region of very high vessel traffic (see Figure 3-35), potential collisions between marine fauna and vessels would not be limited to project-specific support vessels and drill rigs. For the duration of the exploration drilling an exclusion zone would be established around the drill rig, potentially requiring adjustment of vessel traffic routes. Such re-routing and associated changes in the concentrations of vessels needs to make sure that whale migration routes or feeding aggregation sites are not compromised as a result of the re-routing thereby potentially leading to increased risk of ship strikes (Schoeman *et al.* 2020). Although ship strikes from project vessels are unlikely, they may occur during the transit of the drill rig to or from the Area of Interest for drilling or during transit of the support vessels between Walvis Bay and the drill site.

Ship strikes have been reported to result in medium-term effects such as evasive behaviour by animals experiencing stress, or longer-term effects such as decreased fitness or habitual avoidance of areas where disturbance is common and in the worst case death (see for example Constantine 2001; Hastie *et al.* 2003; Lusseau 2004, 2005; Bejder *et al.* 2006; Lusseau *et al.* 2009). Ship strikes have been documented from many regions and for numerous species of whales (Panigada *et al.* 2006; Douglas *et al.* 2008; Elvin & Taggart 2008) and dolphins (Bloom

& Jager 1994; Elwen & Leeney 2010), with large baleen whales being particularly susceptible to collision (Pirotta *et al.* 2019). Any increase in vessel traffic through areas used as calving grounds or through which these species migrate will increase the risk of collision between a whale and a vessel. Although PEL 82 does not fall within a recognized Important Marine Mammal Area, the chances of collisions would increase between June and December (inclusive) when humpback and fin whales are known to migrate through the area, and in the vicinity of Elizabeth Bay, which serves as calving grounds for humpbacks.

The potential for ship strikes of turtles and cetaceans is dependent on the spatial and temporal abundance and behaviour of cetaceans in the area and vessel speed. For example, Keen *et al.* (2019) modelled fin whale ship strike risk in the California Current System and found that night-time collision risk was twice as high as the daytime risk. The Area of Interest is located within the main shipping lane around southern Africa, with major demersal trawling lanes being located inshore on the western edge of the shelf. Due to their extensive distributions and feeding ranges, the number of cetaceans encountered by project vessels in the offshore environment is expected to be low for much of the year. However, bimodal peaks in abundance of species migrating northwards to their breeding grounds and on their return migrations to low-latitude feeding grounds (e.g. Humpback, Southern Right, Fin, Sei whales) and winter distributions of sperm whales off the shelf edge may, however, occur. For turtles, due to the extensive turtle distributions and feeding ranges, and the extended distance from their nesting sites (>1,000 km), the numbers of individuals encountered during the drilling campaign are likely to be low. Should ship strikes occur, the impacts would be of high intensity for individuals but of small magnitude for the population as a whole for vessel transits. Furthermore, the duration of the impact would be limited to the short-term and be restricted to the license area and to/from the port (regional). As the impact would be partially reversible but unlikely, the potential for ship strikes is therefore considered to be of MINOR significance without mitigation.

<u>Mitigation</u>

Recommendations for mitigation include:

No.	Mitigation measure	Classification
1	Keep a constant watch from all vessels (Vessel Captain and crew) for cetaceans and turtles in the path of the vessel. Alter course and avoid animals when necessary.	Abate on site
2	Make sure vessel transit speed between the Area of Interest and port is a maximum of 12 kts (22 km/h), except within 25 km of the coast where it is reduced further to 10 knots (18 km/h) as well as when sensitive marine fauna are present in the vicinity.	Avoid/reduce at source
3	Report any collisions with large whales to the International Whaling Commission (IWC) database, which has been shown to be a valuable tool for identifying the species most affected, vessels involved in collisions, and correlations between vessel speed and collision risk (Jensen & Silber 2003).	Repair or restore

Residual Impact Assessment

With the implementation of the mitigation measures above, the residual impact would reduce to INCIDENTAL.

Impacts on turtles and cetaceans due to ship strikes		
	Without Mitigation	Assuming Mitigation
Type	Direct	
Extent	Regional	Regional
Duration	Short term	Short-term
Intensity	Small	Small
Significance	Minor	Incidental
Probability	Unlikely	Unlikely

Receptor Sensitivity	High
Reversibility	Partially reversible
Loss of Resources	Low
Mitigation Potential	None

4.4.3 DISTURBANCE OF SEDIMENTS DUE TO ACCIDENTAL LOSS OF EQUIPMENT

Source of Impact

The project activities that will result in the accidental loss of equipment are listed below.

Project phase	Activity
Mobilisation	Accidental loss of equipment to the water column or the seabed during transit to drill site
Operation	Accidental loss of equipment to the water column or the seabed during operation and transit to / from port
Demobilisation	Accidental loss of equipment to the water column or the seabed during transit from drill site

These activities and their associated aspects are described further below:

- Accidental loss of unsecured equipment / waste on deck during transit;
- Accidental loss of equipment during vessel transfer with crane (i.e. waste containers, equipment, tools, consumable package, etc.).

Impact Description

The potential impacts associated with lost equipment include (direct negative impact):

- Potential disturbance and damage to seabed habitats and associated fauna within the equipment footprint.
- Potential injury or mortality to pelagic and neritic marine fauna due to collision or entanglement in equipment drifting on the surface or in the water column.
- The accidental loss of equipment onto the seafloor could physically damage the seabed and/or disturb sediments within the footprint of the lost item.
- The accidental loss of equipment onto the seafloor would provide a localised area of hard substrate for colonisation by benthic organisms (assessed in Section 4.4.7).

Project Controls

Contractors will make sure that the potential drilling activities undertaken in a manner consistent with good international industry practice and BAT. All loose gear on deck should be fully secured and if lost overboard, either on site or in transit, be recovered as soon as practically possible and when safety and metocean conditions allow.

Impact assessment

The accidental and irretrievable loss of equipment to the seabed could potentially disturb and damage seabed habitats and crush any epifauna and infauna within the equipment footprint. Considering the available area of similar habitat on and off the edge of the continental shelf in the Namib and Central Namib ecozone, this disturbance of, and reduction in, benthic biodiversity can be considered of negligible intensity, highly localised and limited to the footprint of the lost equipment (On-site). Any impacts would persist temporarily only, as lost equipment will be retrieved or if irretrievable and left in place on the seabed would offer hard substratum for colonisation by sessile benthic organisms in an area of otherwise unconsolidated sediments or will likely sink into the sediments and be buried over time. The impact for equipment lost would be fully reversible if retrieved with losses being unlikely. The impact is thus considered to be of INCIDENTAL significance without mitigation.

Mitigation

The following measures will be implemented to manage accidental loss of equipment:

No.	Mitigation measure	Classification
1	Make sure containers are sealed / covered during transport and loads are lifted using the correct lifting procedure and within the maximum lifting capacity of crane system.	Avoid
2	Minimise the lifting path between vessels.	Avoid
3	Maintain an inventory of all equipment and undertake frequent checks to make sure these items are stored and secured safely on board each vessel.	Avoid
4	Undertake a post drilling ROV survey to scan seafloor for any dropped equipment and other removable features around the well site. In the event that equipment is lost, assess safety and metocean conditions before performing any retrieval operations.	Repair/restore

No.	Mitigation measure	Classification
5	Notify SAN Hydrographer of any hazards left on the seabed or floating in the water column, with the dates of abandonment/loss and locations and request that they send out a Notice to Mariners with this information.	Repair / restore

Residual Impact Assessment

In the case of large lost items such as cables, anchors, drill string sections etc, this potential residual impact could be mitigated by retrieval of the lost item (if possible and safe to do so) or if it becomes buried over time. Such recoveries would, however, only occur within the programmed exploration-drilling period due to the financial and environmental risk of the rig staying on site longer than scheduled. The environmental impact of retrieving lost equipment (disturbance of seabed habitats through dragging snag anchors) must also be weighed up against the impact of leaving the lost equipment in place. With the implementation of the above-mentioned mitigation measures, the residual impact is considered to remain of INCIDENTAL significance.

Monitoring

- Establishing a hazards database listing the type of gear left on the seabed and/or in the license area with the dates of abandonment/loss and location, and where applicable, the dates of retrieval.

Disturbance or crushing of benthic macrofauna of unconsolidated sediments by lost equipment		
	Without Mitigation	Assuming Mitigation
Type	Direct	
Extent	On-site: limited to equipment footprints	On-site
Duration	Temporary (equipment retrieved) to Short-term: succession communities would develop within a few weeks	Short term
Intensity	Negligible	Negligible
Significance	Incidental	Incidental
Probability	Seldom	Seldom
Receptor Sensitivity	Medium (unconsolidated sediments) to High (hard grounds)	
Reversibility	Fully reversible	
Loss of Resources	Low	
Mitigation Potential	Medium	

4.4.4 ACCIDENTAL OIL RELEASE TO THE SEA DUE TO VESSEL COLLISIONS, BUNKERING ACCIDENT AND LINE / PIPE RUPTURE

Source of Impact

The project activities that may result in the accidental release of diesel / oil are listed below.

Project phase	Activity
Mobilisation	Transit of drilling unit and support vessels to drill site
Operation	Operation of drilling unit at the drill site and transit of support /supply vessels between the drilling unit and port
	Bunkering of fuel
Demobilisation	Transit of drilling unit and support vessels from drill site

These activities and their associated aspects are described further below:

- The movement of the support vessel between the drilling area and the port of Walvis Bay, and presence of drilling unit, may result in limited interaction with commercial, recreational and fishing boats and other marine recreational activities during their approach to the port. Such interaction may cause a vessel strike or collision resulting in oil tank damage.
- Instantaneous spills of marine gas/oil at the surface of the sea can potentially occur during bunkering of fuel and such spills are usually of a low volume. Similarly, there could be small spills of hydraulic fluid due to line/ pipe ruptures.
- Larger volume spills of low sulphur marine gasoil would occur in the event of a vessel collision or vessel accident.

Impact Description

Marine gasoil spilled in the marine environment may have an immediate detrimental effect on water quality, with the toxic effects potentially resulting in mortality (e.g. suffocation and poisoning) of marine fauna or affecting faunal health (e.g. respiratory damage) (direct negative impact). Being highly toxic, marine gasoil released during an operational spill would negatively affect any marine fauna it comes into contact with. Sub-lethal and long-term effects can include disruption of physiological and behavioural mechanisms, and reduced tolerance to stress . The taxa most vulnerable to hydrocarbon spills are coastal and pelagic seabirds. If the spill reaches the coast, it can result in the smothering of sensitive coastal habitats and susceptible species, which are part of the food chain could potentially concentrate carcinogenic PAHs.

Note: the impact associated with the release of unburnt hydrocarbons during well testing ('drop-out') is assessed under normal operations in Section 4.4.2.5.

Project Controls

Compliance with COLREGS (the Convention dealing with safety at sea, particularly to reduce the risk of collisions at sea) and SOLAS (the Convention ensuring that vessels comply with minimum safety standards).

A 500 m safety zone will be enforced around the drilling unit within which fishing and other vessels would be excluded.

Regulation 37 of MARPOL Annex I will be applied, which requires that all ships of 400 gross tonnage and above carry an approved Shipboard Oil Pollution Emergency Plan (SOPEP). The purpose of a SOPEP is to assist personnel in dealing with unexpected discharge of oil, to set in motion the necessary actions to stop or minimise the discharge, and to mitigate its effects on the marine environment.

As standard practice, an Emergency Response Plan (ERP) and an Source Control Contingency Plan (SCCP) will be prepared and available at all times during the drilling operation.

Project vessels will be equipped with appropriate spill containment and clean-up equipment, e.g. booms, dispersants and absorbent materials. All relevant vessel crews will be trained in spill clean-up equipment use and routine spill clean-up exercises.

Impact assessment

Petroleum discharges, both from natural seeps at the seabed and discharges occurring during the production and transport of petroleum are a common source of toxic substances in marine ecosystems (National Research Council 2003). Satellite imagery analysis covering an extensive area of the west coast between Meob Bay and Cape Columbine was used by TEEPNA (in 2021) in an oil slicks detection study. The large radar dataset covering 12 years included medium and high resolution 864 ENVISAT (2002 - 2012) and 1 864 SENTINEL (2015 - 2021) radar images, respectively.

The study demonstrated the isolated presence of oil from other sources in the offshore areas, particularly from vessels orientated mainly NNW-SSE, and thus in agreement with the orientation of the shipping lanes.

Various factors determine the impacts of oil released into the marine environment. The physical properties and chemical composition of the oil, volume spilled, local weather and sea state conditions and currents greatly influence the transport and fate of the released product. As a general rule, oils with a volatile nature, low specific gravity and low viscosity (e.g. marine gasoil) are less persistent and tend to disappear rapidly from the sea surface. In contrast, high viscosity oils containing bituminous, waxy or asphaltenic residues, dissipate more slowly and are more persistent, usually requiring a clean-up response (see section 4.4.5). Such small spills of crude oil (<7 tons) represent an estimated 80% (by number) of all recorded spills, and yet many of such smaller spills may go unnoticed and remain unreported (ITOPF 2014). Despite such small spills typically disappearing visually within a few days, Brussaard *et al*. 2016 found that dissolved oil compounds in the water column below the slick remained high, spreading beyond the original slick footprint. The high bioavailability and toxicity of the dissolved and dispersed oil to as deep as 8 m below the slick, had immediate adverse effects on plankton communities.

The consequences and effects of small (2,000 – 20,000 litres) diesel fuel spills into the marine environment are summarised below (NOAA 1998). As project vessels typically have larger tank capacities, these figures represent potential spill volumes rather than total tank breaches; more severe consequences would follow a complete breach.

Diesel is a light oil that, when spilled on water, spreads very quickly to a thin film and evaporates or naturally disperses within a few days or less, even in cold water. This rapid dispersal of small spills helps to limit environmental impacts (NOAA 2023). Diesel oil can be physically mixed into the water column by wave action, where due to its hydrophobic nature it adheres to fine-grained suspended sediments, which can subsequently settle out on the seafloor. Marine sediments can therefore act as deposits for hydrocarbons that can have lethal and sublethal effects on benthic invertebrates (Zhou *et al.* 2019) and affect the structure and function of the meio- and macrofaunal communities inhabiting the sediments (Egres *et al.* 2019). As it is not very sticky or viscous, diesel tends to penetrate porous sediments quickly, but wave action and currents in coastal waters contributes to rapid weathering of the oil and therefore its low persistence in the sediments (Sandrini-Neto *et al.* 2016). In combination with biological processes such as biodegradation by microbial communities and the release of oil toxic compounds from the sediment to the water column by bioturbation by benthic fauna (Powell *et al.* 2005; Queirȯs *et al.* 2013), hydrocarbon concentrations in the sediments can be rapidly reduced, resulting in fast recovery of macrobenthic assemblages and the development of resistance in communities exposed to recurrent impacts (Egres *et al.* 2019). In the case of a coastal spill, shoreline clean-up is thus usually not needed. Nonetheless, in terms of toxicity to marine organisms, diesel is considered to be one of the most acutely toxic oil types and recovery of biota following high concentration spills in sheltered environments can take years. Many of the compounds in petroleum products are known to smother organisms, lower fertility and cause disease. In the offshore environment surface spills are unlikely to have an immediate effect on the seabed, but surface spills near the coast may result in the death of intertidal invertebrates and seaweed that come in direct contact with a diesel spill. Fish kills, however, have never been reported for small spills in open water as the diesel dilutes so rapidly. Due to differential uptake and elimination rates, filter-feeders (particularly mussels) can bio-accumulate hydrocarbon contaminants. Crabs and shellfish can be tainted from small diesel spills in shallow, nearshore areas.

Chronic and acute oil pollution is a significant threat to both pelagic and inshore seabirds. Diving sea birds that spend most of their time on the surface of the water are particularly likely to encounter floating oil and will die as a result of even moderate oiling which damages plumage and eyes. The majority of associated deaths are as a result of the properties of the oil and damage to the water repellent properties of the birds' plumage. This allows water to penetrate the plumage, decreasing buoyancy and leading to sinking and drowning. In addition, thermal insulation capacity is reduced requiring greater use of energy to combat cold.

Impacts of oil spills on turtles is thought to primarily affect hatchling survival (CSIR & CIME 2011). Turtles encountered in the project area would mainly be migrating adults and vagrants. Similarly, little work has been done on the effect of an oil spill on fur seals.

The effects of oil pollution on marine mammals are poorly understood (White *et al.* 2001), with the most likely immediate impact of an oil spill on cetaceans being the risk of inhalation of volatile, toxic benzene fractions when the oil slick is fresh and unweathered (Geraci & St Aubin

1990, cited in Scholz *et al.* 1992). Common effects attributable to the inhalation of such compounds to include absorption into the circulatory system and mild irritation to permanent damage to sensitive tissues such as membranes of eyes, mouth and respiratory tract. Direct oiling of cetaceans is not considered a serious risk to the thermoregulatory capabilities, as cetacean skin is thought to contain a resistant dermal shield that acts as a barrier to the toxic substances in oil. Baleen whales may experience fouling of the baleen plates, resulting in temporary obstruction of the flow of water between the plates and, consequently, reduce feeding efficiency. Field observations record few, if any, adverse effects among cetaceans from direct contact with oil, and some species have been recorded swimming, feeding and surfacing amongst heavy concentrations of oil (Scholz *et al.* 1992) with no apparent effects.

The outcomes of an operational spill or tank breach following a vessel collision would depend on timely incident response, management capacity, and preparedness to implement emergency protocols. Response effectiveness varies based on collision type and structural compromise and may require external support should the crew be unable to initiate necessary procedures. In the unlikely event of an operational spill or a spill from a vessel collision, the intensity of the impact would depend on whether the spill occurred in offshore waters where encounters with pelagic seabirds, turtles and marine mammals would be low due to their extensive distribution ranges, or whether the spill occurred closer to the shore where encounters with sensitive receptors will be higher. Due to the dominant winds and currents in the license area, a diesel slick would be blown as a narrow plume extending in a north-westerly direction. The diesel would most likely remain at the surface for a number of days with a negligible probability of reaching sensitive coastal habitats. In offshore environments, impacts associated with a spill or vessel collision would thus be of medium magnitude, local to regional (depending on the nature of the spill), and temporary (days). The impact of a marine gasoil spill would be fully reversible, with a low probability (unlikely (vessel collision) to seldom (operational spill)) of occurring, but based on the high sensitivity of receptors is considered of MAJOR significance without mitigation.

In the case of a spill or collision *en route* to the license area, the spill may extend into coastal MPAs and reach the shore affecting intertidal and shallow subtidal benthos and sensitive coastal bird species, in which case the intensity would be considered high, but remaining local over the short-term. The impact of a marine gasoil spill near the coast would be partially reversible, with a low probability of occurring, and is therefore considered of SEVERE significance without mitigation.

Mitigation

In addition to the best industry practices and project standards, the following measures will be implemented to manage the impacts associated with small accidental spills:

No.	Mitigation measure	Classification
Hydrocarbon Spills		
1	Information about installation operations will be shared with vessel operators through national communication channels, including notices and radio navigation warnings.	Avoid / reduce at source

No.	Mitigation measure	Classification
Hydrocarbon Spills		
2	Make sure personnel are adequately trained in both accident prevention and immediate response, and resources are available on each vessel.	Avoid / reduce at source
3	Develop an Oiled Wildlife Contingency Plan (OWCP) in collaboration with specialist wildlife response organisations with experience in oiled wildlife response. The OWCP should be integrated into the site-specific OSPC and include detailed protocols on the collection, handling and transport of oiled marine fauna.	Avoid / Reduce at source
4	Obtain permission from MFMR to use low toxicity dispersants should these be required; Use cautiously.	Abate on and off site
5	As far as possible, and whenever the sea state permits, attempt to control and contain the spill at sea with suitable recovery techniques to reduce the spatial and temporal impact of the spill	Abate on site
6	Make sure adequate resources are provided to collect and transport oiled birds to a cleaning station. Capturing and transportation of oiled or injured seabirds must be undertaken according to specific protocols as outlined in the OWCP.	Restore
7	Make sure offshore bunkering is not undertaken in the following circumstances: • Wind force and sea state conditions of ≥6 on the Beaufort Wind Scale; • During any workboat or mobilisation boat operations; • During helicopter operations; • During the transfer of in-sea equipment; and • At night or times of low visibility.	Avoid / Reduce at source

Impacts of an operational spill or vessel collision on marine fauna		
	Without Mitigation	Assuming Mitigation
Type	Direct	
Extent	Local to Regional	Local
Duration	Temporary (days) to Short-term	Temporary
Intensity	Medium	Small
Significance	Major (operational spill) to Severe (vessel collision)	Moderate
Probability	Unlikely (vessel collision) to Seldom (operational spill)	Unlikely
Receptor Sensitivity	High	
Reversibility	Partially reversible	

Loss of Resources	Medium
Mitigation Potential	Medium

Residual Impact Assessment

With the implementation of the project controls and mitigation measures, which would reduce the intensity of a nearshore impact to low, the residual impact will be of small magnitude and of MODERATE significance for both offshore and nearshore spills.

4.4.5 WELL LOSS OF CONTAINMENT

Source of Impact

The project activities that will result in the accidental release of oil are listed below.

Project phase	Activity
Mobilisation	n/a
Operation	well loss of containment
Demobilisation	n/a

The greatest environmental threat from offshore drilling operations is the risk of a major spill of crude oil occurring either from a well loss of containment (LOC) event. It is the uncontrolled release of crude oil and/or natural gas from a well after pressure control systems have failed.

Impact Description

Oil spilled in the marine environment would have an immediate detrimental effect on water quality, with the toxic effects potentially resulting in mortality (e.g. suffocation and poisoning) of marine fauna, affecting faunal health (e.g. respiratory damage) and long-term effects including disruption of behavioural mechanisms, reduced tolerance to stress and incorporation of carcinogens into the food chain (Beyer et al. 2016). If the spill reaches the coast, it can result in the smothering of sensitive coastal habitats.

Project Controls

The drilling contractor will make sure that the potential drilling campaign adheres to recognized international industry standards and Best Available Techniques (BAT).

The primary safeguard against a well loss of containment event is the column of drilling fluid in the well, which exerts hydrostatic pressure on the wellbore. Under normal drilling conditions, this pressure should balance or exceed the natural rock formation pressure to help prevent an influx of gas or other formation fluids. As the formation pressures increase, the density of the drilling fluid is increased to help maintain a safe margin and prevent “blowouts”. However, if the density of the fluid becomes too heavy, the formation can break down. If drilling fluid is lost in the resultant fractures, a reduction of hydrostatic pressure occurs. Maintaining the appropriate fluid density for the wellbore pressure regime is therefore critical to safety and wellbore stability. Abnormal formation pressures are detected by primary well control equipment (pit level indicators, return mud-flow indicators and return mud gas detectors) on the drill unit. The drilling fluid is also tested frequently during drilling operations and its composition can be adjusted to account for changing downhole conditions. The likelihood of a well LOC event is further minimised by installation of a blowout preventer (BOP) on the wellhead at the start of the risered drilling stage. The BOP is a secondary control system, which contain a stack of independently operated cut-off mechanisms, to make sure redundancy in case of failure. The BOP is designed to close in the well to prevent the uncontrolled flow of hydrocarbons from the reservoir. A well LOC event occurs in the highly unlikely event of these pressure control systems failing.

If the BOP does not successfully shut off the flow from the well, the drilling rig would disconnect and move away from the well site while crews mobilise a capping system. The capping system would be lowered into place from its support barge and connected to the top of the BOP to stop the flow of oil or gas.

Oil Spill Response Limited (OSRL), the global oil spill response co-operative funded by more than 160 oil and energy companies, has a base in Saldanha Bay and another base in Aberdeen, which houses cutting-edge well capping equipment designed to shut-in an uncontrolled subsea well. The Saldanha based capping stack is available to oil and gas companies across the industry and provides for swift subsea incident response around the world. The equipment is maintained ready for immediate mobilisation and onward transportation by sea and/or air in the event of an incident. CNEL is a member of OSRL. This would significantly reduce the spill period, should a well loss of containment event occur. All CNEL's wells are designed to allow for capping.

Other project controls include the preparation and implementation of plans that would include aspects related to Shipboard Oil Pollution Emergency Plan (SOPEP), Oil Spill Contingency Plan (OSCP) and Source Control Contingency Plan (SCCP).

Impact assessment

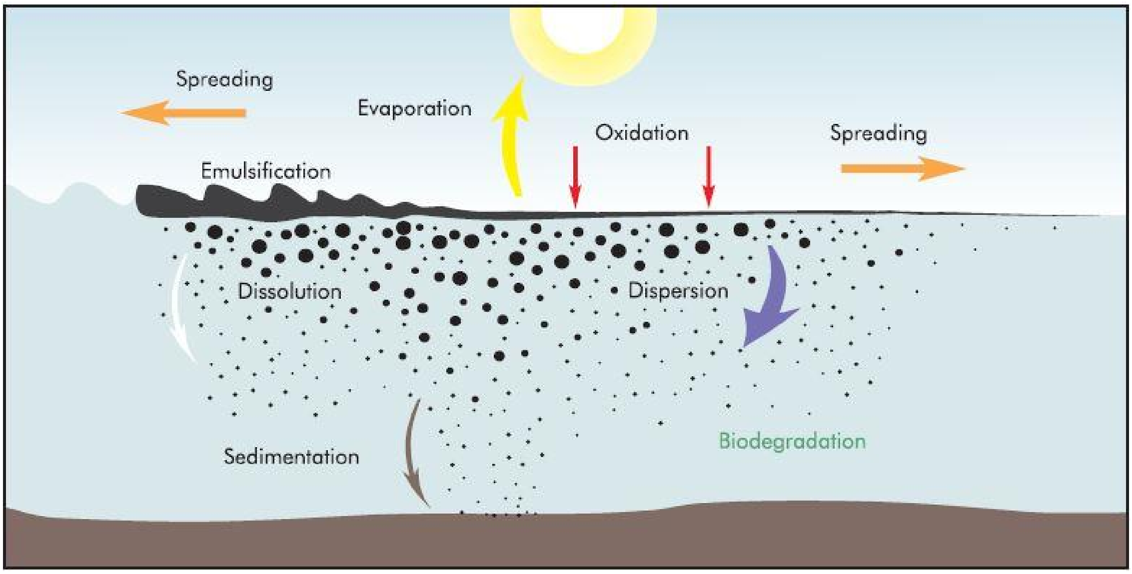
In the order of 52 wells have been drilled in the Namibian offshore environment to date and no well LOC events have been recorded. Global data maintained by Lloyds Register indicates that frequency of a well LOC event from normal exploration wells is in the order of 1.43×10^{-4} per well drilled. While the probability of a major spill happening is thus extremely small, the impact nonetheless needs to be considered as it could have devastating effects on the marine environment.

This assessment examines the potential environmental impacts of hydrocarbon spills on marine fauna using oil spill modelling results and relevant scientific literature. The analysis incorporates both stochastic and deterministic modelling outputs for six well LOC events scenarios within the PEL 82 license area, offshore Namibia.

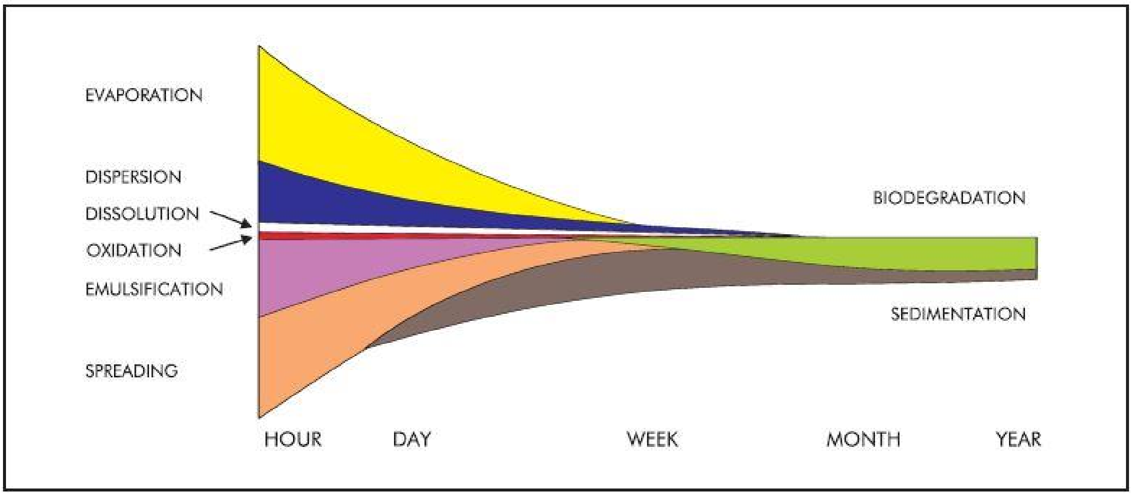
Various factors determine the impacts of oil released into the marine environment. The physical properties and chemical composition of the oil, local weather and sea state conditions and currents greatly influence the transport and fate of the released product. The physical properties that affect the behaviour and persistence of an oil spilled at sea are specific gravity (API), viscosity and pour point, all of which are dependent on the oil's chemical composition (e.g. the amount of asphaltenes, resins and waxes). As soon as oil is spilled, it undergoes physical and chemical changes (collectively termed 'weathering') (Figure 4-7A), which in combination with its physical transport, determine the spatial extent of oil contamination and the degree to which the environment will be exposed to the toxic constituents of the released product. It is estimated that of the oil forming surface layers during a spill, ~40% is rapidly lost to weathering (McNutt *et al.* 2012). Although the individual weathering processes may act simultaneously, their relative importance varies with time (Figure 4-7B). Whereas spreading, evaporation, dispersion, emulsification and dissolution are most important during the early stages of a spill, the ultimate fate of oil is determined by the longer term processes of oxidation, sedimentation and biodegradation.

FIGURE 4-7 A) THE WEATHERING PROCESSES ACTING ON SPILLED CRUDE OIL, AND B) THE FATE OF A TYPICAL MEDIUM CRUDE OIL UNDER MODERATE SEA CONDITIONS - THE WIDTH OF EACH BAND INDICATES THE IMPORTANCE OF THE PROCESS (ITOPF 2002).

A)

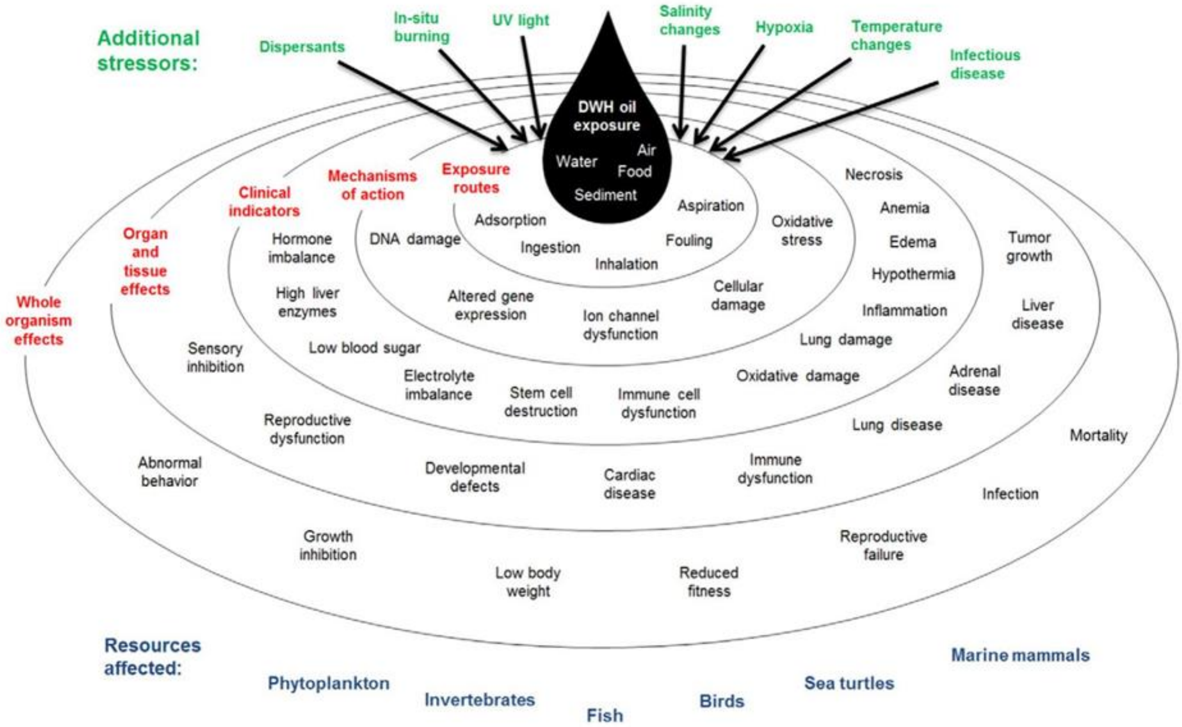


B)



The components of oil known to be toxic to marine organisms include volatile organic compounds (VOCs) such as benzene, toluene, ethylbenzene, and xylene, collectively known as BTEX, as well as polycyclic aromatic hydrocarbons (PAHs), which are known for their persistence in the environment. The polar components of oil (defined as the nitrogen-sulfur-oxygen (NSO)- containing compounds), have a less established toxicity, but can account for ~70% of all oil compounds dissolved in water and are therefore thought to be more toxic to marine organisms and more persistent in the environment than other crude oil components (Liu & Kujawinski 2015). When considering the impact of oil on marine organisms, it is important to consider the composition and comparative toxicity of the specific oil compounds that are present as well as the amount and duration of the oil exposure and the bioavailability of the oil (Saadoun 2015). Oil is most toxic in the first few days after the spill, losing some of its toxicity as it begins to weather and emulsify (Reddy *et al.* 2012; Gros *et al.* 2014). Most of the toxic effects are associated with the monoaromatic compounds and low molecular weight polycyclic hydrocarbons, as these are the most water-soluble components of the oil (NRC 2003). When the additive toxic levels of hydrocarbons exceed the threshold concentration, their effects can lead to mortality. On ingestion, oil hydrocarbons travel to the liver where the resulting metabolites of PAHs become highly toxic and carcinogenic due to their ability to attack and bind to DNA and proteins. As hydrocarbons are highly volatile, the inhalation of concentrated petroleum vapours by mammals, turtles and birds can results in the inflammation of and damage to the mucus membranes of airways, lung congestion or even pneumonia. Inhalation of benzene and toluene, results in these volatiles being rapidly transferred into the bloodstream where accumulation in the brain and liver, can cause neurological disorders (e.g. narcosis) and hepatic damage (Saadoun 2015). Physical contact with the oil is the major route of exposure usually affecting birds and furred mammals at the sea surface. As these rely on their coats for buoyancy and warmth, they typically succumb to hypothermia, drowning and smothering when oil adheres to them.

