9 IMPACT ASSESSMENT - NORMAL OPERATION

9.1 OPERATION OF DRILL UNIT, VESSELS AND HELICOPTERS

9.1.1 Emissions to Atmosphere

Source of Impact

The project activities likely to emit pollutants to the atmosphere and affect air quality are:

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 and helicopters between the drilling unit and port and airport, respectively
	Incineration of waste (subject to AEL)
	Well (flow) testing / flaring*
Demobilisation	Transit of drilling unit and support vessels from drill site
* Well testing and flaring does not fall under the vessel operation, but under drilling operations (see Section 9.2.5). However, all emissions are considered and assessed cumulatively in this section.	

Emissions from these activities will include:

- The principal sources of emissions to air will be exhaust gas emissions produced by the combustion of fuel (project vessels – including drill unit - and helicopter). As with any stationary or mobile combustion engine powered by fossil fuels, some emissions of unburned hydrocarbons, gaseous pollutants, volatile organic compounds and particles are likely to be generated by the propulsion system of the vessels.
- Well or flow testing may be undertaken to determine the economic potential of a discovery before the well is either abandoned or suspended. One test may be undertaken per exploration well should a resource be discovered and an 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). For the proposed project, an estimated 10 000 barrels (bbl) of oil could be flared per test, i.e., up to 20 000 bbl over the two tests associated with an appraisal well.
- Although it is not TEEPSA's intension to incinerate waste during the proposed exploration campaign (their other drilling campaigns off the South Coast did not incinerate waste), incineration of certain wastes onboard the drilling unit and support vessels would also produce limited occasional emissions. Should TEEPSA wish to incinerate waste on an offshore installation, an application for an AEL would need to be undertaken.

9.1.1.1 Impacts on Air Quality

Potential Impact Description

The release of gaseous pollutants, principally sulphur oxides (SO_x), nitrogen oxides (NO_x) and carbon monoxide (CO), together with lesser quantities of particulate matter (PM_{10}/$PM_{2.5}$) and volatile organic compounds (VOCs), from the project vessels, helicopters and well testing have the potential to cause reductions in local air quality close to the emissions source (**direct negative** impact), which in turn could have effects on health (e.g., respiratory effects), ozone layer, acidification of air and water, etc (**indirect negative** impact). The impact assessment is summarised in Table 9-2.

Project Controls

TEEPSA will comply with the requirements set out in MARPOL Annex VI Regulation 18 - Fuel Quality. Project vessels will be supplied with marine gasoil (MGO) or heavy fuel oil (HFO) with less than 0.5% sulphur (mass). They will be operated and maintained to ensure the efficient consumption of fuel in completion of the required activities.

Sensitivity of Receptors

Emissions from activities described above would primarily take place within the area of interest and along the route taken by the supply vessels (Cape Town or Saldanha) and helicopter (Cape Town). Although a significant amount of marine (ship) traffic can be anticipated in the vicinity of Block 5/6/7 and is expected to pass through the area of interest, the air quality in the area of interest expected to be relatively good.

The area of interest is located more than 60 km offshore and far removed from any sensitive receptors (e.g., settlements, bird or seal colonies, etc.). The atmosphere has the capacity to disperse relatively minor emissions without detectable alteration in local air quality and such emissions are unlikely to have a direct effect on any receptor or other activity, other than the project vessels themselves. This said, the sensitivity of offshore marine fauna and coastal receptors to changes in air quality is considered **medium**.

Impact Magnitude (or Consequence)

The release of gaseous pollutants to the atmosphere from proposed activities may cause a short-term reduction in local air quality. The emission levels of the project vessels (excluding flaring) are comparable to those produced by commercial vessels sailing through the licence area. The calculated emissions from a single appraisal drilling and well testing campaign (2 DST) is summarised in Table 9-1. Considering the European Monitoring and Evaluation Programme (EMEP) / European Environment Agency (EEA) emission factors, the drilling unit constitutes approximately 46% to 67% of the emissions (depending on the pollutant) with flaring approximately 1.2 % to 34% (depending on the pollutant). Vessels (including minor contributions from helicopter) contribute about 18% to 34% (depending on the pollutant) of the total emissions. The highest concentrations were predicted with the inclusion of well testing activities. **Since the proposed operations would be far removed offshore, their contribution of air pollution along the coastline is expected to be low considering the dilution effect due to atmospheric dispersion of the air emissions. The predicted concentrations are well below the respective National Ambient Air Quality Standards (NAAQS)[46] limit values for NO_2, SO_2, CO and $PM_{2.5}$.**

[46] The regulation of routine air emissions from industry focuses on community exposures and is governed through compliance with the DFFE National Ambient Air Quality Standards (NAAQS).

TABLE 9-1: SUMMARY OF POLLUTANT EMISSIONS FOR A SINGLE SUCCESSFUL APPRAISAL WELL WITH TWO TESTS

Source Group	Pollutant Emission [tonne] {EMEP/EEA Emission Factors}									
	NOx		CO		NMVOC		SO_2		PM	
Drilling Unit	486.07	65%	61.92	46%	19.14	52%	118.94	67%	14.50	56%
Vessel Exhausts	254.34	34%	23.98	18%	9.07	25%	32.40	18%	4.86	19%
Helicopter Transport	0.42	0%	2.89	2%	0.25	1%	0.04	0%	0.00	0%
Oil Flaring	10.10	1%	49.11	34%	9.00	23%	27.29	15%	6.52	25%
Fugitive Emissions	-	-	-	-	0.0004	0%	-	-	-	-
Total	**750.93**	100%	**137.90**	100%	**37.47**	100%	**178.67**	100%	**25.88**	100%
NOx = Oxides of nitrogen CO = Carbon monoxide NMVOC = Non-methane volatile organic compound					SO_2 = Sulphur dioxide PM = Particulate Matter					

In order to predict air quality at the shoreline due to the air emissions of criteria pollutants from drilling operations (including flaring), Screening Dispersion Simulations were undertaken using two atmospheric conditions and worst-case meteorological conditions. The results of the dispersion simulations are summarised in Table 4-10 and Table 4-11 in the Climate Change and Air Emissions Impact Assessment (refer to Appendix 15 in Volume 3). A summary is provided below.

- The highest hourly average NO_2 concentrations expected at the coast is 41.8 µg/m³ during calm wind, stable night-time conditions. The hourly average NAAQS limit value for NO_2 is 200 µg/m³, which means that the highest NO_2 concentration is predicted to be 20.9% of the national standard.
- The highest hourly average SO_2 concentration expected at the coast is 7.7 µg/m³ during calm wind, stable night-time conditions. The hourly average NAAQS limit value for SO_2 is 350 µg/m³, which means that the highest SO_2 concentration is predicted to be 2.2% of the national standard.
- The highest hourly average $PM_{2.5}$ concentration expected at the coast is 1.0 µg/m³. The highest hourly