FIGURE 4-8 CONCEPTUAL FIGURE ILLUSTRATING THE BIOLOGICAL EFFECTS OF THE DEEPWATER HORIZON OIL SPILL (SOURCE: BEYER ET AL. 2016).



The fate of the released hydrocarbons during DWH was influenced by an array of factors including the great depth, the composition and magnitude of the well LOC event, high sea surface temperature, strong solar irradiation, the presence of a community of indigenous oil degrading microbes, the oceanic circulation pattern in deep and surface waters during the spill and the extensive use of dispersants (both deep and surface applied). It must be pointed out that, as the factors influencing the fate of the hydrocarbons were thus fairly site specific, some of the biological effects described for the DWH spill may not be applicable to a potential LOC of the continental slope of the southern African West Coast. For example, sea surface temperatures off the West Coast are likely to be lower, and communities of oil degrading microbes less well established (if present at all) (see Blaizot 2019). Furthermore, many of the ecological impacts reported for the DWH spill were the result of the application of dispersants, both at the leaking well head and at the sea surface. Dispersants applied to the DWH spill modified the spreading, dispersal, weathering, biodegradation, and toxicity of the spilled oil, and their use is now thought to have negatively influenced the total environmental impact of the DWH spill as some of the components proved to be considerably more persistent than originally thought (Kujawinski *et al.* 2011; White *et al.* 2014).

Plankton: Crude oil spills affect phytoplankton communities in a variety of ways and estimates of toxicity varies widely depending on the species involved (Abbriano *et al.* 2011; Zhou *et al.* 2013; Buskey *et al.* 2016). Oil toxicity can impact both phytoplankton community composition and abundance, but while productivity and growth may be reduced (Hallare *et al.* 2011; Brussaard *et al*. 2016), some species appear to be highly tolerant of oil exposure, and in some cases it may even stimulate their growth (Ozhan *et al.* 2015; D'Souza *et al.* 2016; Tang *et al.* 2019).

Zooplankton similarly respond to oil in a variety of ways ranging from significant but short-term impacts on zooplankton assemblages (Almeda *et al.* 2013b, 2014a, 2014b; Carassou *et al.* 2014; Cohen *et al.* 2014), with some taxa decreasing in density, while others increased. The stimulation of microbial activity in response to oil may also result in increased production of zooplankton. Small ciliates and copepods are particularly sensitive to oil exposure responding by reduced egg production rates, faecal pellet production rates, and egg hatching. Copepods, euphasiids and mysids will ingest emulsified oil droplets leading to acute toxicity, bioaccumulation and transfer to hydrocarbon contaminants to higher order consumers (Buskey *et al.* 2016) and to benthic detritivores (Almeda *et al.* 2015). Larger gelatinous zooplankton are also sensitive to bioaccumulation effects (Almeda *et al.* 2013a), potentially acting as vehicles for contaminant transfer up the food web to apex predators such as turtles. However, there is still insufficient evidence of the extent to which oil transfers to the next trophic level.

A further consideration regarding impacts on plankton is photo-enhanced toxicity, especially where drilling is proposed in areas known as fish spawning habitats. Certain PAHs are classified as phototoxic, raising an additional level of complexity regarding the exact chemical composition of different oils. Photo-enhanced toxicity occurs when certain wavelengths enhance the observed toxicity of a compound, thereby posing additional risks to the buoyant eggs of pelagic fish and the shallow spawning habitat of many nearshore species, as these areas are likely to receive higher intensities of ultraviolet light.

The time of year during which a large spill takes place will significantly influence the magnitude of the impact on plankton and pelagic fish eggs and larvae. Should the spill coincide with a major spawning peak in the kingklip, squid, hake, anchovy and pilchard spawning areas (see Figure 3-15) during spring and summer, it could result in severe mortalities and consequently a reduction in recruitment (Baker *et al.* 1990; Langangen *et al.* 2017), although Neff (1991) maintains that temporally variable and environmental conditions are likely to have a far greater impact on spawning and recruitment success than a single large spill. Sensitivity of fish eggs and larvae was thought to be primarily associated with exposure to fresh (unweathered) oils (Teal & Howarth 1984; Neff 1991), but recent studies have demonstrated that the weathered water accommodated fraction of the spill results in increased toxicity (Esbaugh *et al.* 2016).

Benthic biota: In a deep-water well LOC event, oil can reach the sediments by a number of pathways (reviewed in NRC 2003). The hydrocarbon mixture escaping from the well has a density lower than that of seawater and rises towards the surface. Typically, some of the rising hydrocarbons split off and form a subsurface plume of neutrally buoyant oil droplets that are distributed by deep currents and may become trapped at depth by stratification of the water column. The finely dispersed oil droplets in the subsurface plume stay suspended in the water column and undergo microbial degradation or are sorbed onto suspended sediments that are then deposited on the seabed. Depending on the characteristics of the deep currents these deep plumes may extend over substantial distances and cover large areas before the hydrocarbons settle out thereby potential impacting habitats far removed from the well site (Gong *et al.* 2014; Payne & Driskell 2015; Stout *et al.* 2017). Following the DWH spill, it was discovered that a substantial fraction of the hydrocarbons that reached the surface, were returned to the seabed over a period of weeks as bacteria-mediated, mucous-rich marine snow that had proliferated in the near surface waters during the spill (Passow 2014; Passow & Ziervogel 2016). Several mechanisms have been proposed to explain the formation of the marine snow, including coagulation of phytoplankton and/or suspended matter with oil droplets and production of mucosoid material from bacterial degradation of the oil both at the surface and at depth. Oil-degrading microbial communities, present naturally in the area due to deep-water hydrocarbon seeps, grew and multiplied rapidly following the spill event (Passow *et al.* 2012), with successions of diverse oil-degrading bacterial communities responding to post-spill conditions (Arnosti *et al.* 2016; Yang *et al.* 2016).

Oil may be transported to the seabed *via* oil–particle aggregates (Khelifa *et al.* 2005; Niu *et al.* 2011) or sink directly in the form of tar-like residues from weathered oil. As the use of dispersants can enhance the formation of sediment aggregates, oil-particle interactions can play a significant role in more ecologically sensitive nearshore areas where suspended sediment concentrations are typically higher than in offshore waters (NRC 2005; Gong *et al.* 2014; Cai *et al.* 2017). Following the DWH event, oil deposited in deep-sea sediments was estimated to cover an area in excess of 2 000 km^2 (Stout *et al.* 2017). This pulse in sedimentation resulted in changes in sedimentary redox conditions over a period of two years (Hastings *et al.* 2016) with concomitant changes in benthic communities.

A wide range of effects of oil on benthic invertebrates has been recorded, with much of the research focussing on meiofauna and the various life stages of polychaetes, molluscs and crustaceans (Elmgren *et al.* 1983; Frithsen *et al.* 1985; Volkman *et al.* 1994; Qu *et al.* 2016).

Following the DWH spill Montagna *et al.* (2013) reported severe reduction in abundance and diversity of soft-bottom benthic macrofauna and meiofauna extending 3 km from the wellhead in all directions and covering an area of 24 km^2 with moderate impacts extending over 148 km^2 (see also Fisher *et al.* 2014a). Effects over larger spatial scales were, however, also reported (Salcedo *et al.* 2017). However, as tolerances and sensitivities vary greatly, generalisations cannot be confidently made. Some burrowing infauna show high tolerances to oils, as the weathered product serves as a source of organic material that is suitable as a food source. Deposit- and suspension-feeding polychaetes in particular can take advantage of bioturbation and degradation of oiled sediments (Scholtz *et al.* 1992; Kotta *et al.* 2007). Volkman *et al.* (1994) suggest that some epifauna produce complex responses to oiling and that bioaccumulation of petroleum hydrocarbons can in some cases readily occur, with cascade effects to higher order consumers. Sessile and motile mussels and crustaceans are frequent victims of direct oiling or coating, although the latter appear capable of metabolising and excreting accumulated hydrocarbons quite rapidly due to a well-developed mixed-function oxygenase system. Filter-feeders in particular are susceptible to ingestion of oil in solution, in dispersion or adsorbed on fine particles (Saadoun 2015). Chronic oiling is known to cause a multitude of sub-lethal responses in taxa at different life stages, variously affecting their survival and potential to re-colonise oiled areas. Tolerances to oil vary between life stages, with larvae and juvenile stages generally being more sensitive to the water-soluble fractions of oil than adults. This results in highly modified benthic communities with (potentially lethal) 'knock-on' effects for higher order consumers.

Abundance and diversity of megafauna (Valentine & Benfield 2013; Felder *et al.* 2014; McClain *et al.* 2019) were also reported to be negatively affected by oiling, with significant toxicity effects from both oil and dispersants reported for deep-water corals (White *et al.* 2012; Fisher *et al.* 2014a, b; Prouty *et al.* 2014; DeLeo *et al.* 2016). In PEL 82, the fauna inhabiting unconsolidated sediments is expected to be relatively ubiquitous, usually comprising fast-growing species able to rapidly recruit into disturbed areas. In contrast, benthic biota associated with hard grounds are typically more vulnerable to disturbance due to their long generation times.

<u>Sandy shores</u>: Although only a portion of the oil spilled from an offshore well typically reaches the shoreline, even small amounts can cause widespread contamination of coastal habitats and ecosystems, including estuaries and wetlands. Landfall of oil is generally considered an unfavourable situation as stranding causes a multitude of new environmental impacts compared to those experienced in the offshore environment. Kostka *et al.* (2011) reported a rapid response in the development of oil-degrading microbial communities in beach sands following the DWH spill (see also Mortazavi *et al.* 2013), resulting in a significant fraction of the oil buried in beaches expected to have biodegraded within 5 years. Following a spill, weathered oil can appear on beaches as tar mats, and despite clean-up efforts can remain on sandy shorelines for a number of years, as smaller oil fragments and mats can become buried in the sediments to depths of over a metre through accretion (Fernández-Fernández *et al.* 2011; Michel *et al.* 2013). Heavy weather conditions and littoral drift can re-expose these deposits, redistributing the oil particles and mats along the shore and resulting in the re-oiling of beaches even three years after the initial oil stranding (Bejarano & Michel 2016; Beyer *et al.* 2016). On sheltered sandy beaches, buried oil can persist for decades (Bejarano & Michel 2010; Bernabeu *et al.* 2013). Oil burial and persistence is strongly influenced by beach

erosion and deposition cycles, with the grain characteristics and degree of shoreline exposure influencing the penetration and weathering of the oil.

From the comprehensive review of Bejarano and Michel (2016) it becomes evident that oil spilled on beaches results in significant declines in abundance, biomass and diversity of meiofaunal and macrofaunal communities, with recovery of macrofaunal communities typically occurring at between 2-5 years but with recovery of burrowing and long-lived species potentially taking up to 10 years on heavily oiled beaches. Recovery of meiobenthos is typically more rapid. In some cases, recovery of the invertebrate communities was hampered by both re-oiling frequency and the type and degree of beach clean-up following the spill, while in other cases clean-up attempts promoted recovery.

<u>Rocky shores</u>: In the case of oiling of rocky shores, natural recolonisation begins after the processes of physical and chemical degradation have started, with recovery of benthic communities typically occurring within three years. Active clean-up operations of the shores can have a negative or marginal influence on the rate of recovery by sterilising the substratum by removing or killing those biota that survived the initial effects of oiling and would have formed the basis of the subsequent recovery process (Sell *et al.* 1995). In high-energy environments, where the natural removal and degradation of oil is relatively rapid, non-intervention is considered the most effective means of ensuring recovery. Alternatively, adding nutrients to the affected area enriches oil-degrading microorganisms thereby enhancing biodegradation of the oil while preserving the substratum (Serrano *et al.* 2011).

<u>Fish</u>: Adult free-swimming fish in the open sea seldom suffer long-term damage from oil spills because oil concentrations in the water column decline rapidly following a spill, rarely reaching levels sufficient to cause mortality or significant harm. Adult pelagic fish are expected to actively avoid very contaminated waters, and consequently documented cases of fish-kills in offshore waters are sparse (ITOPF 2014). Only in extreme cases of coastal spills when gills become coated with oil can effects be lethal, particularly for benthic or inshore species. Sub-lethal and long-term effects can include disruption of physiological and behavioural mechanisms, reduced tolerance to stress and opportunistic pathogens, and incorporation of PAHs through ingestion of contaminated sediments or prey that has accumulated oil (Thomson *et al.* 2000; Beyer *et al.* 2016).

Following the DWH spill, high PAH metabolites were recorded in the bile of certain fish species, with higher concentrations closer to the spill. However, as metabolites, as chemical markers of oil exposure, were inconsistent among species surveyed and the metabolites measured, their validation is required before use as an indicator of oil contamination (Weisberg *et al.* 2016). In contrast, gene expression and potential effects on sex determination, sexual differentiation, growth regulation and DNA damage in fish was found to be a robust indicator of oil exposure in fish (Beyer *et al.* 2016). Furthermore, the well-developed hepatic mixed function oxygenase (MFO) system in fish make sures that accumulation and retention of high concentrations of petroleum hydrocarbons does not occur and hydrocarbons are thus unlikely to be transfered to predators (Saadoun 2015). Experimental exposure of fish to oil-contaminated sediments was found to reduced fitness and thereby increase the potential for population-level impacts, but field studies of population impacts related to sediment contamination are lacking (Pearson 2014). In a comprehensive field study to determining PAH exposures in demersal fish species in the Gulf of Mexico, Pulster *et al.* (2020) recently concluded that complex interactions exist between multiple hydrocarbon input sources and possible re-suspension or bioturbation of oil-contaminated sediments.

The embryonic and larval life stages of fish, however, show acute toxicity to PAHs, even at low concentrations, although effects vary depending on the species and the extent of exposure. Toxicity effects on the early life stages of fish are generally defined by the occurrence of pericardial edema, which is often accompanied by reduced heart rate and atrial contractility, particularly in large predatory pelagic species such as tunas and billfish (Incardona *et al.* 2014; Esbaugh *et al.* 2016). The cardiotoxic effect may also be accompanied by spinal curvature, finfold damage, and craniofacial malformations (Incardona *et al.* 2014). Impaired cardiovascular development in fish embryos thought to reduce individual cardiovascular performance reduced swimming performance in later life and therefore a high risk for reduced productivity of these commercially-important species.

<u>Seabirds</u>: Chronic and acute oil pollution is a significant threat to both pelagic and inshore seabirds, many of which breed on the islands of the NIMPA, which could be impacted by a large spill. Diving sea birds that spend most of their time on the surface of the water are particularly likely to encounter floating oil and will die as a result of even moderate oiling, which damages plumage and eyes. The majority of associated deaths are as a result of the properties of the oil and damage to the water repellent properties of the birds' plumage. This allows water to penetrate the plumage, decreasing buoyancy and leading to sinking and drowning. In addition, thermal insulation capacity is reduced requiring greater use of energy to combat cold. Oil is also ingested as the birds preen in an attempt to clear oil from plumage and may furthermore be ingested over the medium to long term as it enters the food chain (Integral Consulting Inc. 2006). The effects of ingested oil include anaemia, pneumonia, intestinal irritation, kidney damage, altered blood chemistry, decreased growth, impaired osmoregulation, and decreased production and viability of eggs (Scholz *et al.* 1992; Finch 2011, 2012). Furthermore, even small concentrations of oil transferred from adult birds to the eggs can cause embryo mortalities and significantly reduce hatching rate. Oil spills can thus affect shorebirds through direct acute mortality, as well as indirectly or long term by sub-lethal effects on bird health and behaviour. Habitat degradation of distant feeding or breeding areas may affect bird populations in ways that carry over to subsequent seasons.

<u>Turtles</u>: Impacts of oil spills on turtles is thought to primarily affect hatchling survival (CSIR & CIME 2011), but direct coating of nesting females, contamination of nests and absorption of oil by eggs and hatchlings will occur with heavy shoreline oiling (Hale *et al.* 2017), potentially with far-reaching effects on recruitment success and population status (Putman *et al.* 2015). As the nesting sites in South Africa are all located over 1 500 km away on the KwaZulu Natal coastline, these would not be affected in the event of a spill, but hatchlings carried southwards in the Agulhas Current and into the Agulhas retroflection zone may become oiled. As turtles spend much of their time at the surface, inhalation of the volatile oil fractions will occur leading to respiratory stress, while coating of eyes, nostrils and mouths with oil will cause vision loss, inhalation and ingestion. Indirect ingestion of oil through contamination of their gelatinous prey or coastal foraging sites is also possible. As turtles often feed in convergence zones, they are particularly at risk to oiling as such oceanic features tend to accumulate oil (NOAA 2010; Wallace *et al.* 2016). Direct miring in oil is the most likely impact, decreasing an animal’s ability to move and dive, causing exhaustion, dehydration, overheating, and eventually death.

Any turtle deaths from oil exposure would remove them from the breeding population. For species considered 'endangered' or 'critically endangered' such a loss can be significant.

Seals: Little work has been done on the effect of an oil spill on fur seals and sea lions (pinnipeds), but they are expected to be particularly vulnerable as oil would clog their fur and depending on how they maintain their core body temperature, they may die of hypothermia. The following description is summarised from Helm *et al.* (2015). Although pinnipeds should be able to detect oil through vision and/or smell, they apparently do not actively avoid oil, and are therefore likely to come in contact with it if it comes into their habitat. Acute and long-term chronic exposure to oil in pinnipeds negatively affects the mucous membranes, eyes, ears, external genitalia, and internal organ systems. However, due to small sample sizes, the magnitude of the harm and its long-term consequence to individuals and local populations remain unknown. For those pinnipeds that rely primarily on blubber for insulation (sea lions, seals, walrus), external oiling does not significantly impact their ability to maintain their core body temperature. In fur seals and sea lions, the vulnerability to an oil spill will probably be determined by the degree and time of exposure. Wide-ranging species (e.g. elephant seals) that do not congregate in nearshore waters except to breed and moult, are likely less vulnerable than fur seals and sea lions that spend most of their time nearshore. Fur seals rely mostly on air trapped in their fur, rather than blubber for insulation. Individuals would likely face a serious challenge in maintaining their core body temperature if oiled. Population-level impacts are also likely if spilled oil reaches the haul-out sites and rookeries where these seals rest or annually mass to breed. An ill-timed large spill in the vicinity of a fur seal breeding colony would thus likely be devastating. The feeding and movement pattern of pinnipeds would also directly affect their susceptibility to an oil spill, especially in species that forage at great distances from their breeding colonies. Fur seals tend to forage in the coastal zone along the continental shelf and will thus be more susceptible to both the acute and chronic effects of an oil spill, especially where the oil is transported to the coast. Differences in foraging behaviour will also result in differences in exposure after an oil spill, with benthic foragers being more susceptible to chronic exposure through bioaccumulation of PAHs in their prey than pelagic-feeding species.

Cetaceans: The effects of oil pollution on cetaceans are poorly understood (White *et al.* 2001), but their low vulnerability to oil has also been attributed to their ability to detect and avoid slicks (Helm *et al.* 2015), although conflicting reports exist (see for example Evans 1982; Smultea & Würsig 1995; Matkin *et al.* 2008; Helm *et al.* 2015). Field observations record few, if any, adverse effects among cetaceans from direct contact with oil, and some species have been recorded swimming, feeding and surfacing amongst heavy concentrations of oil (Scholz *et al.* 1992) with no apparent effects. As oil does not adhere to the skin of cetaceans, is not expected to accumulate in or around the eyes, mouth, blow hole, or other potentially sensitive external areas. The skin is thought to contain a resistant dermal shield that acts as a barrier to the toxic substances in oil, and direct oiling of cetaceans is thus not considered a serious risk to the thermoregulatory capabilities. Dispersants added to oil spills have, however, been found to be cytotoxic and genotoxic to whale skin fibroblast cells (Wise *et al.* 2014a, 2014b).

The most likely immediate impact of an oil spill on cetaceans is the risk of inhalation of volatile, toxic benzene fractions when the oil slick is fresh and unweathered (Geraci & St Aubin 1990, cited in Scholz *et al.* 1992). Common effects attributable to the inhalation of such compounds include absorption into the circulatory system leading to narcosis and drowning (St Aubin & Geraci 1994; Matkin *et al.* 2008), inflame mucous membranes, lung congestion leading to pneumonia, neurological damage and liver disorders (Matkin *et al.* 2008), compromised health status and increased disease prevalence (Venn-Watson *et al.* 2015), and mild irritation to permanent damage to membranes of eyes, mouth and respiratory tract. For certain species that frequent or live in nearshore waters, a spill may pose significant risk. For example, populations of coastal-oriented odontocetes that show strong site fidelity restricted to nearshore habitats could be significantly impacted by a spill oiling nearshore waters. If those habitats were oiled, the animals would experience both acute and chronic exposure through their respiratory system and through ingestion of oil-contaminated prey. This may have long-term effects on population structure and size (Matkin *et al.* 2008; Beyer *et al.* 2016; Frasier *et al.* 2019). In contrast, in highly mobile, wide-ranging species, the contact with an oil spill would be relatively brief.

In offshore species, the potential for oil disrupting the reproductive behaviour is remote. However, it is a concern for inshore reproducers, particularly in highly social species, where the disruption of social groups through loss of some key individuals could potentially impact reproductive success over the long-term (see for example Matkin *et al.* 2008).

The impact of oil pollution on local and migrating cetacean populations will obviously depend on the timing and extent of the spill. It is assumed that the majority of cetaceans will be able to avoid oil pollution, though effects on the population could occur where the region of avoidance is critical to population survival. However, oil pollution in areas of cetacean critical habitat (areas important to the survival of the population), such as the extreme near-shore calving / nursing grounds of the humpback whale (e.g. in Elizabeth Bay), could be the most likely to impact populations.

Assuming the worst-case scenario, the intensity of the potential impact of a well LOC event of crude oil varies depending on the faunal group affected ranging from medium for marine mammals, turtles, shoreline benthic communities, spawning areas and cetacean and seal breeding areas, to large for pelagic seabirds. As the spill will rise rapidly to the sea surface where it will disperse and evaporate over time, impacts of deposited oil on benthic communities associated with unconsolidated seabed or deep-water reefs are likely to be negligible, but should deposition of oil on the seabed occur the impacts of deposited oil is likely to persist over the long term. Although predicted not to reach the shoreline, should oil reach the shore it would likely also persist over the medium- to long-term. Impacts to pelagic fauna and seabirds would persist over the medium-term and potentially be only partially reversible, but with impacts to marine fauna being of high likelihood considering the extensive area of the slick. In the unlikely event of a well LOC the slick would spread in a northwest direction entering Angolan and International waters beyond the EEZ and thus be of international extent. The significance would therefore range from SEVERE to CARASTROPHIC depending on the faunal group affected. However, collectively, the impact on marine fauna is assessed to be of CATASTROPHIC significance.

Mitigation

The following measures and Project Control standards should be implemented:

No.	Mitigation measure	Classification
1	As far as possible, schedule drilling operations to align with periods of favourable weather and sea state and always within the drilling unit's safe working weather limits. Modelling results suggest that Summer (November – April) present the worst-case conditions in terms of spill extent, In the case of exploration wells drilled in a sequence covering this period, response needs to be enhanced.	Avoid / Reduce
2	Develop a well-specific response strategy and plans (OSCP and SCCP), aligned with the National OSCP, for each well location that identifies the resources and response required to minimise the risk and impact of oiling (shoreline and offshore). An Oiled Wildlife Contingency Plan (OWCP) would be integrated in the OSCP. This response strategy and associated plans must take cognisance to the local oceanographic and meteorological seasonal conditions, local environmental receptors and local spill response resources. The development of the site-specific response strategy and plans must include the following:	Avoid / Abate on and off site / Restore
2.1	Assessment of onshore and offshore response resources (equipment and people) and capabilities at time of drilling, location of such resources (in-country or international), and associated mobilisation / response timeframes.	
2.2	Selection of response strategies that reduce the mobilisation / response timeframes as far as is practicable. Use the best combination of local and international resources to facilitate the fastest response.	
2.3	Should there be any significant changes in the existing modelling input data closer to the spud date of the well, update the modelling report taking into consideration site- and temporal-specific information, the planned response strategy, and associated resources.	
2.4	Develop intervention plans for the most sensitive areas to minimise risks and impacts and integrate these into the well-specific response strategy and associated plans.	

No.	Mitigation measure	Classification
2.5	If modelling and intervention planning indicates that the well-specific response strategy and plans cannot reduce the response times to less than the time it would take oil to disperse, additional proactive measures must be committed to. For example: • Implement measures to reduce surface response times (e.g. pre-mobilise a portion of the dispersant stock on the support vessels, contract additional response vessels and aircrafts, minimise the time it takes to install the subsea dispersant injection (SSDI) kit by ensuring there is a kit on standby, improve dispersant spray capability, etc.). • Deploy and/or pre-mobilise shoreline response equipment (e.g. response trailers, shoreline flushing equipment, shoreline skimmers, storage tanks, shoreline booms, skirt booms, shore sealing booms, etc.) to key localities for the full duration of drilling operation phase to proactively protect sensitive coastal habitats and areas • Include wildlife response in collaboration with specialist wildlife response organisations with experience in oiled wildlife response as part of the OSCP.	
3	Schedule joint oil spill exercises including the operator and local departments / organisations to test the Tier 1, 2 & 3 responses.	Abate on site / Restore
4	Make sure contract arrangements and service agreements are in place to implement the SCCP, e.g. capping stack, SSDI kit, surface response equipment (e.g. booms, dispersant spraying system, skimmers, etc.), dispersants, response vessels, etc.	Abate on site / Restore
5	Use low toxicity dispersants that rapidly dilute to concentrations below most acute toxicity thresholds. Dispersants should be used cautiously and only with the permission of MFMR.	Abate on and off site
6	Contracted support vessels will be equipped for dispersant spraying and can be used for mechanical dispersion (using the propellers of the ship and/or firefighting equipment). It should have at least 5 m^3 of dispersant onboard for initial response.	Abate on site
7	As far as possible, and whenever the sea state permits, attempt to control and contain the spill at sea with suitable recovery techniques to reduce the spatial and temporal impact of the spill	Abate on site
8	In the event of a spill, use drifter buoys and satellite-borne Synthetic Aperture Radar-based (SAR) oil pollution monitoring to track the behaviour and size of the spill and optimise available response resources	Abate off site
9	Submit all forms of financial insurance and assurances to MIME to manage all damages and compensation requirements in the event of an unplanned pollution event.	Restore

Residual Impact Assessment

After best practice measures (like source control and capping stack deployment), impacts may be reduced to SEVERE but cannot go lower and are deemed As Low As Reasonably Practicable

(ALARP). Although blowouts are highly unlikely, their potential impact requires robust prevention and response plans

Impacts of a major spill following a well LOC event on deepwater benthic macrofauna, pelagic fish and larvae, seabirds, marine mammals and turtles		
	Without Mitigation	Assuming Mitigation
Type	Direct	
Extent	National to International	Inter-regional
Duration	Medium to long	Medium
Intensity	Medium to large (pelagic seabirds)	Medium
Significance	Severe to Catastrophic (pelagic seabirds)	Severe
Probability	Unlikely	Remote
Receptor Sensitivity	High	
Reversibility	Partially reversible	
Loss of Resources	Medium	
Mitigation Potential	Medium	

4.4.6 IMPACT SUMMARY FOR UNPLANNED EVENTS

The residual impacts on marine habitats and communities associated with the unlikely event of an oil spill or other unplanned events are summarised in the Table below, and the main mitigation measures are listed.

For the sake of completeness, impacts deemed Incidental have been included in the assessment above but have subsequently been excluded from the assessment in the ESIA report. These are highlighted below.

IMPACT ASSESSMENT SUMMARY		
Main Impacts	Main Mitigations	Main residual impact
Biological component		
Collision of Vessels with marine fauna and entanglement in gear	• Keep a constant watch from all vessels (Vessel Captain and crew) for cetaceans and turtles in the path of the vessel. Alter course and avoid animals when necessary. • Make sure vessel transit speed between the Area of Interest and port is a maximum of 12 kts (22 km/h), except within 25 km of the coast where it is reduced further to 10 knots (18 km/h) as well as when sensitive marine fauna are present in the vicinity.	Incidental

IMPACT ASSESSMENT SUMMARY		
Main Impacts	Main Mitigations	Main residual impact
	• Report any collisions with large whales to the IWC database	
Accidental loss of equipment to seabed and water column	• Make sure containers are sealed / covered and loads are lifted using the correct lifting procedure and within the maximum lifting capacity of crane system. • Minimise the lifting path between vessels. • Maintain an inventory of all equipment and undertake frequent checks to make sure these items are stored and secured safely on board each vessel. • Undertake a post drilling ROV survey to scan seafloor for any dropped equipment and other removable features around the well site. In the event that equipment is lost during the operational stage, assess safety and metocean conditions before performing any retrieval operations. • Notify Ministry of Works and Transport (Directorate of Maritime Affairs) and the SAN Hydrographer of any hazards left on the seabed or floating in the water column, with the dates of abandonment/loss and locations and request that they send out a Notice to Mariners with this information.	Incidental

IMPACT ASSESSMENT SUMMARY		
Main Impacts	Main Mitigations	Main residual impact
Accidental oil release to the sea due to vessel collisions, bunkering accident and line / pipe rupture	• Information about installation operations will be shared with vessel operators through national communication channels, including notices and radio navigation warnings. • Make sure personnel are adequately trained in both accident prevention and immediate response, and resources are available on each vessel. • Use low toxicity dispersants cautiously and only with the permission of MFMR. • As far as possible, and whenever the sea state permits, attempt to control and contain the spill at sea with suitable recovery techniques to reduce the spatial and temporal impact of the spill. • Make sure adequate resources are provided to collect and transport oiled birds to a cleaning station as per specific protocols for capturing oiled and injured seabirds as outlined in the Oiled Wildlife Contingency Plan (part of the OSCP). • Make sure offshore bunkering is not undertake in the following circumstances: – Wind force and sea state conditions of ≥6 on the Beaufort Wind Scale; – During any workboat or mobilisation boat operations; – During helicopter operations; – During the transfer of in-sea equipment; and – At night or times of low visibility.	Moderate
Effects of well loss of containment event on marine fauna	• As far as possible, schedule drilling operations to align with periods of favourable weather and sea state and always within the drilling unit's safe working weather limits. Modelling results suggest that Summer (November – April) present the worst-case conditions in terms of spill extent. In the case of exploration wells drilled in a sequence covering this period, response needs to be enhanced	Severe

IMPACT ASSESSMENT SUMMARY		
Main Impacts	Main Mitigations	Main residual impact
Effects of well loss of containment event on marine fauna (cont.)	• Develop a well-specific response strategy and plans (OSCP and SCCP), aligned with the National OSCP, for each well location that identifies the resources and response required to minimise the risk and impact of oiling (shoreline and offshore). An Oiled Wildlife Contingency Plan (OWCP) would be integrated in the OSCP. This response strategy and associated plans must take cognisance to the local oceanographic and meteorological seasonal conditions, local environmental receptors and local spill response resources. The development of the site-specific response strategy and plans must include the following: – Assessment of onshore and offshore response resources (equipment and people) and capabilities at time of drilling, location of such resources (in-country or international), and associated mobilisation / response timeframes. – Selection of response strategies that reduce the mobilisation / response timeframes as far as is practicable. Use the best combination of local and international resources to facilitate the fastest response. – Should there be any significant changes in the modelling input data closer to the spud date of the well, these should be considered and the modelling report must be updated accordingly in order to guide the final response strategy – Develop intervention plans for the most sensitive areas to minimise risks and impacts and integrate these into the well-specific response strategy and associated plans.	Severe

IMPACT ASSESSMENT SUMMARY		
Main Impacts	Main Mitigations	Main residual impact

Effects of well loss of containment event on marine fauna
 	
(cont.)
	– If modelling and intervention planning indicates that the well-specific response strategy and plans cannot reduce the response times to less than the time it would take oil to reach the shore, additional proactive measures must be committed to:
	  – Implement measures to reduce surface response times (e.g. pre-mobilise a portion of the dispersant stock on the support vessels, contract additional response vessels and aircrafts, minimise the time it takes to install the subsea dispersant injection (SSDI) kit by ensuring there is a kit on standby, improve dispersant spray capability, etc.).
	  – Deploy and/or pre-mobilise shoreline response equipment (e.g. response trailers, shoreline flushing equipment, shoreline skimmers, storage tanks, shoreline booms, skirt booms, shore sealing booms, etc.) to key localities for the full duration of drilling operation phase to proactively protect sensitive coastal habitats and areas
	  – Include wildlife response in collaboration with specialist wildlife response organisations with experience in oiled wildlife response as part of the OSCP
	• Schedule joint oil spill exercises including CNEL and local departments / organisations to test the Tier 1, 2 & 3 responses.
	• Make sure contract arrangements and service agreements are in place to implement the SCCP, e.g. capping stack, SSDI kit, surface response equipment (e.g. booms, dispersant spraying system, skimmers, etc.), dispersants, response vessels, etc.
		Severe

IMPACT ASSESSMENT SUMMARY		
Main Impacts	Main Mitigations	Main residual impact
Effects of well loss of containment event on marine fauna (cont.)	• Use low toxicity dispersants that rapidly dilute to concentrations below most acute toxicity thresholds. Dispersants should be used cautiously and only with the permission of MFMR. • Contracted support vessels will be equipped for dispersant spraying and can be used for mechanical dispersion (using the propellers of the ship and/or firefighting equipment). It should have at least 5 m^3 of dispersant onboard for initial response. • As far as possible, and whenever the sea state permits, attempt to control and contain the spill at sea with suitable recovery techniques to reduce the spatial and temporal impact of the spill • In the event of a spill, use satellite-borne Synthetic Aperture Radar-based oil pollution monitoring to track the behaviour and size of the spill and optimise available response resources. • Submit all forms of financial insurance and assurances to MIME to manage all damages and compensation requirements in the event of an unplanned pollution event.	Severe

4.5 CUMULATIVE IMPACTS

Cumulative impacts include those which result from combined impacts on areas of influence and/or resources from a proposed project and any other past, present, or reasonably foreseeable future projects or activities in the same area of influence or which may impact on the same resources/receptors. Cumulative effects may be collectively significant despite the individual impacts of a project/activity being minor. The proposed project and any future activities will have a cumulative impact on the receiving environments (physical and socio-economic).

It is difficult to predict cumulative effects as they entail the interaction of numerous projects and/or activities. The exact details of future planned activities are unknown; therefore, the assessment of cumulative impacts must be assessed qualitatively.

Currently various exploration activities have been undertaken or are planned across various PEL blocks. Without knowing which exploration activities may yield commercially viable results, it is difficult to predict where and when future oil and gas activity (ongoing exploration or production) may occur. The extent, duration and scale of these activities is also unknown. The methods used for the exploration, production and transport of petroleum products will also vary depending on the resource type, the area and the operator.

To effectively manage cumulative impacts, the project will need to cooperate with other operators in the area and government level stakeholders. The project should implement mitigation measures that are proportionate to the contribution made to cumulative impacts.

The primary impacts associated with the drilling of exploration wells in the central Namib offshore Bioregion on the Namibian coast, relate to physical disturbance of the seabed, discharges of drilling solids and cement to the benthic environment, the presence of infrastructure remaining on the seabed and increased ambient noise during drilling operations. The development of the potential exploration well(s) in this assessment would impact a maximum cumulative area of ~0.016 km^2 [8](per well) in Namibian offshore Biozones, which can be considered an insignificant percentage of the bioregion as a whole. By 1991, fewer than 10 hydrocarbon wells had been drilled in Namibia, with a further 13 wells drilled between 2010 and 2014. Since 2018, more than 20 additional wells have been drilled in the Walvis and Lüderitz (Orange) Basins. Prior to 1983, technology was not available to remove wellheads from the seafloor, and most of the wells drilled in southern Namibia remain on the seabed. Assuming a conservative estimate of 0.2 km^2 of cumulative seabed affected per well, the total area impacted by the installation and cuttings fall-out of 52 petroleum exploration wells is estimated at ~10.4 km^2, or 0.28% of the total available Namibian marine habitat area (3,778 km^2). Although the cumulative impact area of 10 wells is estimated to be 2 km^2, in reality the total impacted area at any one time is considerably less, due to the natural recovery of benthic communities over the medium term.

Noise associated with the drilling programme would also have cumulative impact on marine fauna. Due to the license area being located within the main vessel traffic routes that pass around southern Africa, ambient noise levels are naturally elevated. Sensitive receptors (e.g. Walvis Ridge and Tripp Seamount) and faunal species (cetaceans, turtles and certain fish) are unlikely to be significantly affected as faunal behaviour will not be affected beyond 11 km during drilling and beyond 400 m during VSP operations. Noise levels would return back to ambient after drilling is complete.

Vessels discharges (e.g. sewage and galley waste) will add to that already occurring in the area, considering that the area of interest is located adjacent to a main shipping route. Based on the small additional volumes, high energy sea conditions and non-continuous, short-term nature of the discharges, the cumulative impact is considered to be negligible.

Although cumulative impacts from other hydrocarbon ventures in the area may increase in future, the cumulative impacts of the potential drilling of 10 exploration wells off central Namibia can be considered of INCIDENTAL significance. It should also be pointed out that despite the drilling of 32 wells in Namibian waters since 1976, there has to date been no blow-out incident. This suggests that hydrocarbon exploration is a comparatively low risk industry.

Activities of other marine users that could lead to cumulative impacts include:

- Shipping, as the block overlaps with a busy shipping route off the African West Coast, leading to potential cumulative noise impacts on marine fauna;

[8] Assuming a threshold deposition thickness of >50 mm and a worst-case area of 15,814 m^2

- Fishing, as pelagic longline, demersal trawl, demersal longline and pole line fisheries periodically overlap with the project area, leading to potential cumulative noise and behavioural impacts on marine fauna; and
- Oil and gas exploration, which is underway in neighbouring blocks in Namibia. Intermittent exploration activities are also taking place off the northern West Coast of South Africa, south of the Namibian EEZ, where an application has been lodged for exploration well drilling in the Deep Water Orange Basin. These activities could lead to potential cumulative impacts on marine fauna and habitats related to noise, physical disturbance and changes in water quality.

4.6 ENVIRONMENTAL ACCEPTABILITY

The proposed exploration activities (normal operations) to be undertaken by CNEL are expected to result in impacts on marine invertebrate fauna in the approved drilling area of PEL 82, ranging from incidental to low significance without mitigation. Only in the case of potential impacts of drilling wastes on vulnerable deep-water reef communities are impacts of minor or moderate significance expected. The potential impacts can be adequately mitigated with the implementation of the proposed mitigation measures, which are in line with current industry good practice for drilling undertaken in South African waters. With implementation of recommended mitigation measures, the significance would reduce to incidental.

The total area to be impacted by the potential exploration drilling can be considered negligible with respect to the total area of the Namib offshore bioregion.

If all environmental guidelines, and appropriate mitigation measures advanced in this report, and the EMP for the potential exploration drilling project as a whole, are implemented, there is no reason why the potential well drilling should not proceed.

Pisces Environmental Services is of the opinion that this assessment is sufficiently robust and provides sufficient information for the competent authority to make an informed decision on the potential project taking into consideration the significance of potential impacts on marine fauna and National strategic policy issues relating to energy and climate change. It is recommended that the commitments presented in this report should be conditional to the Environmental Authorisation, should MIME approve the application.

5 REFERENCES

AMORIM, K. & M.L. ZETTLER, 2023. Gradients and instability: Macrozoobenthic communities in the Benguela Upwelling System off Namibia. *Estuarine, Coastal and Shelf Science* 291: 108421.

ATKINSON, L.J., 2009. Effects of demersal trawling on marine infaunal, epifaunal and fish assemblages: studies in the southern Benguela and Oslofjord. PhD Thesis. University of Cape Town, pp 141.

ATKINSON, L.J., 2010. Benthic impact specialist report for proposed well drilling in petroleum licence block 11B/12B, South Coast, South Africa by CNR International Ltd. Report prepared for CCA Environmental. pp. 30

ATKINSON, L.J., FIELD, J.G. & L. HUTCHINGS, 2011. Effects of demersal trawling along the west coast of southern Africa: multivariate analysis of benthic assemblages. *Marine Ecology Progress Series* 430: 241-255.

ATKINSON, L.J. and T. SHIPTON, 2009. Benthic specialist basic assessment report for the proposed drilling exploration permit in Petroleum Lease Block 1, West Coast, South Africa. pp. 28.

BAILEY, G.W., 1991. Organic carbon flux and development of oxygen deficiency on the modern Benguela continental shelf south of 22°S: spatial and temporal variability. In: TYSON, R.V., PEARSON, T.H. (Eds.), Modern and Ancient Continental Shelf Anoxia. *Geol. Soc. Spec. Publ.*, 58: 171–183.

BAILEY, G.W., 1999. Severe hypoxia and its effect on marine resources in the southern Benguela upwelling system. Abstract, *International Workshop on Monitoring of Anaerobic processes in the Benguela Current Ecosystem off Namibia.*

BAILEY, G.W., BEYERS, C.J. DE B. and S.R. LIPSCHITZ, 1985. Seasonal variation of oxygen deficiency in waters off southern South West Africa in 1975 and 1976 and its relation to catchability and distribution of the Cape rock-lobster *Jasus lalandii*. *S. Afr. J. Mar. Sci.*, 3: 197-214.

BAILEY G.W. and P. CHAPMAN, 1991. Chemical and physical oceanography. In: Short-term variability during an Anchor Station Study in the southern Benguela Upwelling system. *Prog. Oceanogr.*, 28: 9-37.

BAKKE, T., GREEN, A.M.V. & P.E. IVERSEN, 2011. Offshore environmental monitoring in Norway - regulations, results and developments. In: LEE, K. & J. NEFF, (Eds.), Produced Water. Springer, NY (Chapter 25).

BAKKE, T., KLUNGSØYR, J. & S. SANNI, 2013. Environmental impacts of produced water and drilling waste discharges from the Norwegian offshore petroleum industry. *Mar. Environ. Res*. 92: 154-169.

BANKS, A. BEST, P.B., GULLAN, A., GUISSAMULO, A., COCKCROFT, V. and K. FINDLAY, 2011. Recent sightings of southern right whales in Mozambique. Document SC/S11/RW17 submitted to IWC Southern Right Whale Assessment Workshop, Buenos Aires 13-16 Sept. 2011.

BARENDSE, J., BEST, P.B., THOMTON, M., POMILLA, C. CARVALHO, I. and H.C. ROSENBAUM, 2010. Migration redefined? Seasonality, movements and group composition of humpback whales *Megaptera novaeangliae* off the west coast of South Africa. *Afr. J. mar. Sci.*, 32(1): 1-22.

BARENDSE, J., BEST, P.B., THORNTON, M., ELWEN, S.H., ROSENBAUM, H.C., CARVALHO, I., POMILLA, C., COLLINS, T.J.Q. and M.A. MEŸER, 2011. Transit station or destination? Attendance patterns, regional movement, and population estimate of humpback whales *Megaptera novaeangliae* off West South Africa based on photographic and genotypic matching. *African Journal of Marine Science*, 33(3): 353-373.

BARNARD, P., 1998. *Biological diversity in Namibia - a country study*. Namibian National Biodiversity Task Force, Windhoek.

BATURIN, G.N., 2002. Nodular Fraction of Phosphatic Sand from the Namibia Shelf. *Lithology and Mineral Resources*, 37: 1–17.

BENTHIC SOLUTIONS LTD, 2019. Venus 1X Environmental Baseline Survey. Vol 2: Environmental Baseline Survey and Habitat Assessment Report. Prepared for Total E and P Namibia B.V. May 2019, pp152.

BERG, J.A. and R.I.E. NEWELL, 1986. Temporal and spatial variations in the composition of seston available to the suspension-feeder *Crassostrea virginic*a. *Estuar. Coast. Shelf. Sci*., 23: 375–386.

BEST, P.B., 2001. Distribution and population separation of Bryde's whale *Balaenoptera edeni* off southern Africa. *Mar. Ecol. Prog. Ser.*, 220: 277 – 289.

BEST, P.B., 2007. Whales and Dolphins of the Southern African Subregion. Cambridge University Press, Cape Town, South Africa.

BEST, P.B. and C. ALLISON, 2010. Catch History, seasonal and temporal trends in the migration of humpback whales along the west coast of southern Africa. IWC sc/62/SH5.

BEST, P.B. and C.H. LOCKYER, 2002. Reproduction, growth and migrations of sei whales *Balaenoptera borealis* off the west coast of South Africa in the 1960s. *South African Journal of Marine Science*, 24: 111-133.

BEST P.B., MEŸER, M.A. and C. LOCKYER, 2010. Killer whales in South African waters – a review of their biology. *African Journal of Marine Science*. 32: 171–186.

BEYER, J., GOKSØYR, A., HJERMANN, D.Ø. & J. KLUNGSØYR, 2020. Environmental effects of offshore produced water discharges: A review focused on the Norwegian continental shelf. *Mar. Environ. Res*., 162: 105155.

BEYERS, C.J. DE B., WILKE, C.G. & P.C GOOSEN, 1994. The effects of oxygen deficiency on growth, intermoult period, mortality and ingestion rates of aquarium-held juvenile rock lobster *Jasus lalandii*. South African Journal of Marine Science 14, 79-88.

BIANCHI, G., CARPENTER, K.E., ROUX, J.-P., MOLLOY, F.J., BOYER, D. and H.J. BOYER, 1999. FAO species identification guide for fishery purposes. Field guide to the Living Marine Resources of Namibia, 256 pp.

BIANCHI, G., HAMUKUAYA, H. and O. ALVHEIM, 2001. On the dynamics of demersal fish assemblages off Namibia in the 1990s. *South African Journal of Marine Science* 23: 419-428.

BICCARD, A. & B.M. CLARK, 2016. De Beers Marine Namibia Environmental Monitoring Programme in the Atlantic 1 Mining Licence Area: 2013 Benthic Sampling Campaign. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants (Pty) Ltd. Report no. 1527/3.

BICCARD, A., CLARK, B.M. & E.A. BROWN, 2016. De Beers Marine Namibia Environmental Monitoring Programme in the Atlantic 1 Mining Licence Area: 2014 Benthic Sampling Campaign. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants (Pty) Ltd. Report no. 1527/4.

BICCARD, A., CLARK, B.M., BROWN, E.A., DUNA, O., MOSTERT, B.P., HARMER, R.W., GIHWALA, K. & A.G. WRIGHT, 2017. De Beers Marine Namibia Environmental Monitoring Programme: Atlantic 1 Mining Licence Area 2015 Benthic Sampling Campaign. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants (Pty) Ltd. Report no. 1527/4.

BICCARD, A., GIHWALA, K., CLARK, B.M., MOSTERT, B., BROWN, E., HUTCHINGS, K., MASSIE, V. and M. MELIDONIS, 2018. Desktop study of the potential impacts of marine mining on marine ecosystems and marine biota in South Africa – Final report. Report prepared by Anchor Research & Monitoring (Pty) Ltd for Council for Geoscience. Report no. 1795/1.

BICCARD A, GIHWALA K, CLARK BM, HARMER RW, BROWN EA, MOSTERT BP, WRIGHT AG & A MASOSONKE. 2018. De Beers Marine Namibia Environmental Monitoring Programme: Atlantic 1 Mining Licence Area 2016 Benthic Sampling Campaign. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants (Pty) Ltd. Report no. 1726/1.

BICCARD, A., K. GIHWALA, B.M. CLARK, E.A. BROWN, B.P. MOSTERT, A. MASOSONKE, C. SWART, S. SEDICK, B. TSHINGANA & J. DAWSON, 2019. De Beers Marine Namibia Environmental Monitoring Programme: Atlantic 1 Mining Licence Area 2017 Benthic Sampling Campaign. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants (Pty) Ltd. Report no. 1775/1.

BICKERTON, I.B. and R.A. CARTER, 1995. Benthic Macrofauna Distributions on the Inner Continental Shelf off Lüderitz. In: CSIR, 1995. Environmental Impact Assessment for the proposed mining of Concession Area M46/3/1607 off Lüderitz Bay: Namibia. CSIR Report EMAS-C95040b, Stellenbosch, South Africa.

BIRCH, G., 1990. Phosphorite deposits on the South African continental margin and coastal terrace. In: BURNETT, W.C. and S.R. RIGGS (eds.) Phosphate deposits of the world, Vol. 3, Neogene to modern phosphorites. Cambridge University Press, Cambridge, UK:153-158

BIRCH G.F., ROGERS J., BREMNER J.M. and G.J. MOIR, 1976. Sedimentation controls on the continental margin of Southern Africa. *First Interdisciplinary Conf. Mar. Freshwater Res. S. Afr.*, Fiche 20A: C1-D12.

BIRDLIFE INTERNATIONAL, 2004. *Tracking ocean wanderers: the global distribution of albatrosses and petrels. Results from the Global Procellariiform Tracking Workshop, 1–5 September, 2003, Gordon's Bay, South Africa.* Cambridge, UK: BirdLife International.

BIRDLIFE SOUTH AFRICA, 2022. Threatened seabird habitats in the South African Exclusive Economic Zone: biodiversity feature layer submission to the National Coastal and Marine Spatial Biodiversity Plan. BirdLife South Africa SCP Report 2022/1.

BLABER, S.J.M. & T.G. BLABER, 1980. Factors affecting the distribution of juvenile estuarine and inshore fish. *Journal of Fish Biology* 17: 143-162.

BOYD, A..J. and G.P.J. OBERHOLSTER, 1994. Currents off the west and south coasts of South Africa. *S. Afr. Shipping News and Fish. Ind. Rev.*, 49: 26-28.

BOYER, D. and H. BOYER 2015. Albatrosses, White-chinned Petrel and Northern Giant-Petrel. In: SIMMONS, R.E., BROWN, C.J. and J. KEMPER (eds). *Birds to watch in Namibia: red, rare and endemic species*. National Biodiversity Programme, Windhoek, Namibia

BOYER, D., BOYER, H., FOSSEN, I. and A. KREINER, 2006. Changes in abundance of the northern Benguela sardine stock during the decade 1990 - 2000, with comments on the relative importance of fishing and the environment. *African Journal of Marine Science*, 23: 67–84.BRANDÃO, A., VERMEULEN, E., ROSS-GILLESPIE, A., FINDLAY, K. and D.S. BUTTERWORTH, 2017. Updated application of a photo-identification based assessment model to southern right whales in South African waters, focussing on inferences to be drawn from a series of appreciably lower counts of calving females over 2015 to 2017. Paper SC/67b/SH22 to the 67th Meeting of the Scientific Committee of the International Whaling Commission, Bled, Slovenia.

BREEZE, H., DAVIS, D.S. BUTLER, M. and V. KOSTYLEV, 1997. Distrbution and status of deep sea corals off Nova Scotia. Marine Issues Special Committee Special Publication No. 1. Halifax, NS: Ecology Action Centre. 58 pp.

BREMNER, J.M., 1980. Concretionary phosphorite from SW Africa. J. geol. Soc. London, 137: 773-786.

BRICELJ, V.M. and R.E. MALOUF, 1984. Influence of algal and suspended sediment concentrations on the feeding physiology of the hard clam *Mercenaria mercenari*a. *Mar. Biol.*, 84: 155–165.

BRÖKER, K.C.A., 2019. An Overview of Potential Impacts of Hydrocarbon Exploration and Production on Marine Mammals and Associated Monitoring and Mitigation Measures. *Aquatic Mammals*, 45(6): 576-611.

BRÜCHERT, V., BARKER JǾRGENSEN, B., NEUMANN, K., RIECHMANN, D., SCHLÖSSER M. and H. SCHULZ, 2003. Regulation of bacterial sulfate reduction and hydrogen sulfide fluxes in the central Namibian coastal upwelling zone. *Geochim. Cosmochim. Acta*, 67(23): 4505-4518.

BRUNNSCHWEILER, J.M., BAENSCH, H., PIERCE, S.J. & D.W. SIMS, 2009. Deep-diving behaviour of a whale shark *Rhincodon typus* during long-distance movement in the western Indian Ocean. Journal of Fish Biology, 74: 706–714.

CARLUCCI, R., MANEA, E., RICCI, P., CIPRIANO, G., FANIZZA, C., MAGLIETTA, R. & E. GISSI, 2021. Managing multiple pressures for cetaceans' conservation with an Ecosystem-Based Marine Spatial Planning approach. Journal of Environmental Management, 287:112240.

CHAPMAN, P. and L.V. SHANNON, 1985. The Benguela Ecosystem. Part II. Chemistry and related processes. *Oceanogr. Mar. Biol. Ann. Rev*., 23: 183-251.

CHILD, M.F., ROXBURGH, L., DO LINH SAN, E., RAIMONDO, D. and H.T. DAVIES-MOSTERT, (editors). 2016. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa (https://www.ewt.org.za/Reddata/Order%20Cetacea.html).

CHIVERS, S., LEDUC, R., ROBERTSON, K., BARROS, N. and A. DIZON, 2004. Genetic variation of *Kogia* spp. With preliminary evidence for two species of *Kogia sima. Marine Mammal Science*, 21: 619-634.

CHRISTIE, N.D., 1974. Distribution patterns of the benthic fauna along a transect across the continental shelf off Lamberts Bay, South Africa. Ph.D. Thesis, University of Cape Town, 110 pp and Appendices.

CHRISTIE N.D. and A.G. MOLDAN, 1977. Effects of fish factory effluent on the benthic macro-fauna of Saldanha Bay. *Marine Pollution Bull*etin, 8: 41-45.

CLARK, B.M., 1997a. Variation in surf zone fish community structure across a wave exposure gradient. *Estuarine & Coastal Shelf Science* 44: 659-674.

CLARK, B.M., 1997b. Dynamics and Utilisation of Surf Zone Habitats by Fish in the South-Western Cape, South Africa. Unpublished PhD Thesis, University of Cape Town.

CLARK, B.M., BENNETT, B.A. and S.L. LAMBERTH, 1994. A comparison of the ichthyofauna of two estuaries and their adjacent surf zones, with an assessment of the effects of beach-seining on the nursery function of estuaries for fish. *South African Journal of Marine Science*, 14: 121-131.

CLARK, M.R., O'SHEA, S., TRACEY, D. and B. GLASBY, 1999. New Zealand region seamounts. Aspects of their biology, ecology and fisheries. Report prepared for the Department of Conservation, Wellington, New Zealand, August 1999. 107 pp.

CLIFF, G., ANDERSON-READE, M.D., AITKEN, A.O., CHARTER, G.E. & V.M. PEDDEMORS, 2007. Aerial census of whale sharks (*Rhincodon typus*) on the northern KwaZulu-Natal coast, South Africa. *Fish Res*., 84: 41–46.

COCKCROFT, A.C, SCHOEMAN, D.S., PITCHER, G.C., BAILEY, G.W.AND D.L. VAN ZYL, 2000. A mass stranding, or 'walk out' of west coast rock lobster, *Jasus lalandii*, in Elands Bay, South Africa: Causes, results and implications. In: VON VAUPEL KLEIN, J.C.and F.R. SCHRAM (Eds), *The Biodiversity Crisis and Crustacea: Proceedings of the Fourth International Crustacean Congress*, Published by CRC press.

COETZEE, J.C., VAN DER LINGEN, C.D., HUTCHINGS, L. and T.P. FAIRWEATHER, 2008. Has the fishery contributed to a major shift in the distribution of South African sardine? *ICES Journal of Marine Science* 65: 1676–1688.

COMPAGNO, L.J.V., 2001. Sharks of the World: an annotated and illustrated catalogue of shark species known to date. Bullhead, mackerel and carpet sharks (Heterodontiformes, Lamniformes and Orectolobiformes). FAO Species Catalogue for Fisheries Purposes No. 1, vol. 2. Food and Agriculture Organization of the United Nations, Rome, Italy

COMPAGNO, L.J.V., EBERT, D.A. and P.D. COWLEY, 1991. Distribution of offshore demersal cartilaginous fish (Class Chondrichthyes) off the West Coast of southern Africa, with notes on their systematics. *S. Afr. J. Mar. Sci.* 11: 43-139.

COMPTON, J.S. & E.W. BERGH, 2016. Phosphorite deposits on the Namibian Shelf. *Marine Geology*, 380: 290-314.

COSTA, D., SCHWARZ, L., ROBINSON, P., SCHICK, R., MORRIS, P.A., CONDIT, R., *et al*., 2016. A bioenergetics approach to understanding the population consequences of disturbance: Elephant seals as a model system. In: POPPER, A.N. & A. HAWKINS (Eds.), *The effects of noise-on aquatic life II: Advances in experimental medicine and biology,* 875: 161-169.

COX, T.M. and 35 others. 2006. Understanding the impacts of anthropogenic sound on beaked whales. *J. Cetacean Res. Manage*., 7(3): 177-187.

CRAWFORD, R.J.M. & G. DE VILLIERS, 1985. Snoek and their prey – interrelationships in the Benguela upwelling system. *S. Afr. J. Sci.,* 81(2): 91–97.

CRAWFORD, R.J.M., SHANNON, L.V. and D.E. POLLOCK, 1987. The Benguela ecosystem. 4. The major fish and invertebrate resources. *Oceanogr. Mar. Biol. Ann. Rev.*, 25: 353 - 505.

CROWTHER CAMPBELL and ASSOCIATES CC and CENTRE FOR MARINE STUDIES (CCA and CMS). 2001. Generic Environmental Management Programme Reports for Oil and Gas Prospecting off the Coast of South Africa. Prepared for Petroleum Agency SA, October 2001.

CRUIKSHANK, R.A., 1990. Anchovy distribution off Namibiadeduced from acoustic surveys with an interpretation of migration by adults and recruits. *S. Afr. J. Mar. Sci*., 9: 53-68.

CSIR, 1996. Elizabeth Bay monitoring project: 1995 review. *CSIR Report ENV/S-96066.*

CSIR, 1999. Synthesis and assessment of information on the BCLME. BCLME Thematic Report 4: Integrated overview of the offshore oil and gas industry in the Benguela Current Region. CSIR Report ENV-S-C 99057.

CSIR, 2009. Environmental Impact Assessment for the Proposed Desalination Project at Mile 6 near Swakopmund, Namibia, Draft EIA Report, CSIR Report No. CSIR/CAS/EMS/ER/2009/0015/A, Stellenbosch.

CUNHA, H.A., DE CASTRO, R.L., SECCHI, E.R., CRESPO, E.A., LAILSON-BRITO, J., AZEVEDO, A.F., LAZOSKI, C. & A.M. SOLÉ-CAVA, 2015. Molecular and morphological differentiation of common dolphins (*Delphinus* spp.) in the southwestern Atlantic: testing the two species hypothesis in sympatry. PloS One 10:e0140251.

CURRIE, H., GROBLER, K. and J. KEMPER (eds), 2009. Namibian Islands' Marine Protected Area. Ministry of Fisheries and Marine Resources, Namibia. http://www.nacoma.org.na/key_Activities/Marine Protected Areas.htm.

DA SILVA, C., KERWATH, S.E., WILKE, C., MEŸER, M. & S.J. LAMBERT, 2010. First documented southern transatlantic migration of blue shark *Prionace glauca* tagged off South Africa. *African Journal of Marine Science*, 32(3) : 639-642.

DAVID, J.H.M, 1989., Seals. In: Oceans of Life off Southern Africa, Eds. Payne, A.I.L. and Crawford, R.J.M. Vlaeberg Publishers. Halfway House, South Africa.

DE CAUWER, V., 2007. BEP/BAC/03/02 Mapping of the BCLME Shoreline, Shallow Water & Marine Habitats: Physical mapping project. Project in collaboration with the Benguela Environment Fisheries Interaction & Training Programme (BENEFIT) for the BCLME Programme.

DE DECKER, A.H., 1970. Notes on an oxygen-depleted subsurface current off the west coast of South Africa. *Invest. Rep. Div. Sea Fish. South Africa*, 84, 24 pp.

DE ROCK, P., ELWEN, S.H., ROUX, J-P., LEENEY, R.H., JAMES, B.S., VISSER, V., MARTIN, M.J. & T. GRIDLEY, 2019. Predicting large-scale habitat suitability for cetaceans off Namibia using MinxEnt. *Marine Ecology Progress Series*, 619: 149-167.

DESPREZ, M., 2000. Physical and biological impact of marine aggregate extraction along the French coast of the Eastern English Channel: short-and long-term post-dredging restoration. *ICES Journal of Marine Science*, 57: 1428–1438.

DE WET, A. 2013. *Factors affecting survivorship of loggerhead (Caretta caretta) and leatherback (Dermochelys coriacea) sea turtles of South Africa.* MSc, Nelson Mandela Metropolitan University.

DINGLE, R.V., 1973. The Geology of the Continental Shelf between Lüderitz (South West Africa) and Cape Town with special reference to Tertiary Strata. *J. Geol. Soc. Lond*., 129: 337-263.

DRAKE, D.E., CACCHIONE, D.A. and H.A. KARL, 1985. Bottom currents and sediment transport on San Pedro Shelf, California. *J. Sed. Petr*., 55: 15-28.

DUBOIS, M.J., PUTMAN, N.F. & S.E. PIACENZA, 2021. A Global Assessment of the Potential for Ocean-Driven Transport in Hatchling Sea Turtles. *Water*, 13: 757.

DUNA, O., CLARK, B.M., BICCARD, A., HUTCHINGS, K., HARMER, R., MOSTERT, B., BROWN, E., MASSIE, V., MAKUNGA, M., DLAKU, Z. & A, MAKHOSONKE, 2016. Assessment of mining-related impacts on macrofaunal benthic communities in the Northern Inshore

Area of Mining Licence Area MPT 25-2011 and subsequent recovery. Technical Report. Report prepared for De Beers Marine by Anchor Environmental Consultants (PTY) Ltd. Report no. 1646/1.

DUNCOMBE RAE, C.M., 2005. A demonstration of the hydrographic partition of the Benguela upwelling ecosystem at 26°40'S. *Afr. J. mar. Sci.*, 27(3): 617–628.

DUNDEE, B.L., 2006. *The diet and foraging ecology of chick-rearing gannets on the Namibian islands in relation to environmental features: a study using telemetry*. MSc thesis, University of Cape Town, South Africa.

DUNLOP, R.A., BRAITHWAITE, J., MORTENSEN, L.O. & C.M. HARRIS, 2021. Assessing Population-Level Effects of Anthropogenic Disturbance on a Marine Mammal Population. *Front. Mar. Sci.*, 8: 1 12.

ECKERT, S.A. & B.S. STEWART, 2001. Telemetry and satellite tracking of whale sharks, *Rhincodon typus*, in the Sea of Cortez, Mexico, and the north Pacific Ocean. *Environmental Biology of Fishes*, 60: 299–308.

ECKERT, S.A., ECKERT, K.L., PONGANIS, P. & G.L. KOOMAN, 1989. Diving and foraging behavior of leatherback sea turtles (*Dermochelys coriacea*). *Canadian Journal of Zoology* 67: 28-34.

EISENBARTH, S. & M. ZETTLER, 2015. Diversity of the benthic macrofauna off northern Namibia from the shelf to the deep sea. *Journal of Marine Systems*. 1-10. 10.1016/j.jmarsys.2015.10.017.

EKAU, W. and H. M. VERHEYE, 2005. Influence of oceanographic fronts and low oxygen on the distribution of ichthyoplankton in the Benguela and southern Angola currents. *Afr. J. mar. Sci.*, 27(3): 629–639.

ELLISON, W.T., RACCA, R., CLARK, C.W., STREEVER, B. *et al*. 2016. Modeling the aggregated exposure and responses of bowhead whales *Balaena mysticetus* to multiple sources of anthropogenic underwater sound. *Endang. Species Res.,* 30: 95–108.

ELWEN, S.H., GRIDLEY, T., ROUX, J.-P., BEST, P.B. and M.J. SMALE, 2013. Records of Kogiid whales in Namibia, including the first record of the dwarf sperm whale (*K. sima*). *Marine Biodiversity Records*. 6, e45 doi:10.1017/S1755267213000213.

ELWEN, S.H. and R.H. LEENEY, 2011. Interactions between leatherback turtles and killer whales in Namibian waters, including predation. *South African Journal of Wildlife Research,* 41(2): 205-209.

ELWEN, S., LEENEY, R. and T. GRIDLEY, 2019. Abundance estimates of an isolated population of common bottlenose dolphins *Tursiops truncatus* in Walvis Bay, Namibia, 2008–2012. *African Journal of Marine Science*, *41*(1), 61–70.

ELWEN, S.H. MEŸER, M.A.M, BEST, P.B., KOTZE, P.G.H, THORNTON, M. and S. SWANSON, 2006. Range and movements of a nearshore delphinid, Heaviside's dolphin *Cephalorhynchus heavisidii* a determined from satellite telemetry. *Journal of Mammalogy*, 87(5): 866–877.

ELWEN, S.H., BEST, P.B., REEB, D. and M. THORNTON, 2009b. Near-shore diurnal movements and behaviour of Heaviside's dolphins (*Cephalorhynchus heavisidii*), with some comparative data for dusky dolphins (*Lagenorhynchus obscurus*). *South African Journal of Wildlife Research,* 39(2): 143-154.

ELWEN, S.H., BEST, P.B., THORNTON, M., and D. REEB, 2010. Near-shore distribution of Heaviside's (*Cephalorhynchus heavisidii*) and dusky dolphins (*Lagenorhynchus obscurus*) at the southern limit of their range in South Africa. *African Zoology*, 45(1).

ELWEN, S.H., FINDLAY, K.P., KISZKA, J. & C.R. WEIR, 2011. Cetacean research in the southern African subregion: a review of previous studies and current knowledge, African Journal of Marine Science 32(3)

ELWEN S.H., REEB D., THORNTON M. and P.B. BEST, 2009a. A population estimate of Heaviside's dolphins *Cephalorhynchus heavisidii* in the southern end of their range. *Marine Mammal Science* 25: 107-124.

ELWEN, S.H., TONACHELLA, N., BARENDSE, J,. COLLINS, T.J.Q., BEST, P.B., ROSENBAUM, H.C., LEENEY, R.H. and T. GRIDLEY. 2014. Humpback Whales off Namibia: Occurrence, Seasonality, and a Regional Comparison of Photographic Catalogs and Scarring. Journal of Mammalogy, 95 (5): 1064–76. doi:10.1644/14-MAMM-A-108.

EMANUEL, B.P., BUSTAMANTE, R.H., BRANCH, G.M., EEKHOUT, S. and F.J. ODENDAAL, 1992. A zoogeographic and functional approach to the selection of marine reserves on the west coast of South Africa. *S. Afr. J. Mar. Sci*., 12: 341-354.

EMEIS, K.-C., BRÜCHERT, V., CURRIE, B., ENDLER, R., FERDELMAN, T., KIESSLING, A., LEIPE, T., NOLI-PEARD, K., STRUCK, U. and T. VOGT, 2004. Shallow gas in shelf sediments of the Namibian coastal upwelling ecosystem. *Continental Shelf Research*, 24: 627-642.

ENVIRONMENTAL EVALUATION UNIT, 1996. Impacts of Deep Sea Diamond Mining, in the Atlantic 1 Mining Licence Area in Namibia, on the Natural Systems of the Marine Environment. *Environmental Evaluation Unit Report No. 11/96/158*, University of Cape Town. Prepared for De Beers Marine (Pty) Ltd. 370 pp.

FAO, 2008. International Guidelines for the Management of Deep-Sea Fisheries in the High Seas. SPRFMO-VI-SWG-INF01

FEGLEY, S.R., MACDONALD, B.A. and T.R. JACOBSEN, 1992. Short-term variation in the quantity and quality of seston available to benthic suspension feeders. *Estuar. Coast. Shelf Sci.*, 34: 393–412.

FINDLAY K.P., BEST P.B., ROSS G.J.B. and V.C. COCKROFT. 1992. The distribution of small odontocete cetaceans off the coasts of South Africa and Namibia. *S. Afr. J. Mar. Sci.* 12: 237-270.

FINKE, G., GEE, K., KREINER, A., AMUNYELA, M. & R. BRABY, 2020b. Namibia's Way to Marine Spatial Planning – Using Existing Practices or Instigating Its Own Approach? *Marine Policy* 121: 104107.

FINKE, G., GEE, K., GXABA, T., SORGENFREI, R., RUSSO, V., PINTO, D., NSIANGANGO, S.E.,et al. 2020a. Marine Spatial Planning in the Benguela Current Large Marine Ecosystem. *Environmental Development*, 36: 100569.

FOSSING, H., FERDELMAN, T.G. and P. BERG, 2000. Sulfate reduction and methane oxidation in continental margin sediments influenced by irrigation (South-East Atlantic off Namibia). *Geochim. Cosmochim. Acta*. 64(5): 897–910.

FOULIS, A.J., 2013. A retrospective analysis of shark catches made by pelagic longliners off the east coast of South Africa and biology and life history of shortfin mako shark, *Isurus oxyrinchus*. MSc. Thesis, University of KwaZulu-Natal, Durban, South Africa. pp. 117.

FRANCIS, C.D., ORTEGA, C.P. & A. CRUZ, 2009. Cumulative consequences of noise pollution: Noise changes avian communities and species interactions. *Current Biology*, 19: 1415–1419.

GEOMAR, 2014. RV SONNE Fahrtbericht / Cruise Report SO233 WALVIS II: Cape Town, South Africa - Walvis Bay, Namibia: 14.05-21.06.2014. Hoernle, K., Werner, R., Lüter, C (eds). HelmholtzZentrum für Ozeanforschung Kiel, Germany: Nr. 22 (N. Ser.), 153 pp.

GIHWALA, K., BICCARD, A., CLARK, B.M., BROWN, E.A., MAKHOSONKE, A., SWART, C. & B. TSHINGANA, 2018. De Beers Marine Namibia Environmental Monitoring Programme: Mining-related impacts in mining license area MPT 25-2011 and subsequent recovery. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants (Pty) Ltd. Report no. 1800/1.

GIHWALA, K., BICCARD, A., CLARK, B.M., BROWN, E.A., MAKHOSONKE, A., SWART, C. & B. TSHINGANA, 2019. Mining-related impacts to soft bottom benthic habitats and associated macrofauna assemblages in mining license area SASA 2C and subsequent recovery. Report prepared for De Beers Group of Companies by Anchor Environmental Consultants (Pty) Ltd. Report no. 1800/1.

GOOSEN, A.J.J., GIBBONS, M.J., MCMILLAN, I.K., DALE, D.C. and P.A. WICKENS, 2000. Benthic biological study of the Marshall Fork and Elephant Basin areas off Lüderitz. Prepared by De Beers Marine (Pty) Ltd. for Diamond Fields Namibia, January 2000. 62 pp.

GRAY, J.S., ASCHAN, M., CARR, M.R., CLARKE, K.R., GREEN, R.H., PEARSON, T.H., ROSENBERG, R. & R.M. WARWICK, 1988. Analysis of community attributes of the benthic macrofauna of Frierfjord-Langesundfjord and in a mesocosm experiment. *Mar. Ecol. Prog. Ser.*, 46: 151-165.

GRAY, J.S., CLARKE, K.R., WARWICK, R.M. & G. HOBBS, 1990. Detection of initial effects of pollution on marine benthos e an example from the Ekofisk and Eldfisk oilfields, North-Sea. *Mar. Ecol. Prog. Ser.*, 66: 285-299.

GRIFFITHS, M.H., 2002. Life history of South African snoek *Thyrsites atun* (Pisces: Gempylidae): a pelagic predator of the Benguela ecosystem. *Fishery Bull., Wash.* 100(4): 690-710.

GRIFFITHS, M.H., 2003. Stock structure of snoek *Thyrsites atun* in the Benguela: a new hypothesis. *Afr. J. Mar. Sci.*, 25: 383-386.

GRIFFITHS, M.H. & P.C. HEEMSTRA, 1995. A contribution to the taxonomy of the marine fish genus *Argyrosomus* (Perciformes: Sciaenidae), with descriptions of two new species from southern Africa. *Ichthyol. Bull., J.L.B. Smith Inst. Ichthyol.* No. 65, 40 p

GROENEVELD, J.C., G. CLIFF, S.F.J. DUDLEY, A.J. FOULIS, J. SANTOS & S. P. WINTNER, 2014. Population structure and biology of Shortfin Mako, *Isurus oxyrinchus*, in the south-west Indian Ocean. *Marine and Freshwater Research* 65:1045–1058.

HAMANN, M., GRECH, A., WOLANSKI, E. & J. LAMBRECHTS, 2011. Modelling the fate of marine turtle hatchlings. *Ecol. Modelling* 22: 1515–1521.

HAMMAR, L., MOLANDER, S., PÅLSSON, J., CRONA SCHMIDTBAUER, J., CARNEIRO, C., JOHANSSON, T., HUME, D., KÅGESTEN, G., MATTSSON, D., TÖRNQVIST, O., ZILLÉN, L., MATTSSON, M., BERGSTRÖM, U., PERRY, D., CALDOW, C. & J. ANDERSEN, 2020. Cumulative impact assessment for ecosystem- based marine spatial planning. *Science of The Total Environment*, 734: 139024.

HAMPTON, I., 1992. The role of acoustic surveys in the assessment of pelagic fish resources on the South African continental shelf. *South African Journal of Marine Science*, 12: 1031-1050.

HAMPTON, I., 2003. Harvesting the Sea. In: MOLLOY, F. and T. REINIKAINEN (Eds), 2003. Namibia's Marine Environment. Directorate of Environmental Affairs, Ministry of Environment and Tourism, Namibia, 31-69.

HANEY, J.C., HAURY, L.R., MULLINEAUX, L.S. and C.L. FEY, 1995. Sea-bird aggregation at a deep North Pacific seamount. *Marine Biology*, 123: 1-9.

HANSEN. F.C., CLOETE. R.R. and H.M. VERHEYE, 2005. Seasonal and spatial variability of dominant copepods along a transect off Walvis Bay (23ºS), Namibia. *African Journal of Marine Science*, 27: 55-63.

HARRIS, L.R., NEL, R., OOSTHUIZEN, H., MEŸER, M., KOTZE, D., ANDERS, D., MCCUE, S. & S. BACHOO, 2018. Managing conflict between economic activities and threatened migratory species toward creating a multiobjective blue economy. *Conservation Biology,* 32(2): 411-423.

HARRIS, L.R., HOLNESS, S.D., KIRKMAN, S.P., SINK, K.J., MAJIEDT, P. & A. DRIVER, 2022. National Coastal and Marine Spatial Biodiversity Plan, Version 1.2 (Released 12-04-2022): Technical Report. Nelson Mandela University, Department of Forestry, Fisheries and the Environment, and South African National Biodiversity Institute. South Africa. 280 pp.

HAWKINS, A.D., ROBERTS, L. & S. CHEESMAN, 2014. Responses of freeliving coastal pelagic fish to impulsive sounds. *Journal of the Acoustical Society of America*, 135: 3101–3116.

HAYS, G.C. HOUGHTON, J.D.R., ISAACS, C. KING, R.S. LLOYD, C. and P. LOVELL, 2004. First records of oceanic dive profiles for leatherback turtles, *Dermochelys coriacea*, indicate behavioural plasticity associated with long-distance migration. *Animal Behaviour,* 67: 733-743.

HAZIN, F.H.V., PINHEIRO, P.B. & M.K. BROADHURST, 2000. Further notes on reproduction of the blue shark, *Prionace glauca*, and a postulated migratory pattern in the South Atlantic Ocean. *Cienca e Cultura* 52: 114–120.

HOLNESS, S., KIRKMAN, S., SAMAAI, T., WOLF, T., SINK, K., MAJIEDT, P., NSIANGANGO, S., KAINGE, P., KILONGO, K., KATHENA, J., HARRIS, L., LAGABRIELLE, E., KIRCHNER, C., CHALMERS, R. and M. LOMBARD, 2014. Spatial Biodiversity Assessment and Spatial Management, including Marine Protected Areas. Final report for the Benguela Current Commission project BEH 09-01.

HOLSMAN, K., JAMEAL SAMHOURI, J., COOK, G., HAZEN, E., OLSEN, E., DILLARD, M., KASPERSKI, S., GAICHAS, S., KELBLE, C.R., FOGARTY, M. & K. ANDREWS, 2017. An ecosystem-based approach to marine risk assessment, Ecosystem Health and Sustainability, 3: 1, e01256.

HOLTZHAUZEN, J.A., 2000. Population dynamics and life history of westcoast steenbras *Lithognathus aureti* (Sparidae), and management options for the sustainable exploitation of the steenbras resource in Namibian waters. PhD Thesis, University of Port Elizabeth: 233 pages.

HOLTZHAUSEN, J.A., KIRCHNER, C.H. and S.F. VOGES, 2001. Observations on the linefish resources of Namibia, 1999-2000, with special reference to West Coast steenbras and silver kob. *South African Journal of Marine Science* 23: 135-144.

HOVLAND, M., VASSHUS, S., INDREEIDE, A., AUSTDAL, L. and Ø. NILSEN, 2002. Mapping and imaging deep-sea coral reefs off Norway, 1982-2000. *Hydrobiol*. 471: 13-17.

HOWARD, J.A.E., JARRE, A., CLARK, A.E. and C.L. MOLONEY, 2007. Application of the sequential t-test algorithm or analyzing regime shifts to the southern Benguela ecosystem. *African Journal of Marine Science* 29(3): 437-451.

HUBERT, J., CAMPBELL, J., VAN DER BEEK, J. G., DEN HAAN, M. F., VERHAVE, R., VERKADE, L. S. & H. SLABBEKOORN, 2018. Effects of broadband sound exposure on the interaction between foraging crab and shrimp – A field study. *Environmental Pollution*, 243: 1923–1929.

HUGHES, G. R. 1974. *The sea turtles of south east Africa.* PhD, University of Natal.

HUGHES, G.R., LUSCHI, P., MENCACCI, R. & F. PAPI, 1998. The 7000 km journey of a leatherback turtle tracked by satellite. *Journal of Experimental Marine Biology and Ecology*, 229: 209 - 217.

HUGHES, G. & R. NEL, 2014ª. Family Cheloniidae. In: BATES, M.F., BRANCH, W.R., BAUER, A.M., BURGER, M., MARAIS, J., ALEXANDER, G.J., DE VILLIERS, M.S. (eds) Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland. Suricata 1, SANBI, Pretoria.

HUGHES, G. & R. NEL, 2014b. Family Dermochelyidae. In: BATES, M.F., BRANCH, W.R., BAUER, A.M., BURGER, M., MARAIS, J., ALEXANDER, G.J., DE VILLIERS, M.S. (eds) Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland. Suricata 1, SANBI, Pretoria.

HUI, C,A., 1985. Undersea topography and the comparative distributions of two pelagic cetaceans. *Fishery Bulletin*, 83(3): 472-475.

IUCN, 2025. The IUCN Red of Threatened Species. Version 2025-1. https://www.iucnredlist.org ISSN 2307-8235.

IWC [International Whaling Commission], 2012. Report of the Scientific Committee. Annex H: Other Southern Hemisphere Whale Stocks Committee 11–23.

JACKSON, L.F. ad S. McGIBBON, 1991. Human activities and factors affecting the distribution of macro-benthic fauna in Saldanha Bay. *S. Afr. J. Aquat. Sci.*, 17: 89-102.

JOHNSON, C., REISINGER, R., PALACIOS, D., FRIEDLAENDER, A., ZERBINI, A., WILLSON, A., LANCASTER, M. , BATTLE, J., GRAHAM, A., COSANDEY-GODIN, A., JACOB T., FELIX, F., GRILLY, E., SHAHID, U., HOUTMAN, N., ALBERINI, A., MONTECINOS, Y., NAJERA, E. & S. KELEZ, 2022. Protecting Blue Corridors, Challenges and Solutions for Migratory Whales Navigating International and National Seas. WWF, Oregon State University, University of California, Santa Cruz, Publisher: WWF International, Switzerland.

JONSSON, P.R., HAMMAR, L., WÅHLSTRÖM, I., et al. 2021. Combining seascape connectivity with cumulative impact assessment in support of ecosystem-based marine spatial planning. *J Appl Ecol*., 58: 576–586.

KANWISHER, J.W. & S.H. RIDGWAY, 1983. The physiological ecology of whales and porpoises. *Scientific American*, 248: 110–120.

KARENYI, N., 2014. Patterns and drivers of benthic macrofauna to support systematic conservation planning for marine unconsolidated sediment ecosystems. PhD Thesis, Nelson Mandela Metropolitan University, South Africa.

KARENYI, N., SINK, K. & R. NEL, 2016. Defining seascapes for marine unconsolidated shelf sediments in an eastern boundary upwelling region: The southern Benguela as a case study. *Estuarine, Coastal and Shelf Science* 169: 195–206.

KAVANAGH, A.S., NYKÄNEN, M., HUNT, W., RICHARDSON, N. & M.J. JESSOPP, 2019. Seismic surveys reduce cetacean sightings across a large marine ecosystem. *Scientific Reports*, 9(1): 1-10.

KEEN, K., BELTRAN, R., & PIROTTA, E. & D. COSTA, 2021. Emerging themes in Population Consequences of Disturbance models. *Proceedings of the Royal Society B: Biological Sciences*. 288. 20210325. 10.1098/rspb.2021.0325.

KEMPER, J., UNDERHILL, L.G., CRAWFORD, R.J.M. and S.P. KIRKMAN, 2007. Revision of the conservation status of seabirds and seals breeding in the Benguela Ecosystem. In: KIRKMAN, S.P. (ed). *Final Report of the BCLME (Benguela Current Large Marine Ecosystem) Project on Top Predators as Biological Indicators of Ecosystem Change in the BCLME*: 325-342. Avian Demography Unit, University of Cape Town, Cape Town, South Africa

KENDALL, M.A. and S. WIDDICOMBE, 1999. Small scale patterns in the structure of macrofaunal assemblages of shallow soft sediments. *Journal of Experimental Marine Biology and Ecology*, 237:127-140.

KENNY, A.J., REES, H.L., GREENING, J. and S. CAMPBELL, 1998. The effects of marine gravel extraction on the macrobenthos at an experimental dredge site off north Norfolk, U.K. (Results 3 years post-dredging). *ICES CM 1998/V*:14, pp. 1-8.

KERSHAW, J.L., RAMP, C.A., SEARS, R., PLOURDE, S., BROSSET, P., MILLER, P.J.O., et al., 2021. Declining reproductive success in the Gulf of St. Lawrence's humpback whales (*Megaptera novaeangliae*) reflects ecosystem shifts on their feeding grounds. *Glob. Change Biol.*, 27: 1027–1041.

KIRCHNER, C.H., 2001. Fisheries regulations based on yield per recruit analysis for the linefish silver kob *Argyrosomus inodorus* in Namibian waters. *Fisheries Research*, 52: 155–167.

KIRCHNER, C.H., SAKKO, A. and J.I. BARNES, 2000. Estimation of the economic value of the Namibian recreational rock-and-surf fishery. *South African Journal of Marine Science* 22: 17-25.

KIRKMAN, S.P., OOSTHUIZEN, W.H., MEŸER, M.A., KOTZE, P.G.H., ROUX, J-P. & L.G. UNDERHILL, 2007. Making sense out of censuses and dealing with missing data: trends in pup counts of Cape fur seals *Arctocephalus pusillus pusillus* between 1972 and 2004. *African Journal of Marine Science,* 29: 161–176

KIRKMAN, S.P., YEMANE, D., OOSTHUIZEN, W.H., MEYER, M.A., KOTZE, P.G.H, SKRYPZECK, H., VAZ VELHO, F. and L.G. UNDERHILL, 2012. Spatio-temporal shifts of the dynamic Cape fur seal population in southern Africa, based on aerial censuses (1972-2009). *Marine mammal Science*, doi: 10.1111/j.1748-7692.2012.00584.x

KIRKMAN, S.P., MEYER, M.A. and M. THORNTON, 2010. False Killer Whale Pseudorca crassidens mass stranding at Long Beach on South Africa's Cape Peninsula, 2009. *African Journal of Marine Science* 31 (1): 167–70. doi:10.2989/1814232X.2010.481168.

KOLBERG, H., 2015. Namibia's Important Bird and Biodiversity Areas 2: NA014 Sandwich Harbour. Lanioturdus 48(3): 10-18.

KOSLOW, J.A., 1996. Energetic and life history patterns of deep-sea benthic, benthopelagic and seamount associated fish. *Journal of Fish Biology*, 49A: 54-74.

KYHN, L.A., WISNIEWSKA, D.M., BEEDHOLM, K., TOUGAARD, J., SIMON, M., MOSBECH, A., *et al.* 2019. Basin-wide contributions to the underwater soundscape by multiple seismic surveys with implications for marine mammals in Baffin Bay, Greenland. Mar. Pollut. Bull., 138: 474–490.

LAIRD, M.C., HUTCHINGS, K., NALUSHA, S.H. & B.M. CLARK, 2018. *Marine Ecology Report for the National Oil Storage Facilities Project, Walvis Bay*. Report No. 1790/4 prepared by Anchor Environmental Consultants (Pty) Ltd and Green Team Consultants CC for Om'kumoh AIJ JV. 95 pp.

LAMBARDI, P., LUTJEHARMS, J.R.E., MENACCI, R., HAYS, G.C. and P. LUSCHI, 2008. Influence of ocean currents on long-distance movement of leatherback sea turtles in the Southwest Indian Ocean. *Marine Ecology Progress Series*, 353: 289–301.

LAMBERTH, S.J., VAN NIEKERK, L. & K. HUTCHINGS, 2008. Comparison of, and the effects of altered freshwater inflow on, fish assemblages of two contrasting South African estuaries: the cool-temperate Olifants and the warm-temperate Breede. *African Journal of Marine Science* 30: 311-336.

LANE, S.B. and R.A. CARTER, 1999. *Generic Environmental Management Programme for Marine Diamond MIning off the West Coast of South Africa*. Marine Diamond Mines Association, Cape Town, South Africa. 6 Volumes.

LARGE, S.I., FAY, G., FRIEDLAND, K.D. & J.S. LINK, 2015. Quantifying Patterns of Change in Marine Ecosystem Response to Multiple Pressures. PLoS ONE 10(3): e0119922. doi:10.1371/journal.

LASIAK, T.A., 1981. Nursery grounds of juvenile teleosts: evidence from surf zone of King's beach, Port Elizabeth. *South African Journal of Science* 77: 388-390.

LEENEY, R.H., POST, K., HAZEVOET, C.J. AND S.H. ELWEN, 2013. Pygmy right whale records from Namibia. *African Journal of Marine Science* 35(1): 133-139.

LE GOUVELLO, D.Z.M., NEL, R. & A.E. CLOETE, 2020. The influence of individual size on clutch size and hatchling fitness traits in sea turtles. J. Exp. Mar. Biol. Ecol., 527: 151372.

LE GOUVELLO, D.Z.M., HEYE, S., HARRIS, L.R., TEMPLE-BOYER, J., GASPAR, P., HART-DAVIS, M.G., LOURO, C. & R. NEL, 2024. Dispersal corridors of neonate sea turtles from dominant rookeries in the Western Indian Ocean. *Ecological Modelling*, 487, p.110542.

LE ROUX, L., 1998. Research on Deepsea Red Crab after more than 20 years of Exploitation. *Namibia Brief*, 20: 126-128.

LEVIN, L.A., 2003. Oxygen minimum zone benthos: adaptation and community response to hypoxia. *Oceanography and Marine Biology: an Annual Review* 41: 1-45.

LEVIN, L.A., WHITCRAFT, C.R., MENDOZA, G.F., GONZALEZ, J.P. and G. COWIE, 2009. Oxygen and organic matter thresholds for benthic faunal activity on the Pakistan margin oxygen minimum zone (700 - 1100 m). *Deep-Sea Reserach II* 56: 449-471.

LEVIN, L.A., GAGE, J.D., MARTIN, C. and P.A. LAMONT, 2000. Macrobenthic community structure within and beneath the oxygen minimum zone, NW Arabian Sea, Deep-Sea Res. Pt. II, 47: 189– 226.

LEVIN, P.S., et al. 2014. Guidance for implementation of integrated ecosystem assessments: a US perspective. ICES Journal of Marine Science, 71:1198–1204.

LOEFER, J.K., SEDBERRY, G.R. & J.C. MCGOVERN, 2005. Vertical movements of a shortfin mako in the Western North Atlantic as determined by pop-up satellite tagging. *Southeastern Naturalist* 4, 237-246.

LONGHURST, A. R., 2006. Ecological Geography of the Sea. 2nd edition. Academic Press, San Diego. pp. 560.

LOUW, D.C., 2008. Internal memorandum. Phytoplankton Bloom along the Namibian Coast. Ministry of Fisheries & Marine Resources: Directorate of Resource Management. Date: 10/03/2008.

LUDYNIA, K., 2007. *Identification and characterisation of foraging areas of seabirds in upwelling systems: biological and hydrographic implications for foraging at sea*. PhD thesis, University of Kiel, Germany.

LUDYNIA, K., KEMPER, J. & J-P. ROUX, 2012. The Namibian Islands' Marine Protected Area: Using seabird tracking data to define boundaries and assess their adequacy. Biological Conservation, 156: 136-145.

LUSCHI, P., HAYS, G. C. & F. PAPI, 2003a. A review of long-distance movements by marine turtles, and the possible role of ocean currents. *Oikos,* 103, 293 – 302.

LUSCHI, P., LUTJEHARMS, J.R.E., LAMBARDI, P., MENCACCI, R., HUGHES, G.R. & G.C. HAYS, 2006. A review of migratory behaviour of sea turtles off southeastern Africa. *South African Journal of Science*, 102, 51 - 57.

LUSCHI, P., SALE, A., MENCACCI, R., HUGHES, G. R., LUTJEHARMS, J. R. E. & F. PAPI, 2003b. Current transport of leatherback sea turtles (*Dermochelys coriacea*) in the ocean. *Proceedings of the Royal Society: Biolgical Sciences,* 270, 129 - 132.

MAARTENS, L., 2003. Biodiversity. In: MOLLOY, F. and T. REINIKAINEN (Eds). *Namibia's Marine Environment*. Directorate of Environmental Affairs, Ministry of Environment and Tourism, Namibia: 103-135.

MacISSAC, K., BOURBONNAIS, C., KENCHINGTON, E.D., GORDON JR. and S. GASS, 2001. Observations on the occurrence and habitat preference of corals in Atlantic Canada. *In:* (eds.) J.H.M. WILLISON, J. HALL, S.E. GASS, E.L.R. KENCHINGTON, M. BUTLER, and P. DOHERTY. Proceedings of the First International Symposium on Deep-Sea Corals. Ecology Action Centre and Nova Scotia Museum, Halifax, Nova Scotia.

MacLEOD, C.D. and A. D'AMICO, 2006. A review of beaked whale behaviour and ecology in relation to assessing and mitigating impacts of anthropogenic noise. *Journal of Cetacean Research and Management* 7(3): 211–221.

MacPHERSON, E. and A. GORDOA, 1992. Trends in the demersal fish community off Namibia from 1983 to 1990. *South African Journal of Marine Science* 12: 635-649.

MATE, B.R., BEST, P.B., LAGERQUIST, B.A. and M.H. WINSOR, 2011. Coastal, offshore and migratory movements of South African right whales revealed by satellite telemetry. *Marine Mammal Science*, 27(3): 455-476.

MATE, B.R., LAGERQUIST, B.A., WINDSOR, M., GERACI, J. and J.H. PRESCOTT, 2005. Movements and dive habits of a satellite-monitoring longfinned pilot whales (*Globicephala melas*) in the northwet Atlantic. *Marine Mammal Science* 21(10): 136-144.

MATTHEWS, J.P. and N.L. SMIT, 1979. Trends in the size composition, availability, egg-bearing and sex ratio of the rock lobster *Jasus lalandii* in its main fishing area off South West Africa, 1958-1969. *Investl. Rep. Div. Sea Fish. S. Afr.*, 103: 1-38

MATTHEWS, S.G. and G.C. PITCHER, 1996. Worst recorded marine mortality on the South African coast. In: YASUMOTO, T, OSHIMA, Y. and Y. FUKUYO (Eds), *Harmful and Toxic Algal Blooms*. Intergovernmental Oceanographic Commission of UNESCO, pp 89-92.

McALPINE, D.F., 2018. Pygmy and Dwarf Sperm Whales: *Kogia breviceps* and *K. sima*. In *Encyclopedia of Marine Mammals* (3rd ed., Issue June 2018, p936–938).

McHURON, E.A., SCHWARZ, L.K., COSTA, D.P. & M. MANGEL, 2018. A state-dependent model for assessing the population consequences of disturbance on income-breeding mammals. *Ecological Modelling*, 385: 133- 144.

McLACHLAN, A., 1980. The definition of sandy beaches in relation to exposure: a simple rating system. *S. Afr. J. Sci.*, 76: 137-138.

McLACHLAN, A., 1986. Ecological surveys of sandy beaches on the Namib coast. Report No. 13, Institute for Coastal Research, University of Port Elizabeth, Port Elizabeth, 135 pp.

MECENERO, S., ROUX, J-P., UNDERHILL, L.G. and M.N.BESTER, 2006. Diet of Cape fur seals *Arctocephalus pusillus pusillus* at three mainland breeding colonies in Namibia. 1. Spatial variation. *African Journal of Marine Science* 28: 57-71.

MINISTRY OF FISHERIES AND MARINE RESOURCES (MFMR), 2008. Ministry of Fisheries & Marine Resources: Directorate of Resource Management. Monthly Marine Environmental Update. March 2008. No. 03/2008. Compiled by C.H. Bartholomae.

MINISTRY OF FISHERIES AND MARINE RESOURCES (MFMR), 2019. National Framework for Marine Spatial Planning in Namibia. Ministry of Fisheries and Marine Resources, Windhoek: Namibia.

MINISTRY OF FISHERIES AND MARINE RESOURCES (MFMR), 2021. Current Status Report: Knowledge Baseline for Marine Spatial Planning in Namibia. Second Edition. MFMR, Windhoek: Namibia.

MINISTRY OF FISHERIES AND MARINE RESOURCES, 2022. Monitoring and Evaluation Strategy for Marine Spatial Planning in Namibia. Windhoek: Namibia.

MODDE, T., 1980. Growth and residency of juvenile fishes within a surf zone habitat in the Gulf of Mexico. *Gulf Research Reports* 6: 377-385.

MOLDAN, A.G.S., 1978. A study of the effects of dredging on the benthic macrofauna in Saldanha Bay. *South African Journal of Science*, 74: 106-108.

MOLLOY, F. and T. REINIKAINEN (Eds), 2003. Namibia`s Marine Environment. Directorate of Environmental Affairs, Ministry of Environment and Tourism, Namibia, 160 pp.

MONTAGNA, P.A. and D.E. HARPER, Jr., 1996. Benthic infaunal long-term response to offshore production platforms in the Gulf of Mexico. *Can. J. Fish. Aquat. Sci*., 53: 2567-2588.

MONTEALEGRE-QUIJANO, S. & C.M. VOOREN, 2010. Distribution and abundance of the life stages of the blue shark *Prionace glauca* in the Southwest Atlantic. *Fisheries Research* 101: 168–179.

MONTEIRO, P.M.S. and A.K. VAN DER PLAS, 2006. Low Oxygen Water (LOW) variability in the Benguela System: Key processes and forcing scales relevant to forecasting. In: SHANNON, V., HEMPEL, G., MALANOTTE-RIZZOLI, P., MOLONEY, C. and J. WOODS (Eds). *Large Marine Ecosystems*, Vol. 15, pp 91-109.

MORANT, P.D., 2006. Environmental Management Programme Report for Exploration/Appraisal Drilling in the Kudu Gas Production Licence No 001 on the Continental Shelf of

Namibia. Prepared for Energy Africa Kudu Limited. CSIR Report CSIR/NRE/ECO/2006/0085/C.

MORANT, P.D., 2013. Environmental Management Plan for the proposed marine phosphate prospecting in the Outeniqua West Licence Area on the eastern Agulhas Bank, offshore Mossel Bay. Prepared for Diamond Fields International Ltd. CSIR/CAS/EMS/ER/2013/0000/A, pp266.

MOURA, J.F., ACEVEDO-TREJOS, E., TAVARES, D.C., MEIRELLES, A.C.O., SILVA, C.P.N., OLIVEIRA, L.R., SANTOS, R.A., WICKERT, J.C., MACHADO, R., SICILIANO, S. & A. MERICO, 2016. Stranding events of Kogia whales along the Brazilian coast. *PLoS ONE*, *11*(1): 1–15.

NELSON, G., 1989. Poleward motion in the Benguela area. In: Poleward Flows along Eastern Ocean Boundaries. NESHYBA *et al*. (eds) New York; Springer: 110-130 (Coastal and Estuarine Studies 34).

NELSON G. and L. HUTCHINGS, 1983. The Benguela upwelling area. *Prog. Oceanogr.*, 12: 333-356.

NETTO, S.A., FONSECA, G. & F., GALLUCCI, 2010. Effects of drill cuttings discharge on meiofauna communities of the shelf break in the southwest Atlantic. *Environ. Monit. Assess*., 167: 49–63.

NEWMAN, G.G. and D.E. POLLOCK, 1971. Biology and migration of rock lobster *Jasus lalandii* and their effect on availability at Elands Bay, South Africa. *Investl. Rep. Div. Sea Fish. S. Afr.*, 94: 1-24.

NICOL, S., BOWIE, A., JARMON, S., LANNUZEL, D., MEINERS, K.M., *et al*. 2010. Southern Ocean iron fertilization by baleen whales and Antarctic krill. *Fish and Fisheries*, 11: 203–209.

NIEUKIRK, S.L., MELLINGER, D.K., MOORE, S.E., KLINCK, K., DZIAK, R.P. & J. GOSLIN, 2012. Sounds from airguns and fin whales recorded in the mid-Atlantic Ocean, 1999–2009. *Journal of the Acoustical Society of America*, 131: 1102–1112.

NMP [Namibian Marine Phosphates], 2012. Environmental impact assessment report for the marine component: Proposed recovery of phosphate enriched sediments from the Marine Licence Area No. 170 off Walvis Bay Namibia. Prepared for Namibian Marine Phosphate (Pty) Ltd. J Midgley and Associates, Enviro Dynamics, CSIR.

NRC, 2005. Marine mammal populations and ocean noise, determining when noise causes biologically significant effects. The National Academy Press, Washington, DC.

OLIVIER, J., 1992. Aspects of the climatology of fog in the Namib. *SA geographer* 19(2): 107-125.

OLIVIER, J., 1995. Spatial fog distribution pattern in the Namib using Meteosat images. *J. Arid Environments* 29: 129-138.

OOSTHUIZEN W.H., 1991. General movements of South African (Cape) fur seals *Arctocephalus pusillus pusillus* from analysis of recoveries of tagged animals. *S. Afr. J. Mar. Sci*., 11: 21-30.

PARKINS, C.A. and J. G. FIELD, 1997. A baseline study of the benthic communities of the unmined sediments of the De Beers Marine SASA Grid. Unpublished Report to De Beers Marine, October 1997, pp 29.

PARKINS, C.A. and J.G.FIELD, 1998. The effects of deep sea diamond mining on the benthic community structure of the Atlantic 1 Mining Licence Area. Annual Monitoring Report – 1997. Prepared for De Beers Marine (Pty) Ltd by Marine Biology Research Institute, Zoology Department, University of Cape Town. pp. 44.

PARRY, D.M., KENDALL, M.A., PILGRIM, D.A. and M.B. JONES, 2003. Identification of patch structure within marine benthic landscapes using a remotely operated vehicle. *J. Exp. Mar. Biol. Ecol.,* 285– 286: 497–511.

PAYNE, A.I.L. and R.J.M. CRAWFORD, 1989. *Oceans of Life off Southern Africa.* Vlaeberg, Cape Town, 380 pp.

PENNEY, A.J., KROHN, R.G. and C.G. WILKE. 1992. A description of the South African tuna fishery in the southern Atlantic Ocean. *ICCAT Col. Vol. Sci. Pap.* XXIX(1) : 247-253.

PENNEY, A.J., PULFRICH, A., ROGERS, J., STEFFANI, N. and V. MABILLE, 2007. *Project: BEHP/CEA/03/02: Data Gathering and Gap Analysis for Assessment of Cumulative Effects of Marine Diamond Mining Activities on the BCLME Region.* Final Report to the BCLME mining and petroleum activities task group. December 2007. 410pp.

PENRY, G.S., 2010. Biology of South African Bryde's whales. PhD Thesis. University of St Andrews, Scotland, UK.

PIROTTA, E., BOOTH, C.G., COSTA, D.P., *et al*. 2018. Understanding the population consequences of disturbance. *Ecol Evol.*, 8: 9934–9946. https://doi.org/10.1002/ece3.4458.

PITCHER, G.C., 1998. *Harmful algal blooms of the Benguela Current*. IOC, World Bank and Sea Fisheries Research Institute Publication. 20 pp.

PLÖN, S., 2004. The status and natural history of pygmy (*Kogia breviceps*) and dwarf (*K. sima*) sperm whales off Southern Africa. PhD Thesis. *Department of Zoology and Entomology* (Rhodes University), p. 551.

POLLOCK, D.E. and L.V. SHANNON, 1987. Response of rock-lobster populations in the Benguela ecosystem to environmental change – a hypothesis. South African Journal of Marine Science 5, 887-899.

POTTER, I.C., BECKLEY, L.E., WHITFIELD, A.K., LENANTON, R.C.J., 1990. Comparisons between the roles played by estuaries in the life cycles of fishes in temperate Western Australia and southern Africa. *Environmental Biology of Fishes* 28: 143-178.

POTTS, W.M., SAUER, W.H.H., HENRIQUES, R., SEQUESSEQUE, S., SANTOS, C.V. and P.W. SHAW. 2010. The biology, life history and management needs of a large sciaenid fish, *Argyrosomus coronus* in Angola. *African Journal of Marine Science* 32 (2): 247 — 258.

PULFRICH, A., 2015. Invertebrate macrofaunal communities of the beaches north of Swakopmund. Baseline Field Survey Report. Prepared for Gecko Namibia, August 2015. Pp30.

PULFRICH, A. and A.J. PENNEY, 1999. The effects of deep-sea diamond mining on the benthic community structure of the Atlantic 1 Mining Licence Area. Annual Monitoring Report – 1998. Prepared for De Beers Marine (Pty) Ltd by Marine Biology Research Institute, Zoology Department, University of Cape Town and Pisces Research and Management Consultants CC. pp 49.

PUTMAN, N.F. & K.L. MANSFIELD, 2015. Direct Evidence of Swimming Demonstrates Active Dispersal in the Sea Turtle “Lost Years”. *Curr. Biol.,* 25: 1221–1227.

PUTMAN, N.F., VERLEY, P., SHAY, T.J. & K.J. LOHMANN, 2012. Simulating transoceanic migrations of young loggerhead sea turtles: merging magnetic navigation with an ocean circulation model. *J. Exp. Biol.*, 215: 1863–1870.

PUTMAN, N.F. & E. NARO-MACIEL, 2013. Finding the ‘lost years’ in green turtles: insights from ocean circulation models and genetic analysis. *Proc. R. Soc. Biol*., 280.

PUTMAN, N.F., SENEY, E.E., VERLEY, P., SHAVER, D.J., LOPEZ-CASTRO, M.C., COOK, M., *et al.*, 2020. Predicted distributions and abundances of the sea turtle ‘lost years’ in the western North Atlantic Ocean. *Ecography,* 43: 506–517.

PRDW, 2019. Proposed offshore exploration well drilling in PEL82, Walvis Basin, Namibia. Oil Spill and Drilling Discharge Modelling Specialist Study, Prestedge Retief Dresner Wijnberg (Pty) Ltd Consulting Port and Coastal Engineers, 83 pp.

RAMIL, F. & M. GIL, 2015. Walvis Ridge seamounts benthic fauna. Workshop for preliminary results of the Assesment of Resources and Vulnerable Marine Ecosystems survey in the SEAFO Convention Area. (12/02/2015 - 13/02/2015. Swakopmund (Namibia)).

RIPPLE, W.J., ESTES, J.A., SCHMITZ, O.J., CONSTANT, V., KAYLOR, M.J., LENZ, A., MOTLEY, J.L., SELF, K.E., TAYLOR, D.S. & C. WOLF, 2016. What is a trophic cascade?. Trends in ecology & evolution, 31(11):.842-849.

ROBINSON, N., ANDERS, D., BACHOO, S., HARRIS, L., HUGHES, G., KOTZE, D., MADURAY, S., MCCUE, S., MEYER, M., OOSTHUIZEN, H., PALADINO, F. & P. LUSCHI, 2019. Satellite tracking of leatherback and loggerhead sea turtles on the southeast African coastline. Indian Ocean Turtle Newsletter, 28: 5pp.

ROEL, B.A., 1987. Demersal communities off the west coast of South Africa. *South African Journal of Marine Science* 5: 575-584.

ROGERS, A.D., 1994. The biology of seamounts. *Advances in Marine Biology*, 30: 305–350.

ROGERS, A.D., 2004. The biology, ecology and vulnerability of seamount communities. IUCN, Gland, Switzerland. Available at: www.iucn.org/themes/ marine/pubs/pubs.htm 12 pp.

ROGERS, A.D., CLARK, M.R., HALL-SPENCER, J.M. and K.M. GJERDE, 2008. The Science behind the Guidelines: A Scientific Guide to the FAO Draft International Guidelines (December 2007) For the Management of Deep-Sea Fisheries in the High Seas and Examples of How the Guidelines May Be Practically Implemented. IUCN, Switzerland, 2008.

ROGERS, J., 1977. Sedimentation on the continental margin off the Orange River and the Namib Desert. Unpubl. Ph.D. Thesis, Geol. Dept., Univ. Cape Town. 212 pp.

ROGERS, J. and J.M. BREMNER, 1991. The Benguela Ecosystem. Part VII. Marine-geological aspects. Oceanogr. Mar. Biol. Ann. Rev., 29: 1-85.

ROMAN, J. & J.J. McCARTHY, 2010. The Whale Pump: Marine Mammals Enhance Primary Productivity in a Coastal Basin. PLoS ONE 5(10): e13255. doi:10.1371/

ROMER, G.S., 1988. Fishes. In: McLachlan A. (Ed,). Ecological surveys of sandy beaches of the Namib coast. Institute for Coastal Research Report no. 13. University of Port Elizabeth.

ROSE, B. & A. PAYNE, 1991. Occurrence and behavior of the Southern right whale dolphin Lissodelphis peronii off Namibia. Marine Mammal Science 7: 25-34.

ROSENBAUM, H.C., POMILLA, C., MENDEZ, M., LESLIE, M.S., BEST, P.B., FINDLAY, K.P., MINTON, G., ERSTS, P.J., COLLINS, T., ENGEL, M.H., BONATTO, S., KOTZE, P.G.H., MEŸER, M., BARENDSE, J., THORNTON, M., RAZAFINDRAKOTO, Y., NGOUESSONO, S., VELY, M. and J. KISZKA, 2009. Population structure of humpback whales from their breeding grounds in the South Atlantic and Indian Oceans. PLoS One, 4 (10): 1-11.

ROSS, G.J.B., 1979. Records of pygmy and dwarf sperm whales, genus Kogia, from southern Africa, with biological notes and some comparisons. Annals of the Cape Province Museum (Natural History) 11: 259-327.

ROUX, J-P., BEST, P.B. and P.E. STANDER. 2001. Sightings of southern right whales (Eubalaena australis) in Namibian waters, 1971-1999. J. Cetacean Res. Manage. (Special Issue). 2: 181-185.

ROUX, J-P., BRADY, R. and P.B. BEST, 2011. Southern right whales off Namibian and their relationship with those off South Africa. Paper SC/S11/RW16 submitted to IWC Southern Right Whale Assessment Workshop, Buenos Aires 13-16 Sept. 2011.

ROUX, J-P., BRADY, R. and P.B. BEST, 2015. Does Disappearance Mean Extirpation? The Case of Right Whales off Namibia. Marine Mammal Science, 31 (3): 1132–52. doi:10.1111/mms.12213.

ROWAT, D., 2007. Occurrence of the whale shark (Rhincodon typus) in the Indian Ocean: a case for regional conservation. Fisheries Research, 84: 96-101.

ROWAT, D. & M. GORE, 2007. Regional scale horizontal and local scale vertical movements of whale sharks in the Indian Ocean off Seychelles. Fisheries Research 84: 32–40.

SAVAGE, C., FIELD, J.G. and R.M. WARWICK, 2001. Comparative meta-analysis of the impact of offshore marine mining on macrobenthic communities versus organic pollution studies. Mar Ecol Prog Ser., 221: 265-275.

SCOTT, R., BIASTOCH, A., RODER, C., STIEBENS, V.A. & C. EIZAGUIRRE, 2014. Nano-tags for neonates and ocean-mediated swimming behaviours linked to rapid dispersal of hatchling sea turtles. Proc. R. Soc. B, 281: 20141209.

SEAKAMELA, S.M., KOTZE, P.H.G., MCCUE, S.A., DE GOEDE, J., LAMONT, T., PIETERSE, J., SMITH, M. & T. ANTHONY, 2022. 25. Mortality event of Cape fur seals in South Africa during 2021. In: KIRKMAN, S.P., HUGGETT, J.A., LAMONT, T. & T. HAUPT (Eds.) Oceans and Coasts Annual Science Report 2021. Department of Forestry, Fisheries and the Environment, p28.

SEAKAMELA, S.M., KOTZE, P.H.G., MCCUE, S.A. & S. BENJAMIN, 2022. 23. The first satellite tracking of movements of long-finned pilot whales in South Africa. In: KIRKMAN, S.P., HUGGETT, J.A., LAMONT, T. & T. HAUPT (Eds.) Oceans and Coasts Annual Science Report 2021. Department of Forestry, Fisheries and the Environment, p26.

SEIDERER, L.J. and R.C. NEWELL, 1999. Analysis of the relationship between sediment composition and benthic community structure in coastal deposits: Implications for marine aggregate dredging. ICES Journal of Marine Science, 56: 757–765.

SHANNON, L.J., C.L. MOLONEY, A. JARRE and J.G. FIELD, 2003. Trophic flows in the southern Benguela during the 1980s and 1990s. Journal of Marine Systems, 39: 83 - 116.

SHANNON, L.V., 1985. The Benguela Ecosystem. Part 1. Evolution of the Benguela, physical features and processes. Oceanogr. Mar. Biol. Ann. Rev., 23: 105-182.

SHANNON, L.V. and F.P. ANDERSON, 1982. Application of satellite ocean colour imagery in the study of the Benguela Current system. S. Afr. J. Photogrammetry, Remote Sensing and Cartography, 13(3): 153-169.

SHANNON L.V. and S. PILLAR, 1985. The Benguela Ecosystem III. Plankton. Oceanography and Marine Biology: An Annual Review, 24: 65-170.

SHANNON, L.V. and M.J. O'TOOLE, 1998. BCLME Thematic Report 2: Integrated overview of the oceanography and environmental variability of the Benguela Current region. Unpublished BCLME Report, 58pp

SHAUGHNESSY P.D., 1979. Cape (South African) fur seal. In: Mammals in the Seas. F.A.O. Fish. Ser., 5, 2: 37-40.

SHERLEY, R.B., LUDYNIA, K., DYER, B.M., LAMONT, T., MAKHADO, A.B., ROUX, J.-P., SCALES, K.L., UNDERHILL, L.G. & S.C. VOTIER, 2017. Metapopulation tracking juvenile penguins reveals an ecosystem-wide ecological trap. Current Biology 27: 563-568.

SHILLINGTON, F. A., PETERSON, W. T., HUTCHINGS, L., PROBYN, T. A., WALDRON, H. N. and J. J. AGENBAG, 1990. A cool upwelling filament off Namibia, South West Africa: Preliminary measurements of physical and biological properties. Deep-Sea Res., 37 (11A): 1753-1772.

SICILIANO, S., DE MOURA, J.F., BARATA, P.C.R., DOS PRAZERES RODRIGUES D., MORAES ROGES, E., LAINE DE SOUZA, R., HENRIQUE OTT P. & M. TAVARES, 2013. An unusual mortality of humpback whales in 2010 on the central-northern Rio de Janeiro coast, Brazil. Paper to International Whaling Commission SC63/SH1

SIMMONS, R.E., BARNES, K.N. JARVIS, A.M. and A. ROBERTSON, 1999. Important Bird Areas in Namibia. Research Discussion Paper No. 31. DEA of MET, 68pp.

SIMMONS, R.E., BROWN, C.J. and J. KEMPER, 2015. Birds to watch in Namibia: red, rare and endemic species. Ministry of Environment and Tourism and Namibia Nature Foundation, Windhoek

SINK, K., HOLNESS, S., HARRIS, L., MAJIEDT, P., ATKINSON, L., ROBINSON, T., KIRKMAN, S., HUTCHINGS, L., LESLIE, R., LAMBERTH, S., KERWATH, S., VON DER HEYDEN, S., LOMBARD, A., ATTWOOD, C., BRANCH, G., FAIRWEATHER, T., TALJAARD, S., WEERTS, S., COWLEY, P., AWAD, A., HALPERN, B., GRANTHAM, H. and T. WOLF, 2012. National Biodiversity Assessment 2011: Technical Report. Volume 4: Marine and Coastal Component. South African National Biodiversity Institute, Pretoria.

SINK, K.J., VAN DER BANK, M.G., MAJIEDT, P.A., HARRIS, L.R., ATKINSON, L.J., KIRKMAN, S.P. and N. KARENYI (eds), 2019. South African National Biodiversity Assessment 2018 Technical Report Volume 4: Marine Realm. South African National Biodiversity Institute, Pretoria. South Africa.

SKERN-MAURITZEN, M., KIRKMAN, S.P., OLSEN, E.J.S., BJØRGE, A., DRAPEAU, L., MËYER, M., ROUX, J.-P., SWANSON, S. & W.H. OOSTHUIZEN, 2009. Do inter-colony differences in Cape fur seal foraging behaviour reflect large-scale changes in the northern Benguela ecosystem? African Journal of Marine Science, 31: 399–408.

SLABBEKOORN, H., DALEN, J., DE HAAN, D., WINTER, H.V., RADFORD, C., AINSLIE, M.A., HEANEY, K.D., VAN KOOTEN, T., THOMAS, L. & J. HARWOOD, 2019. Population-level consequences of seismic surveys on fishes: An interdisciplinary challenge. Fish and Fisheries 20(4): 653-685.

SLABBEKOORN, H. & W. HALFWERK, 2009. Behavioural ecology: Noise annoys at community level. Current Biology, 19: R693–R695.

SMALE, M.J., ROEL, B.A., BADENHORST, A. and J.G. FIELD, 1993. Analysis of demersal community of fish and cephalopods on the Agulhas Bank, South Africa. Journal of Fisheries Biology 43:169-191.

SMITH, G.G and G.P. MOCKE, 2002. Interaction between breaking/broken waves and infragravity-scale phenomena to control sediment sediment suspension and transport in the surf zone. Marine Geology, 187: 320-345.

SNELGROVE, P.V.R. and C.A. BUTMAN (1994). Animal-sediment relationships revisited: cause versus effect. Oceanography and Marine Biology: An Annual Review, 32: 111-177.

SPOONER, E., KARNAUSKAS, M., HARVEY, C.J., KELBLE, C., ROSELLON-DRUKER, J., KASPERSKI, S., LUCEY, S.M., ANDREWS, K.S., GITTINGS, S.R., MOSS, J.H., GOVE, J.M., SAMHOURI, J.F., ALLEE, R.J., BOGRAD, S.J., MONACO, M.E., CLAY, P.M., ROGERS, L.A., MARSHAK, A., WONGBUSARAKUM, S., BROUGHTON, K. & P.D. LYNCH, 2021. Using Integrated Ecosystem Assessments to Build Resilient Ecosystems, Communities, and Economies, Coastal Management, 49:1, 26-45, DOI: 10.1080/08920753.2021.1846152

SPRFMA, 2007. Information describing seamount habitat relevant to the South Pacific Regional Fisheries Management Organisation.

STAGE, J. & C.H. KIRCHNER, 2005. An economic comparison of the commercial and recreational linefisheries in Namibia. African Journal of Marine Science 27, 577-584.

STEFFANI, N., 2007a. Biological Baseline Survey of the Benthic Macrofaunal Communities in the Atlantic 1 Mining Licence Area and the Inshore Area off Pomona for the Marine

Dredging Project. Prepared for De Beers Marine Namibia (Pty) Ltd. pp. 42 + Appendices.

STEFFANI, N., 2007b. Biological Monitoring Survey of the Macrofaunal Communities in the Atlantic 1 Mining Licence Area and the Inshore Area between Kerbehuk and Bogenfels. 2005 Survey. Prepared for De Beers Marine Namibia (Pty) Ltd. pp. 51 + Appendices.

STEFFANI, N., 2009a. Biological Monitoring Surveys of the Benthic Macrofaunal Communities in the Atlantic 1 Mining Licence Area and the Inshore Area – 2006/2007. Prepared for De Beers Marine Namibia (Pty) Ltd. (Confidential Report) pp. 81 + Appendices.

STEFFANI, N., 2009b. Assessment of Mining Impacts on Macrofaunal Benthic Communities in the Northern Inshore Area of the De Beers ML3 Mining Licence Area - 18 Months Post-mining. Prepared for De Beers Marine. pp. 47 + Appendices.

STEFFANI, N., 2009c. Baseline Study on Benthic Macrofaunal Communities in the Inner Shelf Region and Assessment of Mining Impacts off Chameis. November 2009. Prepared for Namdeb. pp. 45 + Appendices.

STEFFANI, C.N., 2010a. Assessment of mining impacts on macrofaunal benthic communities in the northern inshore area of the De Beers Mining Licence Area 3 – 2010 . Prepared for De Beers Marine (South Africa). pp 30 + Appendices.

STEFFANI, N., 2010b. Biological Monitoring Surveys of the Benthic Macrofaunal Communities in the Atlantic 1 Mining Licence Area – 2008. Prepared for De Beers Marine Namibia (Pty) Ltd. pp 40 + Appendices.

STEFFANI, N., 2010c. Benthic Grab Monitoring Survey in the Atlantic 1 Mining Licence Area – 2009. Prepared for De Beers Marine Namibia (Pty) Ltd. pp 40 + Appendices.

STEFFANI, N., 2011. Environmental Impact Assessment for the dredging of Marine Phosphate Enriched Sediments from Mining Licence Area No. 170. Specialist Study No. 1c: Marine Benthic Specialist Study for a Proposed Development of Phosphate Deposits in the Sandpiper Phosphate Licence Area off the Coast of Central Namibia. Prepared for Namibian Marine Phosphate (Pty) Ltd. November 2011. 72 pp.

STEFFANI, C.N., 2012. Assessment of Mining Impacts on Macrofaunal Benthic Communities in the Northern Inshore Area of the ML3 Mining Licence Area - 2011. Prepared for De Beers Marine (South Africa), July 2012, 54pp.

STEFFANI, C.N. and A. PULFRICH, 2004a. Environmental Baseline Survey of the Macrofaunal Benthic Communities in the De Beers ML3/2003 Mining Licence Area. Prepared for De Beers Marine South Africa, April 2004., 34pp.

STEFFANI, N. and A. PULFRICH, 2004b. The potential impacts of marine dredging operations on benthic communities in unconsolidated sediments. Specialist Study 2. Specialist Study for the Environmental Impact Report for the Pre-feasibility Phase of the Marine Dredging Project in Namdeb’s Atlantic 1 Mining Licence Area and in the nearshore areas off Chameis. Prepared for PISCES Environmental Services (Pty) Ltd, September 2004.

STEFFANI, C.N. and A. PULFRICH, 2007. Biological Survey of the Macrofaunal Communities in the Atlantic 1 Mining Licence Area and the Inshore Area between Kerbehuk and

Lüderitz 2001 – 2004 Surveys. Prepared for De Beers Marine Namibia, March 2007, 288pp.

STEFFANI, N., SEDICK, S., ROGERS, J. & M.J. GIBBONS, 2015. Infaunal benthic communities from the inner shelf off Southwestern Africa are characterised by generalist species. PLoS ONE 10(11): e0143637. doi:10.1371/journal.pone.0143637.

THOMISCH, K., 2017. Distribution patterns and migratory behavior of Antarctic blue whales. Reports on Polar and Marine Research 707: pp194. doi:10.2312/BzPM_0707_2017

THOMISCH, K., BOEBEL, O', CLARK, C.W., HAGEN, W., SPIESECKE, S., ZITTERBART, D.P. and I. VAN OPZEELAND, 2016. Spatio-temporal patterns in acoustic presence and distribution of Antarctic blue whales Balaenoptera musculus intermedia in the Weddell Sea. doi: 10.3354/esr00739.

TIMONIN, A.G., ARASHKEVICH, E.G., DRITS, A.V. and T.N. SEMENOVA, 1992. Zooplankton dynamics in the northern Benguela ecosystem, with special reference to the copepod Calanoides carinatus. In: PAYNE, A.I.L., BRINK, K.H., MANN, K.H. and R. HILBORN (Eds). Benguela Trophic Functioning. S. Afr. J. mar. Sci. 12: 545–560.

TYACK, P.L., ZIMMER, W.M.X., MORETTI, D., SOUTHALL, B.L., CLARIDGE, D.E., DURBAN, J.W., CLARK, C.W., et al., 2011. Beaked Whales Respond to Simulated and Actual Navy Sonar, 6(3). doi:10.1371/journal.pone.0017009

UTNE-PALM, A.C., SALVANES, A.G.V., CURRIE, B., KAARTVEDT, S., NILSSON, G.E., BRAITHWAITE, V.A., STECYK, J.A.W., HUNDT, M., V.D. BANK, M., FLYNN, B., SANDVIK, G.K., KLEVJER, T.A., SWEETMAN, A.K., BRÜCHERT, V., PITTMAN, K., PEARD, K.R., LUNDE, I.G., STRANDABØ, R.A.U. & M.J. GIBBONS, 2010. Trophic structure and community stability in an overfished ecosystem. Science, 329: 333-336.

VAN DALFSEN, J.A., ESSINK, K., TOXVIG MADSEN, H., BIRKLUND, J., ROMERO, J. and M. MANZANERA, 2000. Differential response of macrozoobenthos to marine sand extraction in the North Sea and the Western Mediterranean. ICES J. Mar. Sci., 57: 1439–1445.

VAN DER BANK, M.G., UTNE-PALM, A.C., PITTMAN, A., SWEETMAN, A.K., RICHOUX, N.B., BRÜCHERT, V. & M.J. GIBBONS, 2011. Dietary success of a 'new' key fish in an overfished ecosystem: evidence from fatty acid and stable isotope signatures. Mar. Ecol. Prog. Ser. 428: 219-233.

VILLEGAS-AMTMANN, S., SCHWARZ, L.K., GAILEY, G., SYCHENKO, O. & D.P. COSTA, 2017. East or west: the energetic cost of being a gray whale and the consequence of losing energy to disturbance. Endangered Species Research, 34: 167-183.

VILLEGAS-AMTMANN, S., SCHWARZ, L.K., SUMICH, J.L. & D.P. COSTA, 2015. A bioenergetics model to evaluate demographic consequences of disturbance in marine mammals applied to gray whales. Ecosphere, 6(10): art183.

VISSER, G.A., 1969. Analysis of Atlantic waters off the coast of southern Africa. Investigational Report Division of Sea Fisheries, South Africa, 75: 26 pp.

WALDRON, F.W., 1901. On the appearance and disappearance of a mud island at Walfish Bay. Trans. S. Afr. Phil. Soc., 11(1): 185-194.

WARD, L.G., 1985. The influence of wind waves and tidal currents on sediment resuspension in Middle Chesapeake Bay. Geo-Mar. Letters, 5: 1-75.

WARWICK, R.M., GOSS-CUSTARD, J.D., KIRBY, R., GEORGE, C.L., POPE, N.D. and A.A. ROWDEN, 1991. Static and dynamic environmental factors determining the community structure of estuarine macrobenthos in SW Britain: why is the Severn estuary different? J. Appl. Ecol., 28: 329–345.

WEARNE, K. & L.G. UNDERHILL, 2005. Walvis Bay, Namibia: a key wetland for waders and other coastal birds in southern Africa. Wader Study Group Bull. 107: 24–30.

WEEKS, S., CURRIE, B. and A. BAKUN, 2002. Massive emissions of toxic gas in the Atlantic. Nature, 415: 493-494.

WEEKS, S.J., CURRIE, B., BAKUN, A. AND K.R. PEARD, , 2004. Hydrogen sulphide eruptions in the Atlantic Ocean off southern Africa: implications of a new view based on SeaWiFS satellite imagery. Deep-Sea Res. I, 51:153-172.

WEIR, C.R., 2011. Distribution and seasonality of cetaceans in tropical waters between Angola and the Gulf of Guinea. African Journal of Marine Science 33(1): 1-15.

WEIR, C.R., COLLINS, T., CARVALHO, I. and H.C. ROSENBAUM, 2010. Killer whales (Orcinus orca) in Angolan and Gulf of Guinea waters, tropical West Africa. Journal of the Marine Biological Association of the U.K. 90: 1601– 1611.

WHITEHEAD, H., 2002. Estimates of the current global population size and historical trajectory for sperm whales. Marine Ecology Progress Series, 242: 295-304.

YATES, M.G., GOSS-CUSTARD, J.D., MCGRORTY, S.M., LAKHANI, DIT DURRELL, S.E.A., LEVIT, CLARKE, R.T., RISPIN, W.E., MOY, I., YATES, T., PLANT, R.A. and A.J. FROST, 1993. Sediment characteristics, invertebrate densities and shorebird densities on the inner banks of the Wash. J. Appl. Ecol., 30: 599– 614.

ZAJAC, R.N., LEWIS, R.S., POPPE, L.J., TWICHELL, D.C., VOZARIK, J., and M.L. DIGIACOMO-COHEN, 2000. Relationships among sea-floor structure and benthic communities in Long Island Sound at regional and benthoscape scales. J. Coast. Res., 16: 627– 640.

ZETTLER, M.L., BOCHERT, R. & F. POLLEHNE, 2009. Macrozoobenthos diversity in an oxygen minimum zone (OMZ) off northern Namibia. Marine Biology 156: 1949-1961

ZETTLER, M.L., BOCHERT, R. & F. POLLEHNE, 2013. Macrozoobenthic biodiversity patterns in the northern province of the Benguela upwelling system. African Journal of Marine Science 35(2): 283-290

ZEYBRANDT, F. and J.I. BARNES, 2001. Economic characteristics of demand in Namibia's marine recreational shore fishery. South African Journal of Marine Science, 23: 145-156.

ZOUTENDYK, P., 1992. Turbid water in the Elizabeth Bay region: A review of the relevant literature. CSIR Report EMAS-I 92004.

ZOUTENDYK, P., 1995. Turbid water literature review: a supplement to the 1992 Elizabeth Bay Study. CSIR Report EMAS-I 95008.

5.1 IMPACT ASSESSMENT

ABBRIANO, R.M., CARRANZA, M.M., HOGLE, S.L., LEVIN, R.A., NETBURN, A.N., SETO, K.L., SNYDER, S.M. & P.J.S. FRANKS, 2011. Deepwater Horizon oil spill: a review of the planktonic response. Oceanography 24: 294–301.

ALDREDGE, A.L., M. ELIAS & C.C. GOTSCHALK, 1986. Effects of drilling muds and mud additives on the primary production of natural assemblages of marine phytoplankton. Mar. Environ. Res. 19: 157-176.

ALMEDA, R., BACA, S., HYATT, C. & E.J. BUSKEY, 2014a. Ingestion and sublethal effects of physically and chemically dispersed crude oil on marine planktonic copepods. Ecotoxicology 23, 988–1003.

ALMEDA, R., CONNELLY, T.L. & E.J. BUSKEY, 2015. How much crude oil can zooplankton ingest? Quantification of dispersed crude oil defecation by planktonic copepods. Environmental Pollution 208:645–654,

ALMEDA, R., HYATT, C. E.J. BUSKEY, 2014b. Toxicity of dispersant Corexit 9500A and crude oil to marine microzooplankton. Ecotoxicol. Environ. Saf. 106, 76–85.

ALMEDA, R.,WAMBAUGH, Z., CHAI, C.,WANG, Z.C., LIU, Z.F. & E.J. BUSKEY, 2013a. Effects of crude oil exposure on bioaccumulation of polycyclic aromatic hydrocarbons and survival of adult and larval stages of gelatinous zooplankton. Plos One 8 (15 pp.).

ALMEDA, R., WAMBAUGH, Z., WANG, Z.C., HYATT, C., LIU, Z.F. & E.J. BUSKEY, 2013b. Interactions between zooplankton and crude oil: toxic effects and bioaccumulation of polycyclic aromatic hydrocarbons. Plos One 8 (21 pp.).

ARNOSTI, C., ZIERVOGEL, K., YANG,T. & A. TESKE, 2014. Oil-derived marine aggregates – hot spots of polysacchride degradation by specialized bacterial communities. Deep Sea Research II, 129: 179-186.

AWBREY, F.T. & B.S. STEWART, 1983. Behavioural responses of wild beluga whales (Delphinapterus leucas) to noise from oil drilling. Journal of the Acoustical Society of America, Suppl. 1, 74: S54.

BAAN, P.J.A., MENKE, M.A., BOON, J.G., BOKHORST, M., SCHOBBEN, J.H.M. & C.P.L. HAENEN, 1998. Risico Analyse Mariene Systemen (RAM). Verstoring door menselijk gebruik. Waterloopkundig Laboratorium, Delft.

BAKER, J.M., CLARK, R.B., KINGSTON, P.F. & R.H. JENKINS, 1990. Natural recovery of cold water marine environments after an oil spill. 13th Annual Arctic and Marine Oil spill Program Technical Seminar, Edmonton, Alberta. pp 1-111.

BAKKE, T., KLUNGSØYR, J. & S. SANNI, 2013. Environmental impacts of produced water and drilling waste discharges from the Norwegian offshore petroleum industry. Mar. Environ. Res. 92: 154-169.

BAKKE, T., GREEN, A.M.V. & P.E. IVERSEN, 2011. Offshore environmental monitoring in Norway - regulations, results and developments. In: LEE, K. & J. NEFF, (Eds.), Produced Water. Springer, NY (Chapter 25).

BAPTIST, M.J., TAMIS, J.E., BORSJE, B.W. & J.J. VAN DER WERF, 2009. Review of the geomorphological, benthic ecological and biogeomorphological effects of nourishments on the shoreface and surf zone of the Dutch coast. Report IMARES C113/08, Deltares Z4582.50, pp69.

BARLOW, M.J. & P.F. KINGSTON, 2001. Observations on the effects of barite on the gill tissues of the suspension feeder Cerastoderma edule (Linne) and the deposit feeder Macoma balthica (Linne). Mar. Pollut. Bull. 42: 71-76.

BAX, N., WILLIAMSON, A., AGUERO, M., GONZALEZ, E. & W. GEEVES, 2003. Marine invasive alien species: a threat to global biodiversity. Marine Policy, 27: 313–323.

BEJARANO, A.C. & J. MICHEL, 2010. Large-scale risk assessment of polycyclic aromatic hydrocarbons in shoreline sediments from Saudi Arabia: environmental legacy after twelve years of the Gulf war oil spill. Environmental Pollution, 158: 1561-1569.

BEJARANO, A.C. & J. MICHEL, 2016. Oil spills and their impacts on sand beach invertebrate communities: A literature review. Environmental Pollution, 218: 709-722.

BEJDER, L., SAMUELS, A., WHITEHEAD, H. & N. GALES, 2006. Interpreting short-term behavioral responses to disturbance within a longitudinal perspective. Animal Behavior 72: 1149-1158.

BERNABEU, A., FERN_ANDEZ-FERN_ANDEZ, S., BOUCHETTE, F., REY, D., ARCOS, A., BAYONA, J. & J. ALBAIGES, 2013. Recurrent arrival of oil to Galician coast: the final step of the Prestige deep oil spill. J. Hazard. Mater., 250: 82-90.

BEYER, J., TRANNUM, H.C., BAKKE, T., HODGESON, P.V. & T.K. COLLIER, 2016. Environmental effects of the Deepwater Horizon oil spill: a review. Marine Pollution Bulletin, 110: 28–51.

BEYER, J., GOKSØYR, A., HJERMANN, D.Ø. & J. KLUNGSØYR, 2020. Environmental effects of offshore produced water discharges: A review focused on the Norwegian continental shelf. Mar. Environ. Res., 162: 105155.

BIJKERK, R., 1988. Ontsnappen of begraven blijven. De effecten op bodemdieren van een verhoogde sedimentatie als gevolg van baggerwerkzaamheden., RDD Aquatic Systems.

BLAIZOT, C., 2019. Oil Seeps Detection in Offshore Frontier Areas Based on Multitemporal Satellite SAR Data and Manual Interpretation: Levantine and Natal Basins, Selected Historical and Recent SAR Data. 2018 International Conference and Exhibition, Cape Town, South Africa.

BLANCHARD, A.L. & H.M. FEDER, 2003. Adjustment of benthic fauna following sediment disposal at a site with multiple stressors in Port Valdez, Alaska. Marine Pollution Bulletin, 46: 1590-1599.

BLOOM, P. & M. JAGER, 1994. The injury and subsequent healing of a serious propeller strike to a wild bottlenose dolphin (Tursiops truncatus) resident in cold waters off the Northumberland coast of England. Aquatic Mammals, 20(2: 59-64.

BOTHNER, M.H., RENDIGS, R.R., CAMPBELL, E.Y., DOUGHTON, M.W., PARMENTER, C.M., O'DELL, C.H., DILISIO, G.P., JOHNSON, R.G., GILSON, J.R. & N. RAIT. 1985. The

Georges Bank Monitoring Program: analysis of trace metals in bottom sediments during the third year of monitoring. Final report submitted to the U.S. Dept. of the Interior, Minerals Management Service, Vienna, VA. Prepared by the U.S. Geological Survey, Woods Hole, MA. 99 pp.

BRABY, J., 2009. The Damara Tern in the Sperrgebiet: Breeding productivity and the impact of diamond mining. Unpublished report to Namdeb Diamond Corporation (Pty) Ltd.

BRETELER, R.J., REQUEJO, A.G. & J.M. NEFF, 1988. Acute toxicity and hydrocarbon composition of a water-based drilling mud containing diesel fuel or mineral oil additives. Pages 375-390 In: LICHTENBERG, J.J., WINTER, F.A., WEBER, C.I. & L. FRADKIN, Eds., Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA.

BROWN, N.A. (1976). Cavitation Noise Problems And Solutions.

BRÜCHERT, V., BARKER JǾRGENSEN, B., NEUMANN, K., RIECHMANN, D., SCHLÖSSER M. & H. SCHULZ, 2003. Regulation of bacterial sulfate reduction and hydrogen sulfide fluxes in the central Namibian coastal upwelling zone. Geochim. Cosmochim. Acta, 67(23): 4505-4518.

BRUSSAARD, C., PEPERZAK, L., BEGGAH, S. et al. 2016. Immediate ecotoxicological effects of short-lived oil spills on marine biota. Nat Commun., 7: 11206. https://doi.org/10.1038/ncomms11206

BUCHANAN, R.A., COOK, J.A. & A. MATHIEU, 2003. Environmental Effects Monitoring for Exploration Drilling. Report for Environmental Studies Research Funds, Alberta. Solicitation No. ESRF – 018. Pp 182.

BULL, A.S. & J.J. KENDALL, Jr., 1994. An indication of the process: offshore platforms as artificial reefs in the Gulf of Mexico. Bull. Mar. Sci. 55: 1086-1098.

BURD, B.J., 2002. Evaluation of mine tailings effects on a benthic marine infaunal community over 29 years. Marine Environmental Research, 53: 481-519.

BUSKEY, E.J., WHITE, H.K. & A.J. ESBAUGH, 2016. Impact of oil spills on marine life in the Gulf of Mexico: Effects on plankton, nekton, and deep-sea benthos. Oceanography 29(3):174–181

CABRERA, J., 1971. Survival of the oyster Crassostrea virginica (Gmelin) in the laboratory under the effects of oil drilling fluids spilled in the Laguna de Tamiahua, Mexico. Gulf Research Reports 3: 197-213.

CAI, Z., FU, J., LIU, W., FU, K., O'REILLY, S.E. & D. ZHAO, 2017. Effects of oil dispersants on settling of marine sediment particles and particle-facilitated distribution and transport of oil components. Marine Pollution Bulletin, 114(1): 408-418.

CANTELMO, F.R., TAGATZ, M.E. & K.R. RAO, 1979. Effect of barite on meiofauna in a flow-through experimental system Mar. EnVirOn. Res., 2: 301-309.

CAPP (Canadian Association of Petroleum Producers), 2001. Technical Report. Offshore Drilling Waste Management Review. Report 2001-0007 from Canadian Association of Petroleum Producers, Halifax, Nova Scotia, Canada. 240 pp.

CARASSOU, L., HERNANDWZ, F.J. & W.M. GRAHAM, 2014. Change and recovery of coastal mesozooplankton community structure during the Deepwater Horizon oil spill. Environ. Res. Lett., 9 (12pp.).

CARLS, M.G. & S.D. RICE. 1984. Toxic Contributions of Specific Drilling Mud Components to Larval Shrimp and Crabs. Marine Environmental Research 12: 45-62.

CARR, R.S., CHAPMAN, D.C., PRESLEY, B.J., BIEDENBACH, J.M., ROBERTSON, L., BOOTHE, P., KILADA, R., WADE, T. & P. MONTAGNA, 1996. Sediment pore water toxicity assessment studies in the vicinity of offshore oil and gas production platforms in the Gulf of Mexico. Can. J. Fish. Aquat. Sci., 53: 2618-2628.

CHANDRASEKARA, W.U. & C.L.J. FRID, 1998. A laboratory assessment of the survival and vertical movement of two epibenthic gastropod species, Hydrobia ulvae (Pennant) and Littorina littorea (Linnaeus), after burial in sediment. Journal of Experimental Marine Biology and Ecology, 221: 191-207.

CHAPMAN, P.M., POWER, E.A., DESTER, R.N. & H.B. ANDERSON, 1991. Evaluation of effects associated with an oil platform, using the sediment quality triad. Environ. Toxicol. Chem., 10: 407-424.

CHEVRON, 1994. Environmental Impact Assessment for Exploration Drilling in offshore Area 2815, Namibia. Impact Assessment Report. Chevron Overseas (Namibia) Limited, 55 pp.

CLARKE, D.G. & D.H. WILBER, 2000. Assessment of potential impacts of dredging operations due to sediment resuspension. DOER Technical Notes Collection (ERDC TN-DOER_E9). U.S. Army Engineer Research and Development Center, Vicksburg, MS.

CLARKE, R., 1956. Marking whales from a helicopter. Norsk Hvalfangst-Tidende 45: 311-318.

COHEN, J.H., MCCORMICK, L.R. & S.M. BURKHARDT, 2014. Effects of dispersant and oil on survival and swimming activity in a marine copepod. Bull. Environ. Contam. Toxicol., 92: 381–387.

COLEY, N.P. 1994. Environmental impact study: Underwater radiated noise. Institute for Maritime Technology, Simon's Town, South Africa. pp. 30.

COLEY, N.P. 1995. Environmental impact study: Underwater radiated noise II. Institute for Maritime Technology, Simon's Town, South Africa. pp. 31.

COLMAN, J.G., GORDON, D.M., LANE, A.P., FORDE, M.J. & J.J. FITZPATRICK, 2005. Carbonate mounds off Mauritania, Northwest Africa: status of deep-water corals and implications for management of fishing and oil exploration activities. In: Cold-water Corals and Ecosystems, Freiwald, A & Roberts, J. M. (eds). Springer-Verlag Berlin Heidelberg pp 417-441.

CONKLIN, P.J., DRYSDALE, D., DOUGHTIE, D.G., RAO, K.R., KAKAREKA, J.P., GILBERT, T.R. & R. SHOKES, 1983. Comparative toxicity of drilling muds: role of chromium and petroleum hydrocarbons. Mar. Environ. Res., 10: 105-125.

CONSTANTINE, R., 2001. Increased avoidance of swimmers by wild bottlenose dolphins (Tursiops truncatus) due to long-term exposure to swim-with-dolphin tourism. Marine Mammal Science 17: 689-702.

CORDES, E.E., JONES, D.O.B., SCHLACHER, T.A., AMON, D.J., BERNARDINO, A.F., BROOKE, S., CARNEY, R., DELEO, D.M., DUNLOP, K.M., ESCOBAR-BRIONES, E.G., et al. 2016. Environmental Impacts of the Deep-Water Oil and Gas Industry: A Review to Guide Management Strategies. Frontiers in Environmental Science 4: 1–26.

CRANFORD, P.J., GORDON, JR., D.C., LEE, K., ARMSWORTHY, S.L. & G.H. TREMBLAY, 1999. Chronic toxicity and physical disturbance effects of water- and oil-based drilling fluids and some major constituents on adult sea scallops (Placopecten magellanicus). Mar. Environ. Res., 48: 225-256.

CRANFORD, P.J., QUERBACH, K., MAILLET, G., LEE, K., GRANT, J. & C. TAGGART, 1998. Sensitivity of larvae to drilling wastes (Part A): Effects of water-based drilling mud on early life stages of haddock, lobster, and sea scallop. Report to the Georges Bank Review Panel, Halifax NS, Canada. 22 pp.

CROFT, B. & B. LI, 2017. Shell Namibia Deepwater Exploration Drilling: Underwater Noise Impact Assessment. Prepared by SLR Consulting Australia Pty Ltd. for SLR Consulting (Cape \Town) Pty Ltd. 19pp.

CSIR & CIME, 2011. Environmental Impact Assessment for Exploration Drilling Operations, Yoyo Mining Concession and Tilapia Exploration Block, Offshore Cameroon. CSIR Report no. CSIR/CAS/EMS/ER/2011/0015/A.

CURRIE, D.R. & L.R. ISAACS, 2005. Impact of exploratory offshore drilling on benthic communities in the Minerva gas field, Port Campbell, Australia. Mar. Environ. Res., 59: 217-233.

CURRIE, D.R., SOROKIN, S.J. & T.M. WARD, 2009. Infaunal macroinvertebrate assemblages of the eastern Great Australian Bight: effectiveness of a marine protected area in representing the region's benthic biodiversity. Marine and Freshwater Research 60: 459-474.

DAAN, R. & M. MULDER, 1993. A study on possible environmental effects of WBM cuttings discharge in the North Sea, one year after termination of drilling. NIOZ Report 1993-16 from the Netherlands Institute of Sea Research, Texel, the Netherlands. 17 pp.

DAAN, R. & M. MULDER, 1996. Long-term effects of OBM cutting discharges at 12 locations on the Dutch Continental Shelf. NIOZ-report 1996-6, NIOZ, Texel, The Netherlands: 1-36.

DAAN, R., VAN HET GROENEWOUD, H., DE JONG, S.A., & M. MULDER, 1992. Physico-chemical and biological features of a drilling site in the North Sea, 1 year after discharges of oil-contaminated drill cuttings. Marine Ecology Progress Series, 91: 37-45.

DAVIES, J., ADDY, J., BLACKMAN, R., BLANCHARD, J., FERBRACHE, J., MOORE, D., SOMMERVILLE, H., WHITEHEAD, A. & T. WILKINSON, 1983. Environmental effects of oil based mud cuttings. UKOOA, Aberdeen, Scotland. 24 pp. plus appendices.

DeLEO, D.M., RUIZ-RAMOS, D.V., BAUMS, I.B. & E.E. CORDES, 2015. Response of deep-water corals to oil and chemical dispersant exposure. Deep-Sea Res. II Top. Stud. Oceanogr. (11 pp.).

DETHLEFSEN, V., SOFFKER, K., BUTHER, H. & U. DAMM, 1996. Organochlorine compounds in marine organisms from the international North Sea incineration area Arch. Fish. Mar. Res., 44(3): 215-242.

DOUGLAS, A.B., CALAMBOKIDIS, J., RAVERTY, S., JEFFRIES, S.J., LAMBOURN, D.M.& S.A. NORMA, 2008. Incidence of ship strikes of large whales in Washington State. Journal of the Marine Biological Association of the United Kingdom 88: 1121-1132.

DOW, F.K., DAVIES, J.M. & D. RAFFAELI, 1990. The effects of drilling cuttings on a model marine sediment system. Mar. Environ. Res., 29: 103-124.

DREWITT, A., 1999. Disturbance effects of Aircraft on birds. English Nature. Birds Network Information Note. 14pp.

D'SOUZA,N.,SUBRAMANIAM,A.,JUHL,A.R.,CHEKALYUK,A.,PHAN,S.,YAN,B.,MACDONALD,I.R.,WEBER,S.C. & J.P. MONTOYA, 2016. Elevated surface chlorophyll associated with natural oil seeps in the Gulf of Mexico. Nat. Geosci., 9:215–218.

DUARTE, C.M., CHAPUIS, L., COLLIN, S.P., COSTA, D.P., DEVASSY, R.P., EGUILUZ, V.M., ERBE, C., GORDON, T.A., HALPERN, B.S., HARDING, H.R., HAVLIK, M.N., et al., 2021. The soundscape of the Anthropocene ocean. Science, 371 (6529).

EDGE, K.J., JOHNSTON, E.L., DAFFORN, K.A., SIMPSON, S.L., KUTTI, T. & R.J. BANNISTER, 2016. Sub-lethal effects of water-based drilling mud on the deep-water sponge Geodia barretti. Environ. Pollut., 212: 525-534.

EGRES, A.G., HATJE, V., GALLUCCI, F., MACHADO, M.E. & F. BARROS, 2019. Effects of an experimental oil spill on the structure and function of benthic assemblages with different history of exposure to oil perturbation. Marine Environmental Research, 152: 104822.

ELLIS, D.V., 2000. Effect of Mine Tailings on The Biodiversity of The Seabed: Example of The Island Copper Mine, Canada. In: SHEPPARD, C.R.C. (Ed), Seas at The Millennium: An Environmental Evaluation. Pergamon, Elsevier Science, Amsterdam, pp. 235-246.

ELLIS, D.V. & C. HEIM, 1985. Submersible surveys of benthos near a turbidity cloud. Marine Pollution Bulletin, 16: 197-202.

ELLIS, M.S., WILSON-ORMOND, E.A. & E.N. POWELL, 1996. Effects of gas-producing platforms on continental shelf macroepifauna in the northwestern Gulf of Mexico: abundance and size structure. Can. J. Fish. Aquat. Sci., 53: 2589-2605.

ELMGREN, R., S. HANSON, U. LARSON, B. SUNDELIN, & P.D. BOEHM, 1983. The ‘Tsesis’ Oil SPill: Acute and long-term impact on the benthos. Marine Biology, 73: 51-65.

ELVIN, S.S. & C.T. TAGGART, 2008. Right whales and vessels in Canadian waters. Marine Policy 32 (3): 379-386.

ELWEN, S.H. & R.H. LEENEY, 2010. Injury and Subsequent Healing of a Propeller Strike Injury to a Heaviside's dolphin (Cephalorhynchus heavisidii). Aquatic Mammals 36 (4): 382-387.

ENVIRONMENTAL PROTECTION AGENCY (EPA), 2000. Environmental assessment of fun] effluent limitations guidelines and standards for synthetic-based drilling fluids and other non-aqueous drilling fluids in the oil and gas extraction point source category. EPA-821-B-00-014. December 2000.

ENVIRONMENTAL EVALUATION UNIT, 1996. Impacts of Deep Sea Diamond Mining, in the Atlantic 1 Mining Licence Area in Namibia, on the Natural Systems of the Marine Environment. Environmental Evaluation Unit Report No. 11/96/158, University of Cape Town. Prepared for De Beers Marine (Pty) Ltd. 370 pp.

ERM, 2025b. ENVIRONMENTAL IMPACT ASSESSMENT FOR PROPOSED EXPLORATION WELL DRILLING IN PEL 82 IN THE WALVIS BASIN OFF THE COAST OF CENTRAL NAMIBIA. Marine Biodiversity Assessment. 0775081. Prepared for Chevron Namibia Exploration Limited II, August 2025. Pp38.

ERM, 2025a. ENVIRONMENTAL IMPACT ASSESSMENT FOR PROPOSED EXPLORATION WELL DRILLING IN PEL 82 IN THE WALVIS BASIN OFF THE COAST OF CENTRAL NAMIBIA. Drill Cuttings Deposition Modeling. 0775081. Prepared for Chevron Namibia Exploration Limited II, June 2025. Pp63.

ESBAUGH, A.J., E.M. MAGER, J.D. STIEGLITZ, R. HOENIG, T.L. BROWN, B.L. FRENCH, T.L. LINBO, C. LAY, H. FORTH, N.L. SCHOLZ, et al. 2016. The effects of weathering and chemical dispersion on Deepwater Horizon crude oil toxicity to mahi-mahi (Coryphaena hippurus) early life stages. Science of the Total Environment 543: 644–651.

ESSINK, K., 1999. Ecological effects of dumping of dredged sediments; options for management. Journal of Coastal Conservation, 5: 12.

EVANS, W., 1982. A study to determine if gray whales detect oil. In: Geraci, J.R. & D.J. St. Aubin (eds) Study on the effects of oil on cetaceans. Contract AA 551-CT9-22. Final report to U.S. Dept. of Interior, BLM, Washington, DC, p 47–61.

FECHHELM, R.G., GALLAWAY, B.J., HUBBARD, G.F., MACLEAN, S. & L.R. MARTIN, 2001. Opportunistic sampling at a deep-water synthetic drilling fluid discharge site in the Gulf of Mexico. Gulf of Mexico Science, 2: 97-106.

FELDER, D.L., B.P. THOMA, W.E. SCHMIDT, T. SAUVAGE, S.L. SELF-KRAYESKY, A. CHISTOSERDOV, H.D. BRACKEN- GRISSOM, & S. FREDERICQ, 2014. Seaweeds and decapod crustaceans on Gulf deep banks after the Macondo oil spill. BioScience, 64: 808–819.

FERNÁNDEZ-FERNÁNDEZ, S., BERNABEU, A., BOUCHETTE, F., REY, D. & F. VILAS, 2011. Beach morphodynamic influence on long-term oil pollution: the Prestige oil spill. J. Coast. Res., 64: 890-893.

FINCH, B.E.,WOOTEN, K.J. & P.N. SMITH, 2011. Embryo toxicity of weathered crude oil from the Gulf of Mexico in mallard ducks (Anas platyrhynchos). Environ. Toxicol. Chem., 30: 1885–1891.

FINCH, B.E., WOOTEN, K.J., FAUST, D.R. & P.N.SMITH, 2012. Embryotoxicity of mixtures of weathered crude oil collected from the Gulf of Mexico and Corexit 9500 in mallard ducks (Anas platyrhynchos). Sci. Total Environ., 426: 155–159.

FINDLAY, K.P., 1996. The impact of diamond mining noise on marine mammal fauna off southern Namibia. Specialist Study #10. In: Environmental Impact Report. Environmental Evaluation Unit (ed.) Impacts of deep sea diamond mining, in the Atlantic 1 Mining Licence Area in Namibia, on the natural systems of the marine environment. No. 11-96-158, University of Cape Town. Report to De Beers Marine (Pty) Ltd. pp. 370

FINNERAN, J.J., E.E. HENDERSON, D.S. HOUSER, K. JENKINS, S. KOTECKI & J. MULSOW, 2017. Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III). Technical report by Space and Naval Warfare Systems Center Pacific (SSC Pacific). 183 p.

FISHER, C.R., A.W.J. DEMOPOULOS, E.E. CORDES, I.B. BAUMS, H.K. WHITE, & J.R. BOURQUE, 2014a. Coral communities as indicators of ecosystem- level impacts of the Deepwater Horizon spill. BioScience 64: 796–807.

FISHER, C.R., P.Y. HSING, C.L. KAISER, D.R YOERGER, H.H. ROBERTS, W.W. SHEDD, E.E. CORDES, T.M. SHANK, S.P. BERLET, M.G. SAUNDERS, et al., 2014b. Footprint of Deepwater Horizon blowout impact to deep-water coral communities. Proceedings of the National Academy of Sciences of the United States of America 111: 11744–11749,

FOSTER, B.A. & R.C. WILLAN, 1979. Foreign barnacles transported to New Zealand on an oil platform. New Zealand Journal of Marine and Freshwater Research 13(1): 143-149.

FRASIER, K.E., SOLSONA-BERGA, A., STOKES, L. & J.A. HILDEBRAND, 2019. Impacts of the Deepwater Horizon Oil Spill on Marine Mammals and Sea Turtles. In: Murawski, S., Ainsworth, C., Gilbert, S., Hollander, D., Paris, C., Schlüter, M., Wetzel, D. (Eds.). Deep Oil Spills: Facts, Fate, and Effects. Springer, pp431-462.

FRITHSEN, J. B., ELMGREN, R. & D.T. RUDNICK, 1985. Responses of benthic meiofauna to long-term low-level additions of No. 2 fuel oil. Mar. Ecol. Prog. Ser., 23: 1-14.

FRITTS, T.H., IRVINE, A.B., JENNINGS, R.D., COLLUM, L.A., HOFFMAN, W. & M.A. McGEHEE, 1983. Turtles, birds, and mammals in the northern Gulf of Mexico and nearby Atlantic waters. FWS/OBS-82/65. Technical Report. U.S. Fish and Wildlife Service, Washington, D.C., USA.

GAMBELL, R., 1968. Aerial observations of sperm whale behaviour. Norsk Hvalangst-Tidende 57: 126-138.

GETLIFF, J., ROACH, A., TOYO, J. & J. CARPENTER, 1997. An overview of the environmental benefits of LAO based drilling fluids for offshore drilling. Report from Schlumberger Dowell. 10 pp.

GONG, Y., ZHAO, X., CAI, Z., O'REILLY, S.E., HAO, X. & D. ZHAO, 2014. A review of oil, dispersed oil and sediment interactions in the aquatic environment: Influence on the fate, transport and remediation of oil spills. Mar. Pollut. Bull., 79: 16–33.

GORDON, J. & A. MOSCROP, 1996. Underwater noise pollution and its significance for whales and dolphins. pp 281-319 In SIMMONDS. M.P. & HUTCHINSON, J.D. (eds.) The conservation of whales and dolphins. John Wiley and Sons, London.

GRAY, J.S., WU, R.S. & Y.Y. OR, 2002. Effects of hypoxia and organic enrichment on the coastal marine environment. Mar. Ecol. Prog. Ser., 238: 249-279.

GREEN, G.A., BRUEGGEMAN, J.J., GROTEFENDT, R.A., C.E. BOWLBY, C.E., M.L. BONNELL, M.L. & K.C. BALCOMB III., 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. In: J.J. BRUEGGEMAN, ed. Oregon and Washington Marine Mammal and Seabird Surveys. OCS Study MMS 91-0093. Minerals Management Service, Pacific OCS Region, Los Angeles, CA, USA, p. 1-100.

GROS, J., NABI, D., WÜRZ, B., WICK, L.Y., BRUSSAARD, C.P., et al., 2014. First day of an oil spill on the open sea: early mass transfers of hydrocarbons to air and water. Environ Sci Technol 48: 9400-9411.

HALE, C., GRAHAM, L., MAUNG-DOUGLASS, E., SEMPIER, S., SKELTON,T., SWANN, L., & M. WILSON, 2017. Oil spill science: Sea turtles and the Deepwater Horizon oil spill. TAMU-SG-17-501.

HALL, S.J., 2001. Is offshore oil exploration good for benthic conservation? Trends in Ecology and Evolution, 16(1): 58.

HALL, S.J., 1994. Physical disturbance and marine benthic communities: life in unconsolidated sediments. Oceanography and Marine Biology: An Annual Review, 32: 179-239.

HALLARE, A.V., K.J.A. LASAFIN, & J.R. MAGALLANES, 2011. Shift in phytoplankton community structure in a tropical marine reserve before and after a major oil spill event. International Journal of Environmental Research 5:651–660.

HARTLEY, J., TRUEMAN, R., ANDERSON, S., NEFF, J., FUCIK, K. & P. DANDO, 2003. Drill Cuttings Initiative: Food Chain Effects Literature Review. United Kingdom Offshore Operators Association, Aberdeen, Scotland. 118 pp + Appendices.

HARVEY, M., GAUTHIER, D. & J. MUNRO, 1998. Temporal changes in the composition and abundance of the macro-benthic invertebrate communities at dredged material disposal sites in the Anse a Beaufils, Baie des Chaleurs, Eastern Canada. Marine Pollution Bulletin, 36: 41-55.

HASTIE, G.D., WILSON, B., TUFFT, L.H. & P.M. THOMPSON, 2003. Bottlenose dolphins increase breathing synchrony in response to boat traffic. Marine Mammal Science 19: 74-84.

HASTINGS, D.W., P.T. SCHWING, G.R. BROOKS, R.A. LARSON, J.L. MORFORD, T. ROEDER, K.A. QUINN, T. BARTLETT, I.C. ROMERO & D.J. HOLLANDER, 2016. Changes in sediment redox conditions following the BP DWH blowout event. Deep Sea Research Part II 129: 167–178.

HELM, R.C., COSTA, D.P., DEBRUYN, T.D., O'SHEA, T.J., WELLS, R.S. & T.M. WILLIAMS, 2015. Overview of Effects of Oil Spills on Marine Mammals. In: FINGAS, M. (Ed.) Handbook of Oil Spill Science and Technology, John Wiley & Sons Inc., 455-475.

HERNANDEZ ARANA, H.A., WARWICK, R.M., ATTRILL, M.J., RODEN, A.A. & G. GOLD-BOUCHOT, 2005. Assessing the impact of oil-related activities on benthic macroinfauna assemblages of the Campeshe shelf, southern Gulf of Mexico. Marine Ecology Progress Series, 289: 89-107.

HEWITT, C.L., GOLLASCH, S. & D. MINCHIN, 2009. The vessel as a vector – biofouling, ballast water and sediments. In: Rilov, G. & J.A. Crooks (eds), Biological invasions in marine ecosystems. Berlin: Springer-Verlag. pp 117–131.

HINWOOD, J.B., POOTS, A.E., DENNIS, L.R., CAREY, J.M., HOURIDIS, H., BELL, R.J., THOMSON, J.R., BOUDREAU, P. & A.M. AYLING, 1994. Drilling activities. Pages 123-207 In: SWAN, J.M., NEFF, J.M. & P.C. YOUNG, Eds., Environmental Implications of Offshore Oil and Gas Development In Australia – Findings of an Independent Scientific Review. Australian Petroleum Production and Exploration Association, Canberra, Australia.

HOUGHTON, J.P., BEYER, D.L. & E.D. THIELK, 1980. Effects of oil well drilling fluids on several important Alaskan marine organisms. pp 1017-1044, In: Proceedings of Symposium, Research on Environmental Fate and Effects of Drilling Fluids and Cuttings, January 21-24, 1980, Lake Buena Vista, Florida. Vol. II. American Petroleum Institute, Washington, DC.

HÜPPOP, O., HÜPPOP, K., DIERSCHKE, J. & R. HILL, 2016. Bird collisions at an offshore platform in the North Sea. Bird Study, 63: 73-82.

HURLEY, G. & J. ELLIS, 2004. Environmental Effects of Exploratory Drilling Offshore Canada: Environmental Effects Monitoring Data and Literature Review - Final Report. Prepared for the Canadian Environmental Assessment Agency - Regulatory Advisory Committee.

HUSKY OIL OPERATIONS LIMITED, 2000. White Rose Oilfield Comprehensive Study. Submitted by Husky Oil Operations Limited as Operator, St. John's, NL.

HUSKY OIL OPERATIONS LIMITED, 2001a. White Rose Oilfield Comprehensive Study Supplemental Report Responses to Comments from Canada-Newfoundland Offshore Petroleum Board, Department of Fisheries and Oceans, Environment Canada, Natural Resources Canada and Canadian Environmental Assessment Agency. Submitted by Husky Oil Operations Limited (Operator). 265 pp. + Appendices.

HUSKY OIL OPERATIONS LIMITED, 2001b. White Rose baseline characterization data report June 2001. Prepared by Jacques Whitford Environment Limited for Husky Oil Operations Limited. St. John's. NL. 109 p. — App.

HYLAND, J., HARDIN, D., STEINHAUER, M., COATS, D., GREEN, R.H., & J. NEFF, 1994. Environmental impact of offshore oil development on the outer continental shelf and slope off Point Arguello, California. Marine Environmental Research, 37: 195-229.

HYLLEBERG, J., NATEEWATHANA, A. & B. CHATANANTHAWEJ, 1985. Temporal changes in the macrobenthos on the west coast of Phuket Island, with emphasis on the effects of offshore tin mining. Research Bulletin of the Phuket Marine Biological Center, 38: 32 pp.

IFC. World Bank Group. 2007. Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities. April, 2007.

INTEGRAL CONSULTING INC., 2006. Exxon Valdez Oil Spill Restoration Project Final Report – 2005. Assessment of Lingering Oil and Resource Injuries from the Exxon Valdez Oil Spill. Report to Exxon Valdez Oil Spill Trustee Council, June 2006. 193pp.

IOGP (International Association of Oil and Gas Producers), 2003. Environmental Aspects of use and disposal of non-aqueaous drilling fluids associated with offshore oil & gas operations. IOGP Report 342, IOGP, London, UK, pp114.

IOGP (International Association of Oil and Gas Producers), 2016. Environmental fates and effects of ocean discharge of drill cuttings and associated drilling fluids from offshore oil and gas operations. IOGP Report 543, pp144.

ITOPF (International Tanker Owners Pollution Federation), 2002. Fate of Marine Oil Spills, London: The International Tanker Owners Pollution Federation Limited.

ITOPF (International Tanker Owners Pollution Federation) 2014. Effects of Oil Pollution on Fisheries and Mariculture. Technical Informaption Paper (TIPS) 11: pp12.

ITOPF (International Tanker Owners Pollution Federation) 2014. Oil tanker spill statistics 2014. Available at www.itopf.com

INCARDONA, J.P., GARDNER, K.D., LINBO, T.L., SWARTS, T.L., ESBAUGH, A.J., MAGER, E.M., STIEGLITZ, J.D., FRENCH, B.L., LABENIA, J.S., LAETZ, C.A. et al. 2014. Deepwater Horizon crude oil cardiotoxicity to the developing hearts of large predatory pelagic fish. Proceedings of the National Academy of Sciences of the United States of America 111(15): E1505–E1508.

JENSEN, T., PALERUD, R., OLSGARD, F. & S.M. BAKKE, 1999. Dispersion and effects of synthetic drilling fluids in the Environment. Technical Report to the Ministry of Oil and Energy. Report no. 99-3507. 49pp.

JENSEN, A.S. & G.K. SILBER, 2003. Large Whale Ship Strike Database. NOAA Technical Memorandum NMFS-OPR. Silver Spring, MD: US Department of Commerce.

JØDESTØL, K. & E. FURUHOLT, 2010. Will Drill Cuttings And Drilling Mud Harm Cold Water Corals? International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, 12-14 April 2010, Rio de Janeiro, Brazil. Pp11.

KEEN, E.M., SCALES, K.L., RONE, B.K., HAZEN, E.L., FALCONE, E.A. & G.S. SCHORR, 2019. Night and day: diel differences in ship strike risk for fin whales (Balaenoptera physalus) in the California current system. Front. Mar. Sci., 6: 730.

KETTEN, D.R., 1998. Marine Mammal Auditory Systems: A summary of audiometric and anatomical data and its implications for underwater acoustic impacts. NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-256.

KHELIFA, A., STOFFYN-EGLI, P., HILL, P.S. & K. LEE, 2005. Effects of salinity and clay type on oil–mineral aggregation. Mar. Environ. Res., 59(3): 235–254.

KINGSTON, P.F., 1987. Field effects of platform discharges on benthic macrofauna. Philosophical Transactions of the Royal Society of London, Series B 317, 545–565.

KINGSTON, P.F., 1992. Impact of offshore oil production installations on the benthos of the North Sea. ICES J. Mar. Sci., 49: 45-53.

KIRK, J.T.O., 1985. Effects of suspensoids on penetration of solar radiation in aquatic ecosystems. Hydrobiologia, 125: 195-208.

KOPER, R.P & S. PLÖN, 2012. The potential impacts of anthropogenic noise on marine animals and recommendations for research in South Africa. EWT Research & Technical Paper No. 1. Endangered Wildlife Trust, South Africa.

KOSTKA, J.E., PRAKASH, O., OVERHOLT, W.A., GREEN, S.J., FREYER, G., CANION, A., DELGARDIO, J., NORTON, N., HAZEN, T.C. & M. HUETTEL, 2011. Hydrocarbon-Degrading Bacteria and the Bacterial Community Response in Gulf of Mexico Beach Sands Impacted by the Deepwater Horizon Oil Spill. Appl. Environ. Microbiol., 77: 7962–7974.

KOTTA, J., MARTIN, G. & R. APS, 2007. Sensitivity of benthic vegetation and invertebrate functional guilds to oil spills and its use in oil contingency management related negotiation processes. Proc. Estonian Acad. Sci. Biol. Ecol., 56: 255-269.

KOZAK, N.V. & I.A. SHPARKOVSKI, 1991. Testing Drilling Muds and their Components with the Use of Fish from the Barents Sea. In Theses of the Second. All-Union Conference on Fisheries Toxicology, 1: 272-273

KRANZ, P.M., 1974. The anastrophic burial of bivalves and its paleoecological significance. Journal of Geology, 82:29

KUJAWINSKI, E.B., SOULE, M.C.K., VALENTINE, D.L., BOYSEN, A.K., LONGNECKER, K.& M.C. REDMOND, 2011. Fate of Dispersants Associated with the Deepwater Horizon Oil Spill. Environ. Sci. Technol. 45, 1298–1306.

LANGANGEN, Ø., OLSEN, E., STIGE, L.C., OHLBERGER, J., YARAGINA, N.A., VIKEBØ, F.B., BOGSTAD, B., STENSETH, N.C. & D.Ø. HJERMANN, 1017. The effects of oil spills on marine fish: Implications of spatial variation in natural mortality. Marine Pollution Bulletin, 119: 102-109.

LAWS, R.M. (Ed.), 2009. Antarctic Seals: Research Methods and Techniques. Cambridge University Press, Cambridge. 390pp.

LEATHERWOOD, S., AWBREY, F.T. & J.A. THOMAS, 1982. Minke whale response to a transiting survey vessel. Report of the International Whaling Commission 32: 795-802.

LEES, D.C. & J.P. HOUGHTON, 1980. Effects of drilling fluids on benthic communities at the Lower Cook Inlet C.O.S.T. well. pp309-350. In: Proceedings of Symposium, Research on Environmental Fate and Effects of Drilling Fluids and Cuttings, Vol. I, January 21-24, 1980, Lake Buena Vista, Florida. American Petroleum Institute, Washington, DC.

LEPLAND, A. & P.B. MORTENSEN, 2008. Barite and barium in sediments and coral skeletons around the hydrocarbon exploration drilling site in the Traena Deep, Norwegian Sea. Environ. Geol., 56: 119–129.

LEUNG-NG, S. & S. LEUNG, 2003. Behavioral response of Indo-Pacific humpback dolphin (Sousa chinensis) to vessel traffic. Mar. Env. Res., 56: 555-567.

LIU, Y., & E.B. KUJAWINSKI, 2015. Chemical Composition and Potential Environmental Impacts of Water-Soluble Polar Crude Oil Components Inferred from ESI FT-ICR MS. PLoS ONE 10(9): e0136376.

LOVE, M.S. & A. YORK, 2006. The relationships between fish assemblages and the amount of bottom horizontal beam exposed at California oil platforms: fish habitat preferences at man-made platforms and (by inference) at natural reefs. Fisheries Bulletin, 104: 542-549.

LOVE, M.S., SCHROEDER, D.M. & W.H. LENARZ, 2005. Distribution of bocaccio (Sebastes paucispinis) and cowcod (Sebastes levis) around oil platforms and natural outcrops off California with implications for larval production. Bulletin of Marine Science, 77(3): 397-408.

LUSSEAU, D., 2004. The hidden cost of tourism: Effects of interactions with tour boats on the behavioral budget of two populations of bottlenose dolphins in Fiordland, New Zealand. Ecology and Society 9 (1): Part. 2.

LUSSEAU, D., 2005. Residency pattern of bottlenose dolphins Tursiops spp. in Milford Sound, New Zealand, is related to boat traffic. Marine Ecology Progress Series 295: 265-272.

LUSSEAU, D., BAIN, D.E., WILLIAMS, R. & J.C. SMITH, 2009. Vessel traffic disrupts the foraging behavior of southern resident killer whales Orcinus orca. Endangered Species Research 6: 211-221.

MACDONALD, J.M., SHIELDS, J.D., & R.K. ZIMMER-FAUST, 1988. Acute toxicities of eleven metals to early lift-history stages of the yellow crab Cancer anthonyi. Mar. Biol., 98: 201-207.

MALME, C.I., MILES, P.R., TYACK, P., CLARK, C.W. & J.E. BIRD, 1985. Investigation of the potential effects of underwater noise from petroleum industry activities on feeding humpback whale behavior. BBN Report 5851, OCS Study MMS 85-0019. Report from BBN Laboratories Inc., Cambridge, MA, for U.S. Minerals Management Service, NTIS PB86-218385. Bolt, Beranek, and Newman, Anchorage, AK.

MarLIN (Marine Life Information Network), 2023. Benchmarks for the Assessment of Sensitivity and Recoverability. The Marine Biological Association of the UK, Citadel Hill, Plymouth, Devon, U.K. Accessed: September 2023. Retrieved from:https://www.marlin.ac.uk/sensitivity/SNCB-benchmarks.

MATKIN, C.O., SAULITIS, E.L., ELLIS, G.M., OLESIUK, P. & S.D. RICE, 2008. Ongoing population-level impacts on killer whales Orcinus orca following the 'Exxon Valdez' oil spill in Prince William Sound, Alaska. Mar. Ecol. Prog. Ser., 356: 269– 281.

MAURER, D., KECK, R.T., TINSMAN, J.C. & W.A. LEATHEM, 1981a. Vertical migration and mortality of benthos in dredged material: Part I – Mollusca. Marine Environmental Research, 4: 299-319.

MAURER, D., KECK, R.T., TINSMAN, J.C. & W.A. LEATHEM, 1981b. Vertical migration and mortality of benthos in dredged material: Part II – Crustacea. Marine Environmental Research, 5: 301.317.

MAURER, D., KECK, R.T., TINSMAN, J.C. & W.A. LEATHEM, 1982. Vertical migration and mortality of benthos in dredged material: Part III – Polychaeta. Marine Environmental Research, 6: 49-68.

MAURER, D.L., LEATHEM, W., KINNER, P. & J. TINSMAN, 1979. Seasonal fluctuations in coastal benthic invertebrate assemblages. Estuarine and Coastal Shelf Science, 8: 181-193.

MAURER, D., KECK, R.T., TINSMAN, J.C. & W.A. LEATHAM, 1986. Vertical migration and mortality of marine benthos in dredged material: A synthesis. Int. Revue Ges. Hydrobiologia, 71: 49-63.

McCAULEY, R.D. 1994. Seismic surveys. In: Swan, J.M., Neff, J.M., Young, P.C. (Eds.). Environmental implications of offshore oil and gas development in Australia - The findings of an Independent Scientific Review. APEA, Sydney, Australia, 695 pp.

McCLAIN, C.R., NUNNALLY, C. & M.C. BENFIELD, 2019. Persistent and substantial impacts of the Deepwater Horizon oil spill on deep-sea megafauna. R. Soc. open sci. 6: 191164. http://dx.doi.org/10.1098/rsos.191164

McNUTT, M.K., CAMILLI,R., CRONE,T.J., GUTHRIE,G.D., HSIEH,P.A., RYERSON,T.B., SAVAS,O. & F. SHAFFER, 2012. Review of flow rate estimates of the Deepwater Horizon oilspill. Proceedings of the National Academy of Sciences, 109: 20260- 20267.

MENN, I., 2002. Ecological comparison of two sandy shores with different wave energy and morphodynamics in the North Sea. Berliner Polarforschung und Meeresforschung, 417: 1-174.

MICHEL, J., OWENS, E.H., ZENGEL, S., GRAHAM, A., NIXON, Z., ALLARD, T., et al., 2013. Extent and Degree of Shoreline Oiling: Deepwater Horizon Oil Spill, Gulf of Mexico, USA. PLoS ONE 8(6): e65087. https://doi.org/10.1371/journal.pone.0065087

MONTAGNA, P.A., & D.E. HARPER, JR., 1996. Benthic infaunal long-term response to offshore production platforms in the Gulf of Mexico. Can. J. Fish. Aquat. Sci., 53: 2567–2588.

MONTAGNA, P.A., J.G. BAGULEY, C. COOKSEY, I. HARTWELL, L.J. HYDE, J.L. HYLAND, R.D. KALKE, L.M. KRACKER, M. REUSCHER & A.C.E. RHODES, 2013. Deep-sea benthic footprint of the Deepwater Horizon blowout. PLoS ONE 8:e70540

MONTEIRO, P.M.S., 1998. Assessment of sediment biogeochemical characteristics in the Espirito Santo Estuary-Maputo, Bay system in order to devise a low risk dredging-disposal management plan linked to the proposed MOZAL Matola Terminal. CSIR Report No: ENV/s-C98131 A. pp 39.

MORANT, P.D., 1999. Synthesis and assessment of information on the BCLME. BCLME Thematic Report 4: Integrated overview of the offshore oil and gas industry in the Benguela Current Region. CSIR Report. ENV-S-C 99057.

MORTAZAVI, B., HOREL, A., BEAZLEY, M.J. & P.A. SOBECKY, 2013. Intrinsic rates of petroleum hydrocarbon biodegradation in Gulf of Mexico intertidal sandy sediments and its enhancement by organic substrates. J. Hazard. Mater., 244: 537-544.

MORTENSEN, P.B., HOVLAND, T., FOSSÅ, J.H. & D.M. FUREVIK, 2001. Distribution, abundance and size of Lophelia perusa coral reefs in mid-Norway in relation to seabed characteristics. Journal of the Marine Biological Association of the UK 81(4): 581-597.

MULLIN, K., HOGGARD, W., RODEN, C., LOHOEFENER, R., ROGERS, C. & B. TAGGART, 1991. Cetaceans on the upper continental slope in the north-central Gulf of Mexico. OCS Study MMS 91-0027. Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA, USA.

MUNRO, P., CROCE, B., MOFFIT, C., BROWN, N., McINTOSH, A., HIRD, S. & R. STAGG, 1997. Solid-Phase Test for Comparison of Degradation Rates of Synthetic Mud Base Fluids Used in the Off-Shore Drilling Industry. Environmental Toxicology and Chemistry, 17(10): 1951-1959.

MUNRO, P.D., CROCE, B., MOFFAT, C.F., BROWN, N.A., MCINTOSH, A.D., HIRD, S.J. & R.M. STAGG, 1998. Solid-phase test for comparison of degradation rates of synthetic mud base fluids used in the off-shore drilling industry. Environmental Toxicology and Chemistry, 17(10): 1951-1959.

MUSCHENHEIM, D.K. & T.G. MILLIGAN, 1996. Flocculation and accummulation of fine drilling waste particulates on the Scotian Shelf (Canada). Marine Pollution Bulletin 32 (10): 740-745.

NATIONAL RESEARCH COUNCIL (NRC), 2003a. Oil in the Sea III: Inputs, Fates, and Effects. The National Academies Press.

NEFF, J.N., 1991. Water Quality in Prince William Sound and the Gulf of Alaska. Arthur D Little, Cambridge, Massachusetts.

NEFF, J.M., RABALAIS, N.N. & D.F. BOESCH, 1987. Offshore oil and gas development activities potentially causing long-term environmental effects. pp 149-174. In: BOESCH D.F. & N.N. RABALAIS, Eds., Long Term Effects of Offshore Oil and Gas Development. Elsevier Applied Science Publishers, London.

NEFF, J.M., BOTHNER, M.H., MACIOLEK, N.J. & J.F. GRASSLE, 1989. Impacts of exploratory drilling for oil and gas on the benthic environment of Georges Bank. Marine Environmental Research, 27: 77-114.

NEFF, J.M., SAUER, T.C. & N. MACIOLEK, 1992. Composition, fate and effects of produced water discharges to nearshore waters. pp371-386. In: RAY, J.P. & F.R. ENGELHARDT, Eds., Produced Water: Technological/Environmental Issues. Plenum Publishing Co., New York.

NEFF, J.M., McKELVIE, S. & R.C. AYERS, Jr., 2000. Environmental Impacts of Synthetic Based Drilling Fluids. OCS Study MMS 2000-64. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Program, New Orleans, LA. 118 pp.

NEFF, J.M., 2005. Composition, Environmental Fates, and Biological Effects of Water Based Drilling Muds and Cuttings Discharged to the Marine Environment: A Synthesis and

Annotated Bibliography. Prepared fro Petroleum Environmental Research Forum (PERF) and American Petroleum Institute. 83pp.

NETTO, S.A., FONSECA, G. & F., GALLUCCI, 2010. Effects of drill cuttings discharge on meiofauna communities of the shelf break in the southwest Atlantic. Environ. Monit. Assess., 167:49–63.

NIU, H., LI, Z., LEE, K., KEPKAY, P. & J.V. MULLIN, 2011. Modeling the transport of oil-mineral-aggregates (OMAs) in the marine environment and assessment of their potential risks. Environ. Model Assess.,16: 61–75.

NOAA, 1998. Fact Sheet: Small Diesel Spills (500-5000 gallons) Available at: http://response.restoration.noaa.gov/oilaids/diesel.pdf

NOAA, 2010 (ed. Shigenaka). Oil and Sea Turtles Biology, Planning, and Response. Retrieved from http://response. restoration.noaa.gov/sites/default/files/Oil_Sea_Turtles.pdf

NOAA World Ocean Atlas, 2023. Worldwide Sound Speed, Temperature, Salinity, and Buoyancy.

NRC, 2003. Ocean noise and marine mammals. National Academy Press, Washington, DC.

NRC, 2005. Marine mammal populations and ocean noise, determining when noise causes biologically significant effects. The National Academy Press, Washington, DC.

OGP, 2003. Environmental aspects of the use and disposal of non aqueous drilling fluids associated with offshore oil and gas operations. Report prepared by the International Association of Oil and Gas Producers No. 342 pp.103.

OLSGARD, F. & J.S. GRAY, 1995. A comprehensive analysis of the effects of offshore oil and gas exploration and production on the benthic communities of the Norwegian continental shelf. Marine Ecology Progress Series, 122: 277–306.

OSPAR, 2008. OSPAR List of Substances / Preparations Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment (PLONOR).

OSPAR COMMISSION, 2009. Assessment of Environmental Impacts of Underwater Noise. Biodiversity Series. Publication number 441/2009.

O'TOOLE, M.J., 1997. A baseline environmental assessment and possible impacts of exploration and mining of diamond deposits (Prospecting Grants Areas M46/3/1946, 1950) off the coast of Namibia. In: LANE, S & CMS, 1996. Environmental Assessment and Management Plan report for deep sea diamond mining in Namibia by Arena Mining (Pty) Ltd.

OZHAN, K., PARSONS, M.L. & S. BARGU, 2014. How Were Phytoplankton Affected by the Deepwater Horizon Oil Spill? BioScience 64: 829–836.

PAGE, H.M., DUGAN, J.E., CULVER, C.S. & J.C. HOESTEREY, 2006. Exotic invertebrate species on offshore oil platforms. Marine Ecology Progress Series, 325: 101-107.

PAINE, M.D., SKINNER, M.A., KILGOUR, B.W., DEBLOIS, E.M. & E. TRACY, 2014. Repeated-measures Regression Designs and Analysis for Environmental Effects Monitoring Programs, 110: 84–91.

PANIGADA, S., PESANTE, G., ZANARDELLI, M., CAPOULADE, F., GANNIER, A. & M.T. WEINRICH, 2006. Mediterranean fin whales at risk from fatal ship strikes. Marine Pollution Bulletin 52 (10): 1287-98.

PARKINS, C.A. and J. G. FIELD, 1997. A baseline study of the benthic communities of the unmined sediments of the De Beers Marine SASA Grid. Unpublished Report to De Beers Marine, October 1997, pp 29.

PARKINS, C.A. and J.G.FIELD, 1998. The effects of deep sea diamond mining on the benthic community structure of the Atlantic 1 Mining Licence Area. Annual Monitoring Report – 1997. Prepared for De Beers Marine (Pty) Ltd by Marine Biology Research Institute, Zoology Department, University of Cape Town. pp. 44.

PARSONS, T.R., KESSLER T.A. & L. GUANGUO, 1986a. An ecosystem model analysis of the effect of mine tailings on the euphotic zone of a pelagic ecosystem. Acta Oceanol. Sin., 5: 425-436.

PARSONS, T.R., THOMPSON, P., WU YONG, LALLI, C.M., HOU SHUMIN & XU HUAISHU, 1986b. The effect of mine tailings on the production of plankton. Acta Oceanol. Sin., 5: 417-423.

PASSOW, U., 2014. Formation of rapidly-sinking, oil-associated marine snow. Deep Sea Research Part II 129:232–240, http://dx.doi.org/10.1016/ j.dsr2.2014.10.001.

PASSOW, U. & K. ZIERVOGEL, 2016. Marine snow sedimented oil released during the Deepwater Horizon spill. Oceanography 29(3):118–125, http://dx.doi.org/10.5670/ oceanog.2016.76.

PASSOW, U., ZIERVOGEL, K., ASPER, V. & A. DIERCKS, 2012. Marine snow formation in the aftermath of the Deepwater Horizon oil spill in the Gulf of Mexico. Environ. Res. Lett. 7.

PATENAUDE, N.J., RICHARDSON, W.J., SMULTEA, M.A., KOSKI, W.R., MILLER, G.W., WÜRSIG, B. & C.R. GREENE, JR., 2002. Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea. Marine Mammal Science 18: 309-335.

PAYNE, J.R.& W.B. DRISKELL, 2015. 2010 DWH offshore water column samples — forensic assessments and oil exposures. U.S. Dept. of Interior, Deepwater Horizon Response & Restoration, Admin. Record (www.doi.gov/deepwaterhorizon/adminrecord, DWHAR0039121, 37 p).

PEARSON, T.H. & R. ROSENBERG. 1978. Macrobenthic Succession in Relation to Organic Enrichment and Pollution of the Marine Environment. Oceanogr. Mar. Biol. Ann. Rev. 16: 229-311.

PEARSON, W.H., 2014. Comment on "multitissue molecular, genomic, and developmental effects of the Deepwater Horizon oil spill on resident gulf killifish (Fundulus grandis)". Environ. Sci. Technol., 48: 7677–7678.

PERRY, C., 1998. A review of the impacts of anthropogenic noise on cetaceans. Document SC/50/E9 submitted to the scientific committee of the International Whaling Commission, Muscat, Oman, 1998. 28 pp + 8 pp appendices.

PERRY, J., 2005. Environmental Impact Assessment for Offshore Drilling the Falkland Islands to Desire Petroleum Plc. 186pp

PETERSON, C.H., LANEY, W. & T. RICE, 2001. Biological impacts of beach nourishment. Workshop on the Science of Beach Renourishment, May 7-8, 2001. Pine Knoll Shores, North Carolina.

PIDCOCK, S., BURTON, C. & M. LUNNEY, 2003. The potential sensitivity of marine mammals to mining and exploration in the Great Australian Bight Marine Park Marine Mammal Protection Zone. An independent review and risk assessment report to Environment Australia. Marine Conservation Branch. Environment Australia, Cranberra, Australia. pp. 85.

PIROTTA, V., GRECH, A., JONSEN, I.D., LAURANCE, W.F. & R.G. HARCOURT, 2019. Consequences of global shipping traffic for marine giants. Frontiers in Ecology and the Environment, 17(1): 39-47.

POOPETCH, T. 1982. Potential effects of offshore tin mining on marine ecology. Proceedings of the Working Group Meeting on environmental management in mineral resource development, Mineral Resource Development Series, 49: 70-73.

POPPER, A.N., HAWKINS, A.D., FAY, R.R., MANN, D.A., BARTOL, S., CARLSON, T.J., ... & W.N. TAVOLGA, 2014. ASA S3/SC1.4 TR-2014 Sound exposure guidelines for fishes and sea turtles: A technical report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. ASA Press. Springer.

POWELL, S.M., SNAPE, T.I., BOWMAN, J.P., THOMPSON, B.A.W., STARK, J.S., MCCAMMON, S. A.& M.J. RIDDLE, 2005. A comparison of the short term effects of diesel fuel and lubricant oils on Antarctic benthic microbial communities. J. Exp. Mar. Biol. Ecol. 322, 53–65

PROUTY, N.G., FISHER, C.R., DEMOPOULOS, A.W.J. & E.R.M.DRUFFEL, 2014. Growth rates and ages of deep-sea corals impacted by the Deepwater Horizon oil spill. Deep-Sea Res. II Top. Stud. Oceanogr. http://dx.doi.org/10.1016/j.dsr2.2014.10.021 (Published online 8 November2014, 17 pp.).

PULFRICH, A. & A.J. PENNEY, 1999. The effects of deep-sea diamond mining on the benthic community structure of the Atlantic 1 Mining Licence Area. Annual Monitoring Report – 1998. Prepared for De Beers Marine (Pty) Ltd by Marine Biology Research Institute, Zoology Department, University of Cape Town and Pisces Research and Management Consultants CC. pp 49.

PULSTER, E.L., GRACIA, A., ARMENTEROS, M., TORO-FARMER, G., SNYDER, S.M., CARR, B., SCHWABB, M.R., NICHOLSON, T.J., MROWICKI, J. & S.A. MURAWSKI, 2020. A first comprehensive baseline of hydrocarbon pollution in Gulf of Mexico fishes. Nature/Scientific reports, 10: 6437.

PURSER, A., 2015. A time series study of Lophelia pertusa and reef megafauna responses to drill cuttings exposure on the Norwegian margin. PLoSONE 10:e0134076.doi:10.1371/journal.pone.0134076.

PURSER, A & L. THOMSEN, 2012. Monitoring Strategies for drill cutting discharge in the vicinity of cold-water coral ecosystems. Mar. Pollut. Bull., 64: 2309-2316

PUTMAN, N.F., ABREU-GROBOIS, F.A., ITURBE-DARKISTADE, I., PUTMAN, E.M., RICHARDS, P.M. & P. VERLEY, 2015. Deepwater Horizon oil spill impacts on sea turtles could span the Atlantic. Biol. Lett. 11: 20150596.

QU, F., NUNNALLY, C.C., LEMANSKI, J.R., WADE, T.L., AMON, A.M.W., ROWE, G.T., 2016. Polychaete annelid (segmented worms) abundance and species composition in the proximity (6–9 km) of the Deepwater Horizon (DWH) oil spill in the deep Gulf of Mexico. Deep-Sea Research Part II: 129: 130-136.

QUEIROS, A.M., BIRCHENOUGH, S.N.R., BREMNER, J., GODBOLD, J.A., PARKER, R.E., ROMERO- RODRIGUES, A., REISS, H., SOLAN, M., SOMERFIELD, P.J., COLEN, C.V., HOEY, G.V., WIDDICOMBE, S., 2013. A bioturbation classification of European marine infaunal invertebrates. Ecol. Evol. 3 (11), 3958–3985.

RANGER, 1993. Exploration Drilling Phase Environmental ImpactAssessment; Licence Area 2213, Namibia. Ranger Oil Limited.

REDDY, C.M., AREY, J.S., JEFFREY, S.S., SEAN, P.S., KARIN, L.L., et al. 2012. Composition and fate of gas and oil released to the water column during the Deepwater Horizon oil spill. Proc Natl Acad Sci USA 109: 20229-20234.

RICHARDSON, W.J., GREENE, C.R., JR., KOSKI, W.R. & M.A. SMULTEA, 1991. Acoustic effects of oil production activities on bowhead and white whales visible during spring migration near Pt. Barrow, Alaska-1990 phase: Sound propagation and whale responses to playbacks of continuous drilling noise from an ice platform, as studied in pack ice conditions. Unpublished report to U.S. Minerals Management Service, Procurement Operations, Herndon, Virginia: Contract 14-12-0001-30412 (LGL Report TA848-)

RICHARDSON, W.J., GREENE, C.R., MALME, C.I. & THOMSON, D.H. 1995. Marine Mammals and Noise. Academic Press, San Diego, CA.

RICHARDSON, W.J. & B. WÜRSIG, 1997. Influences of man-made noise and other human actions on cetacean behaviour. Marine and Freshwater Behaviour and Physiology 29: 183-209.

RICHTER, C.F., DAWSON, S.M. & E. SLOOTEN, 2003. Sperm whale watching off Kaikoura, New Zealand: Effects of current activities on surfacing and vocalisation patterns. Science for Conservation Report No. 219. Department of Conservation, Wellington, New Zealand.

RICHTER, C., DAWSON, S. & E. SLOOTEN, 2006. Impacts of commercial whale watching on male sperm whales at Kaikoura, New Zealand. Marine Mammal Science 22: 46-63.

ROBERTS, R.D., MURRAY, S., GREGORY, R. & B.A. FOSTER, 1998. Developing an efficient macrofauna monitoring index from an impact study - A dredge spoil example. Mar. Pollut. Bull., 36: 231-235.

ROGERS, A.D., 1999. The biology of Lophelia pertusa (Linnaeus 1758) and other deep-water reef-forming corals and impacts from human activities. International Review of Hydrobiology, 84 (4): 315-406.

SAADOUN, I.M.K, 2015. Impacts of Oil on Marine Life. In: Larramendy, M.L. & S. Soloneski (Eds.), Emerging Pollutants in the Environment - Current and Further Implications. http://dx.doi.org/10.5772/60455

SALCEDO, D.L., SOTO, L.A., ESTRADAS-ROMERO, A. & A.V. BOTELLO, 2017. Interannual variability of soft-bottom macrobenthic communities of the NW Gulf of Mexico in relationship to the Deepwater Horizon oil spill. Marine Pollution Bulletin 114:987-994

SANDRINI-NETO, L., MARTINS, C.C. & P.C. LANA, 2016. Are intertidal soft sediment assemblages affected by repeated oil spill events? A field-based experimental approach. Environ. Pollut., 213: 151–159.

SAVAGE, C., FIELD, J.G. & R.M. WARWICK, 2001. Comparative meta-analysis of the impact of offshore marine mining on macrobenthic communities versus organic pollution studies. Mar Ecol Prog Ser., 221: 265-275.

SCHAANNING, M.T., TRANNUM, H.C., OXNEVAD, S., CARROLL, J. & T. BAKKE, 2008. Effects of drill cuttings on biogeochemical fluxes and macrobenthos of marine sediments. Journal of Experimental Marine Biology and Ecology, 361: 49–57.

SCHAFFNER, L.C., 1993. Baltimore Harbor and channels aquatic benthos investigations at the Wolf Alternate Disposal Site in lower Chesapeake Bay. Final report prepared by the College of William and Mary and the Virginia Institute of Marine Science for the US Army Corps of Engineers, Baltimore District: pp. 120.

SCHOEMAN, R.P., PATTERSON-ABROLAT, C. & S. PLÖN, 2020. A Global Review of Vessel Collisions With Marine Animals. Frontiers in Marine Science, 7: doi.org/10.3389/fmars.2020.00292

SCHOLZ, D., MICHEL, J., SHIGENAKA, G. & R. HOFF, 1992. Biological resources. In: An Introduction to Coastal habitats and Biological Resources for Oil Spill Response. Report HMRAD 92-4 pp (4)-1-66. NOAA Hazardous Materials Response and Assessment Division, Seattle.

SCHRATZBERGER, M., REES, H.L. & S.E. BOYD, 2000a. Effects of simulated deposition of dredged material on structure of nematode assemblages - the role of burial. Mar. Biol., 136: 519-530.

SCHRATZBERGER, M., REES, H.L. & S.E. BOYD, 2000b. Effects of simulated deposition of dredged material on structure of nematode assemblages - the role of contamination. Mar. Biol., 137: 613-622.

SELL, D., CONWAY, L., CLARK, T., PICKEN, G.B., BAKER, J.M., DUNNET, G.M., MCINTYRE, A.D. & R.B. CLARK, 1995. Scientific criteria to optimize oil spill Cleanup. In: Proceedings of the 1995 International Oil Spill Conference. American Petroleum Institute, Washington, DC, pp595-610.

SERRANO, R. de la H., LASTRA, M. & J. LOPEZ. 2011, Oil Spills. In: Encyclopedia of Environmental Health. Elsevier

SHPARKOVSKI, I.A., PETROV, V.S. & N.V. KOZAK, 1989. Physiological Criteria [for] Assessment of the Ecological Situation During Drilling on the Shelf. In: Theses of the First All-Union Conference on Fisheries Toxicology, 2:199-200 Riga.

SIMMONS, R.E., 2005. Declining coastal avifauna at a diamond mining site in Namibia: comparisons and causes. Ostrich, 76: 97-103.

SLR CONSULTING CANADA, 2023. Proposed Offshore Exploration Drilling Campaign in Block 3B/4B. Underwater Sound Transmission Loss Modelling. Prepared for EIMS. October 2023. 87pp.

SMIT, M.G.D., HOLTHAUS, K.I.E., TAMIS, J.E., JAK, R.G., KARMAN, C.C., KJEILEN-EILERTSEN, G., TRANNUM, H. & J. NEFF, 2006. Threshold levels and risk functions for non-toxic sediment stressors: burial, grain size changes, and hypoxia - summary report – TNO.

SMIT, M.G.D., HOLTHAUS, K.I.E., TRANNUM, H.C., NEFF, J.M., KJEILEN-EILERTSEN, G., JAK, R.G., SINGSAAS, I., HUIJBREGTS, M.A.J. & A.J. HENDRIKS, 2008. Species sensitivity distributions for suspended clays, sediment burial, and grain size change in the marine environment. Environmental Toxicology and Chemistry, 27: 1006-1012.

SMITH, S.D.A. & M.J. RULE, 2001. The effects of dredge-spoil dumping on a shallow water soft-sediment community in the Solitary Islands Marine Park, NSW, Australia. *Mar. Pollut. Bull.*, 42: 1040-1048.

SMULTEA, M.A., KIECKHEFER, T.R. & A.E. BOWLES, 1995. Response of humpback whales to an observation aircraft as observed from shore near Kauai, Hawaii, 1994. Final Report for the 1994 Marine Mammal Research Program of the Acoustic Thermometry of Ocean Climate (ATOC) study. Prepared by the Bioacoustics Research Program of the Cornell Laboratory of Ornithology, Cornell University, Ithaca, NY, USA. 46 p.

SMULTEA, M.A., MOBLEY, J.R., FERTL, D. & G.L. FULLING, 2008. An unusual reaction and other observations of sperm whales near fixed-wing aircraft. *Gulf and Caribbean Research* 20: 75-80.

SMULTEA, M.A. & B. WÜRSIG, 1995. Behavioral reactions of bottlenose dolphins to the Mega Borg oil spill, Gulf of Mexico 1990. Aquat. Mamm., 21: 171–181.

SOUTHALL, B.L., FINNERAN, J.J., REICHMUTH, C., NACHTIGALL, P.E., KETTEN, D.R., BOWLES, A.E., ELLISON, W.T., NOWACEK, D.P. & P.L. TYACK, 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 2019, 45(2), 125-232,

SPRAGUE, J.B. & W.J. LOGAN, 1979. Separate and joint toxicity to rainbow trout of substances use in drilling fluid for oil exploration. *Environ. Pollut.*, 19: 269-281.

STARCZAK, V.R., FULLER, C.M. & C.A. BUTMAN, 1992. Effects of barite on aspects of ecology of the polychaete *Mediomastus ambiseta*. *Marine Ecology Progress Series,* 85: 269-282.

ST. AUBIN, D.J. & J.R. GERACI, 1994. Summary and conclusions. In: Loughlin TR (ed) Marine mammals and the 'ExxonValdez'. Academic Press, San Diego, CA, p 381–386.

STEFFANI, N., 2007a. Biological Baseline Survey of the Benthic Macrofaunal Communities in the Atlantic 1 Mining Licence Area and the Inshore Area off Pomona for the Marine Dredging Project. *Prepared for De Beers Marine Namibia (Pty) Ltd*. pp. 42 + Appendices.

STEFFANI, N., 2007b. Biological Monitoring Survey of the Macrofaunal Communities in the Atlantic 1 Mining Licence Area and the Inshore Area between Kerbehuk and Bogenfels. 2005 Survey. *Prepared for De Beers Marine Namibia (Pty) Ltd.* pp. 51 + Appendices.

STEFFANI, N., 2009a. Biological monitoring surveys of the benthic macrofaunal communities in the Atlantic 1 Mining Licence Area and the inshore area - 2006/2007. Prepared for De Beers Marine Namibia (Pty) Ltd. pp. 81 + Appendices.

STEFFANI, C.N., 2009b. *Assessment of Mining Impacts on Macrofaunal Benthic Communities in the Northern Inshore Area of the De Beers ML3 Mining Licence Area - 18 Months Post-mining.* Prepared for De Beers Marine (South Africa), 47pp.

STEFFANI, C.N., 2010a. Biological monitoring surveys of the benthic macrofaunal communities in the Atlantic 1 Mining Licence Area - 2008. Prepared for De Beers Marine Namibia (Pty) Ltd. pp. 40 + Appendices.

STEFFANI, C.N., 2010b. Benthic grab monitoring survey in the Atlantic 1 Mining Licence Area - 2009- sediment composition. Prepared for De Beers Marine Namibia (Pty) Ltd. pp. 19 + Appendix.

STEFFANI, C.N., 2010c. *Assessment of mining impacts on macrofaunal benthic communities in the northern inshore area of the De Beers Mining Licence Area 3 – 2010* . Prepared for De Beers Marine (South Africa). pp 30 + Appendices.

STEFFANI, C.N. & A. PULFRICH, 2004. The potential impacts of marine dredging operations on benthic communities in unconsolidated sediments. Specialist Study Report. In: PISCES ENVIRONMENTAL SERVICES (PTY) LTD, 2004. *Marine Dredging Project Pre-Feasibility Study, Environmental Impact Assessment, Volume II: Specialist Studies & Appendices.* Prepared for De Beers Marine (Pty) Ltd. and Namdeb Diamond Corporation (Pty) Ltd. 46pp.

STEFFANI, C.N & A. PULFRICH, 2007. Biological Survey of the Macrofaunal Communities in the Atlantic 1 Mining Licence Area and the Inshore Area between Kerbehuk and Lüderitz 2001 – 2004 Surveys. *Prepared for De Beers Marine Namibia, March 2007*, 288pp.

STEINHAUER, M., CRECELIUS, E. & W. STEINHAUER, 1994. Temporal and spatial changes in the concentrations of hydrocarbons and trace metals in the vicinity of an offshore oil-production platform. *Marine Environmental Research*, 37: 129-163.

STEWART, B.S., EVANS, W.E. & F.T. AWBREY, 1982. Effects of man-made waterborne noise on behaviour of belukha whales (*Delphinapterus leucas*) in Bristol Bay, Alaska. Unpublished report for National Oceanic and Atmospheric Administration, Juneau, Alaska, by Hubbs/Sea World Research Institute, San Deigo, California. HSWRI Technical Report 82-145.

STOUT, S. A., ROUHANI, S., LIU, B., OEHRIG, J., RICKER, R. W., BAKER, G., *et al.* (2017). Assessing the footprint and volume of oil deposited in deep-sea sediments following the Deepwater Horizon oil spill. *Mar. Pollut. Bull*. 114: 327–342.

TAGATZ, M.E. & M. TOBIA, 1978. Effect of barite (BaSO4) on development of estuarine communities. *Estuarine and Coastal Marine Science,* 7: 401-407.

TANG, D., SUN, J., ZHOU, L., WANG, S., SINGH, R.P. & G. PAN, 2019. Ecological response of phytoplankton to the oil spills in the oceans, Geomatics, Natural Hazards and Risk, 10(1): 853-872

TEAL, J.M. & R.W. HOWARTH, 1984. Oil spill studies: a review of ecological effects. *Environmental Management*, 8: 27-44.

Tetra Tech, 2025. Oil Spill Modeling Report - PEL 82/BLOCK 2112B & PEL 82/BLOCK 2212A. Prepared for Chevron Namibia, August 2025.

THOMSON, D.R., DAVIS, R.A., BELLORE, R., GONZALEZ, E., CHRISTIAN, J., MOULTON, V. & K HARRIS, 2000. Environmental assessment of exploration drilling off Nova Scotia. Report by LGL Limited for Canada-Nova Scotia Offshore Petroleum Board. Mobil Oil Canada Properties Ltd.. Shell Canada Ltd.. Imperial Oil Resources Ltd.. Gulf Canada Resources Ltd.. Chevron Canada Resources, PanCanadian Petroleum. Murphy Oil Ltd.. and Norsk Hydro. 278 p.

TRANNUM, H.C., NILSSON, H.C., SCHAANNING, M.T. & S. ØXNEVAD, 2010. Effects of sedimentation from water-based drill cuttings and natural sediment on benthic macrofaunal community structure and ecosystem processes. *Journal of Experimental Marine Biology and Ecology,* 383: 111-121.

TRANNUM, H.C., SETVIK, A., NORLING, K. AND H.C. NILSSON, 2011. Rapid macrofaunal colonization of water-based drill cuttings on different sediments. *Mar. Pollut. Bull*., 62: 2145-2156.

TREFRY, J.H., DUNTON, K.H., TROCINE, R.P, SCHONBERG, S.V., MCTIGUE, N.D., HERSH E.S. & T.J. McDONALD, 2013. Chemical and biological assessment of two offshore drilling sites in the Alaskan Arctic. *Marine Environmental Research*, 86: 35-45.

TURK, T.R. & M.J. RISK, 1981. Effects of sedimentation of infaunal invertebrate populations in Cobequid Bay, Bay of Fundy. *Can. J. Fish. Aquat. Sci.*, 38: 642-648.

U.S. DEPARTMENT OF THE INTERIOR. MMS GULF OF MEXICO OCS REGION. 2000. Press Release: Deepwater Production in the Gulf of Mexico Jumps Dramatically. 26 June, 2000. <http://www.gomr.mms.gov/homepg/whatsnew/newsreal/000626s.html>.

VALENTINE, M.M. & M.C. BENFIELD, 2013. Characterization of epibenthic and demersal megafauna at Mississippi Canyon 252 shortly after the Deepwater Horizon oil spill. *Marine Pollution Bulletin* 77: 196–209.

VENN-WATSON, S., COLEGROVE, K.M., LITZ, J., KINSEL, M., TERIO, K., SALIKI, J., FIRE, S., CARMICHAEL, R., CHEVIS, C., HATCHETT, W., PITCHFORD, J., TUMLIN, M., FIELD, C., SMITH, S., EWING, R., FAUQUIER, D., LOVEWELL, G., WHITEHEAD, H., ROTSTEIN, D., MCFEE, W., FOUGERES, E., ROWLES, T., 2015. Adrenal gland and lung lesions in Gulf of Mexico common bottlenose dolphins (*Tursiops truncatus*) found dead following the Deepwater Horizon oil spill. Plos One 10 (23 pp.).

VOLKMAN, J.K., MILLER, G.J., REVILL, A.T. & D.W. CONNELL, 1994. Environmental implications of offshore oil and gas development in Australia – oil spills. In: SWAN, J.M., NEFF, J.M. & P.C. YOUNG (eds), Environmental implications of offshore oil and gas development in Australia. The findings of an independent scientific review. Australian Exploration Association, Sydney. pp 509-695.

WALLACE, B., RISSING, M., CACELA, D., GARRISON, L., SCHROEDER, B., MCDONALD, T., MCLAMB, D., WITHERINGTON, B. & B. STACY, 2016. *Estimating degree of oiling of sea turtles and surface habitat during the Deepwater Horizon oil spill: implications for injury quantification.* NOAA report. https://www.doi.gov/deepwaterhorizon/adminrecord

WANG, F. & P.M. CHAPMAN, 1999. Biological implications of sulfide in sediment—a review focusing on sediment toxicity. *Environ. Toxicol. Chem*., 18: 2526-2532.

WATKINS, W.A., 1981. Activities and underwater sounds of fin whales. *Scientific Reports of the Whales Research Institute* 33: 83-117.

WATKINS, W.A. 1986. Whale reactions to human activities in Cape Cod waters. Mar. Mamm. Sci., 2(4): 251-262.

WATKINS, W.A. & W.E. SCHEVILL, 1977. Sperm whale codas. *Journal of the Acoustical Society of America* 62: 1485-90 + disk in pocket.

WEISBERG, R.H., ZHENG, L., Liu, Y., MURAWSKI, S., Hu, C. & J.P. CHUANMIN HU, 2016. Did Deepwater Horizon hydrocarbons transit to the west Florida continental shelf? Deep-Sea Research II, 129: 259-272.

WHITE, R.W., GILLON, K.W., BLACK, A.D. & J.B. REID, 2001. Vulnerable concentrations of seabirds in Falkland Islands waters.. JNCC, Peterborough.

WHITE, H.K., P.Y. HSING, W. CHO, T.M. SHANK, E.E. CORDES, A.M. QUATTRINI, R.K. NELSON, R. CAMILLI, A.W.J. DEMOPOULOS, C.R. GERMAN, *et al.*, 2012. Impact of the Deepwater Horizon oil spill on a deep-water coral community in the Gulf of Mexico. Proceedings of the National Academy of Sciences of the United States of America 109: 20303–20308.

WHITE, H.K., LYONS, S.L., HARRISON, S.J., FINDLEY, D.M., LIU, Y. & E.B. KUJAWINSKI, 2014. Long- Term Persistence of Dispersants following the Deepwater Horizon Oil Spill. Environ. Sci. Technol. Lett. 1, 295–299.

WIESE, F.K., MONTEVECCHI, W.A., DAVOREN, G.K., HUETTMANN, F., DIAMOND, A.W. & J. LINKE, 2001. Seabirds at risk around offshore oil platforms in the north-west Atlantic. *Mar. Pollut. Bull*. 42: 1285–1290.

WISE, C.F.,WISE, J.T.F.,WISE, S.S., THOMPSON,W.D.,WISE JR., J.P.,WISE SR., J.P., 2014a. Chemical dispersants used in the Gulf of Mexico oil crisis are cytotoxic and genotoxic to sperm whale skin cells. Aquat. Toxicol., 152: 335–340.

WISE JR., J.P., WISE, J.T.F., WISE, C.F., WISE, S.S., GIANIOS JR., C., XIE, H., THOMPSON, W.D., PERKINS, C., FALANK, C., WISE SR., J.P., 2014b. Concentrations of the genotoxic metals, chromium and nickel, in whales, tar balls, oil slicks, and released oil from the Gulf of Mexico in the immediate aftermath of the Deepwater Horizon oil crisis: Is genotoxic metal exposure part of the Deepwater Horizon legacy? Environ. Sci. Technol., 48: 2997–3006.

WITHROW, D.E., 1983. Gray whale research in Scammon's Lagoon (Laguna Ojo de Liebre). *Cetus* 5(1): 8-13.

WOLFSON, A., VAN BLARICOM, G., DAVIS, N. & G.S. LEWBE, 1979. The marine life of an offshore oil platform. *Marine Ecology Progress Series,* 1: 81-89.

WU, R.S.S., 2002. Hypoxia: from molecular responses to ecosystem responses. *Mar. Pollut. Bull*., 45: 35-45.

WÜRSIG, B., LYNN, S.K., JEFFERSON, T.A. & K.D. MULLIN, 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. *Aquatic Mammals* 24: 41-50.

YANG, T., NIGRO, L.M., GUTIERREZ, T., D'AMBROSIO, L., JOYE, S.B., HIGHSMITH, R. & A. TESKE, 2016, Pulsed blooms and persistent oil-degrading bacterial populations in the water column during and after the Deepwater Horizon blowout, *Deep Sea Res., Part II, 129:* 282–291,

ZHOU, L., TANG, D.L. & J. SUN, 2013. Investigation of marine phytoplankton blooms after the oil spills in the seas. Ecol. Sci., 32: 692–702.

ZHOU, Z., LI, X., CHEN, L., LI, B., WANG, C., GUO, J., SHI, P., YANG, L., LIU, B. & B. SONG, 2019. Effects of diesel oil spill on macrobenthic assemblages at the intertidal zone: A mesocosm experiment *in situ*. Marine Environmental Research 152: 104823.

ZONFRILLO, B., 1992. The menace of low-flying aircraft to Ailsa Craig. *Scottish Bird News*, 28 :4.

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GHG QUANTIFICATION STUDY

PREPARED FOR

Chevron

GHG Quantification

For Offshore Drilling Activities in Namibia in PEL 82

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GHG Quantification

For Offshore Drilling Activities in Namibia in PEL 82

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1. INTRODUCTION

Chevron Namibia Exploration Limited II (CNEL) proposes to initiate an offshore exploration programme within Petroleum Exploration License (PEL) 82, encompassing Blocks 2112B and 2212A situated in the Walvis Basin, Namibia (the proposed project). CNEL holds the Exploration License for both blocks and has appointed Environmental Resource Management Southern Africa (ERM) as the independent Environmental Assessment Practitioner (EAP) to conduct the Scoping and Environmental Impact Assessment (EIA) process for the proposed exploration activities.

Under Namibia's Environmental Management Act, 2007 and the associated Environmental Impact Assessment (EIA) Regulations of 2012, any listed activity that may have significant environmental effects must undergo an EIA and obtain an Environmental Clearance Certificate (ECC). Offshore hydrocarbon exploration is a listed activity due to its potential impacts on air quality, marine ecosystems, and climate. The Act defines "significant effects" to include cumulative and indirect impacts, such as GHG emissions, which contribute to climate change. Furthermore, Namibia's commitment to its Nationally Determined Contributions (NDCs) under the Paris Agreement requires alignment of development projects with national climate mitigation goals.

As such, as part of the ESIA process, a Greenhouse Gas (GHG) Quantification was conducted to estimate and evaluate the emissions generated during the project's key phases: mobilisation, drilling (either exploration and/or appraisal) and demobilisation. This includes potential emissions associated with flaring during well testing if conducted.

2. RELEVANT REGULATIONS, FRAMEWORKS AND STANDARDS

The GHG assessment aligns with both international and national regulatory frameworks and guidelines, as summarised below.

- **Intergovernmental Panel on Climate Change (IPCC):** Provides regular scientific assessments on climate change, its implications and potential future risks, as well as to put forward adaptation and mitigation options.
- **Paris Agreement:** The Paris Agreement is an international treaty on climate change that entered into force in November 2016. Namibia is a party to, and has ratified the Paris Agreement. The Parties to the Paris Agreement acknowledge that "climate change is a common concern of humankind," and the Parties should consider their respective obligations. Countries submit their plans for climate action—these plans are known as NDCs. In their NDCs, countries communicate actions they will take to reduce their GHG emissions to reach the goals of the Paris Agreement. Countries also communicate in the NDCs actions they will take to build resilience to adapt to the impacts of climate change.

  In its most recent NDC, Namibia commits to reducing 11.9 million tonnes of carbon dioxide equivalents (CO_2e) by 2030, with a focus on the energy and land use sectors. Namibia acknowledges that to fully implement the mitigation and adaptation measures contained in its NDC, Namibia will require finance, capacity building and technology transfer, as well as a country driven policy process and robust institutional arrangements.

- **International Organization for Standardisation 14064-1:2019 Part 1:** Sets out principles for quantifying and verifying GHG emissions at the organisational or project level.
- **GHG Protocol:** A globally recognised standard for measuring and managing greenhouse gas emissions, ensuring transparency and comparability across projects and jurisdictions.
- **American Petroleum Institute (API) Compendium:** The API Compendium of Greenhouse Gas Emissions Methodologies for the Natural Gas and Oil Industry provides sector-specific guidance for calculating emissions from upstream oil and gas operations.
- **Petroleum (Exploration and Production) Act, 1991:** Regulates oil and gas activities through a licensing system and requires a Petroleum Agreement that outlines work and environmental obligations.
- **Model Petroleum Agreement (1998):** Establishes terms for exploration, including local content requirements, minimum work programmes and environmental safeguards, providing regulatory clarity for ESIA operations.
- **Environmental Management Act, 2007:** Requires ESIAs for projects with significant environmental risks. An Environmental Clearance Certificate must be obtained before exploration activities commence.
- **EIA Regulations (2012):** Detail the assessment process, including public consultation and risk mitigation measures, ensuring that environmental impacts are addressed early in the project lifecycle.

3. ASSESSMENT SCOPES AND BOUNDARIES

To establish the GHG emissions inventory for the project, it is essential first to define the organisational and operational boundaries of the assessment.

3.1 ORGANISATIONAL BOUNDARIES

This assessment adopts the control approach, where Chevron accounts for 100% of the estimated GHG emissions from the project operations it controls. This approach is consistent with international best practice, as outlined by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI, 2004).

3.2 OPERATIONAL BOUNDARIES

Operational boundaries classify emissions as direct or indirect. The GHG Protocol defines three scopes to ensure clarity and avoid double counting:

- **Scope 1 – Direct GHG Emissions:**
  - These are emissions from sources that are owned or controlled by the organisation. For this project, Scope 1 includes:
    - Combustion of fuel by drillships, support vessels and helicopters during all phases (mobilisation, drilling, demobilisation).
    - Emergency flaring of dry associated gas during the appraisal phase. Although flaring is a temporary activity, it involves the combustion of hydrocarbons

under Chevron's operational control and thus qualifies as a Scope 1 emission source.

- **Scope 2 – Indirect GHG Emissions from Purchased Electricity:**
  - Not applicable for this offshore project, as no grid electricity or external steam is purchased or used.
- **Scope 3 – Other Indirect Emissions:**
  - Excluded from this assessment. These would include emissions from third-party logistics, supply chains, or end-of-life product use, which are beyond the project's immediate control.

4. EMISSIONS SOURCES AND ASSUMPTIONS

The GHG emissions for the project arise from activities across three project phases: mobilisation, drilling (either exploration and/or appraisal) and demobilisation. The principal sources of emissions include marine fuel combustion (support vessels and drillship), aviation fuel combustion (helicopters) and emergency flaring of associated gas during well testing of the appraisal wells.

Emissions were calculated using estimated fuel consumption data, fuel-specific emission factors, and a set of assumptions described below.

Table 4-1 outlines the main emission sources, the associated activities driving fuel consumption and the assumptions applied in estimating emissions for each source. Importantly, the estimated project GHG emissions were calculated on a highest-utilisation basis, assuming up to 90 days of drilling for a single exploration or appraisal well, with a maximum of four wells drilled per year. During this period, up to two mobilisation and two demobilisation phases are also assumed.

TABLE 4-1 EMISSIONS SOURCES AND ASSUMPTIONS

Emission Source	Activity	Assumption
Helicopters	Personnel transport during mobilisation & demobilisation	2 flights/week during mobilisation and demobilisation
	Personnel transport during drilling	4 flights/week during drilling
	Fuel consumption	1.5 m^3 jet fuel per flight
Support Vessels	Marine transport and support services	Up to 4 vessels operating during all project phases
	Fuel consumption	13 m^3/day per vessel of Distillate Fuel #2
Drillship	Drilling operations	40 m^3/day of Distillate Fuel #2
	Duration (exploration)	Total of 5 wells
	Duration (appraisal)	Total of 5 wells

Emission Source	Activity	Assumption
Flaring during appraisal only	Emergency/contingency flaring	10,000 Sm^3/day for 7 days per well
	Gas composition	95% CH_4 (dry associated gas)
	Combustion efficiency	> 98%
	Methane density	0.717 kg/m^3
General	N/A	The sequence of offshore activities is expected to follow this order: mobilisation, exploration drilling and/or potential appraisal drilling (with well testing), well abandonment, and demobilisation. For the purposes of this GHG assessment, a conservative worst-case scenario has been applied. It assumes that each well involves up to 90 days of offshore operations, comprising 15 days for mobilisation, 60 days for either exploration or appraisal drilling, and 15 days for demobilisation. A maximum of four wells is anticipated to be drilled per year, with up to two mobilisation and two demobilisation phases likely to occur during this time. To ensure a conservative estimate, it has been assumed that all four wells are exploration wells, as this represents the highest-emission case compared to appraisal or mixed drilling scenarios.

5. GHG EMISSIONS CALCULATION

5.1 METHODOLOGY

To estimate the project's total GHG emissions, a bottom-up activity-based approach was used, following internationally accepted guidance from the API Compendium. The methodology involves multiplying activity data (e.g., volume of fuel consumed) by corresponding emission factors and converting to CO_2 equivalents using Global Warming Potentials (GWPs). (Note: GWP values used are based on the Intergovernmental Panel on Climate Change Fifth Assessment Report (AR5) to align with Namibia's NDC). This allows aggregation of multiple gases into a single comparable metric. The basic equation is:

$$Emissions = Activity \times Emission\ Factor \times Global\ Warming\ Potential$$

Where:

$Emissions = estimate\ of\ CO_2e\ or\ GHG\ emissions\ in\ tonnes/year$

5.2 FUEL TYPES AND EMISSION FACTORS

The project assumes the use of Jet fuel for helicopters, and Distillate Fuel #2 for support vessels and the drillship. Table 5-1 below shows the emissions factors that were used to estimate the project GHG emissions.

TABLE 5-1 EMISSIONS FACTORS

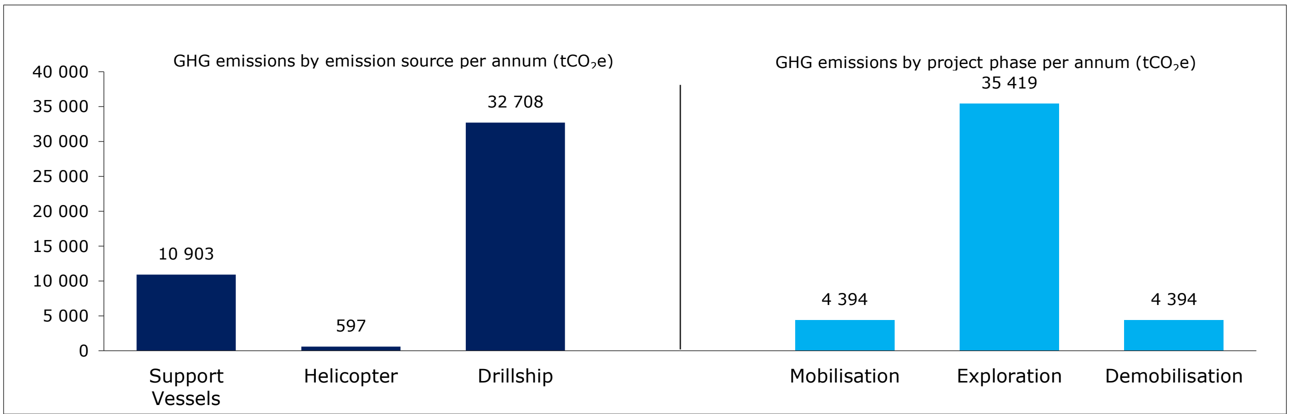
Fuel type	CO_2 (t/m³)	CH_4 (t/m³)	N_2O (t/m³)
Jet Fuel[1]	2.5718400	0.0001070	0.0000214
Distillate #2 fuel[2]	2.7167400	0.0001100	0.0000220

5.3 GHG EMISSIONS

The project is estimated to generate approximately **44,208 tonnes of CO_2 equivalent (tCO_2e) per year**, calculated on a worst-case basis, ie. **assuming four wells are drilled per year**. The key findings are summarised below:

- **Mobilisation Phase:** The estimated total GHG emissions during the mobilisation phase were approximately 4,394 tCO_2e per annum. The majority of these emissions originated from drillship operations, which are the primary contributors in this phase.
- **Drilling Phase (Exploration as the worst case):** GHG emissions during the drilling phase are estimated at 35,419 tCO_2e per annum. Drillships account for approximately 74% of these emissions, with the remaining 26% attributed to helicopter and support vessel operations.
- **Demobilisation Phase:** The estimated GHG emissions for the demobilisation phase are 4,394 tCO_2e per annum, with drillships again being the dominant source of emissions.
- **Overall Emissions Profile:** Across all project phases, drillships are the primary source of GHG emissions. This is largely due to their use of distillate fuel #2, which has a higher carbon intensity compared to jet fuel. Additionally, drillships consume significantly more fuel per operational day than helicopters, owing to their higher frequency and duration of use throughout the project lifecycle. Figure 5-1 present a breakdown of these emissions by source and project phase.

FIGURE 5-1 GHG EMISSIONS BREAKDOWN ON A WORST-CASE BASIS



[1] Jet Fuel: Emission factors were sourced and derived using constants from the API, COMPENDIUM OF GREENHOUSE GAS EMISSIONS METHODOLOGIES FOR THE NATURAL GAS AND OIL INDUSTRY as follows:

- *Table 3-8: Densities, Higher Heating Values, and Carbon Contents for Various Fuels*
- *Table 4-3: CO_2 Combustion Emission Factors (Fuel Basis) for Common Industry Fuel Types*
- *Table 4-8: CH_4 and N_2O Combustion Emission Factors from EPA Mandatory GHG Reporting Rule*

[2] Distillate #2 fuel: Same as the above.

5.4 ASSUMPTIONS, LIMITATIONS AND EXCLUSIONS

The following limitations and exclusions were noted from this assessment:

- Emission factors and calorific values were sourced from the API 2021 Compendium (Tables 3-8, 4-3 and 4-8).
- GWP values are based on the Intergovernmental Panel on Climate Change Fifth Assessment Report (AR5) to align with Namibia's NDC.
- Due to the unavailability of marine gas oil (MGO) data, Distillate Fuel #2 was conservatively used as a proxy for vessels and drillship.
- Scope 2 emissions are not applicable for this offshore project, as no grid electricity or external steam is purchased or used.
- Scope 3 emissions (e.g., upstream fuel extraction, downstream processing, and third-party logistics) are excluded due to data limitations and because they fall outside of Chevron's operational control.
- No emissions from onshore logistics or waste disposal are included, as they are assumed to be minor and not material to the overall project footprint.
- All GHG emission calculations were based on a highest utilisation assumption — using a total of up to 90 days per well. This includes 15 days for mobilisation, 60 days for exploration or appraisal drilling and 15 days for demobilisation. A maximum of four wells are assumed to be drilled per year with 2 mobilisation and demobilisation phases proposed during this time.

6. CONCLUSION AND RECOMMENDATIONS

CNEL should ensure ongoing appropriate carbon management measures to align with:

- International good practice.
- Namibia's NDCs under the Paris Agreement.
- Internal corporate climate objectives.

While the GHG profile is typical for deepwater exploration activities, it presents opportunities for emission reductions, particularly in relation to operational efficiency and flaring controls.

To effectively maintain and manage the project's emissions, the following mitigation measures are recommended to be ongoing:

1. **Flaring Minimisation**
   - Limit flaring duration and volume during appraisal drilling.
   - Maintain high combustion efficiency of >98%.
2. **Drillship Efficiency**
   - Explore low-carbon fuel alternatives.
   - Optimise fuel consumption through maintenance, operating protocols and strategic scheduling.
3. **Logistics Optimisation**
   - Reduce helicopter use by streamlining crew rotations.

- Implement digital tools for remote monitoring to reduce site visits.

4. **Environmental Management Plan**
    - Mitigation actions detailed in the above three points should be incorporated into the Environmental Management Plan.

7. REFERENCES

1. American Petroleum Institute. (2021). Compendium of Greenhouse Gas Emissions Methodologies for the Natural Gas and Oil Industry (4th ed.). Retrieved from https://www.api.org/~/media/files/policy/esg/ghg/2021-api-ghg-compendium-110921.pdf.
2. Congressional Research Service. (2024). Paris Agreement: Nationally Determined Contributions Conditional on International Support—In Brief (CRS Report R48248). Retrieved from https://www.congress.gov/crs_external_products/R/PDF/R48248/R48248.2.pdf
3. NC Incorporated. (2025). Namibia: Energy – Oil & Gas. The Legal 500 Country Comparative Guides. Retrieved from https://www.legal500.com/guides/chapter/namibia-energy-oil-gas/?export-pdf.
4. Republic of Namibia. (1991). Petroleum (Exploration and Production) Act 2 of 1991. Retrieved from https://www.lac.org.na/laws/annoSTAT/Petroleum%20(Exploration%20and%20Production)%20Act%202%20of%201991.pdf.
5. Republic of Namibia. (2007). Environmental Management Act 7 of 2007. Retrieved from https://www.lac.org.na/laws/annoSTAT/Environmental%20Management%20Act%207%20of%202007.pdf.

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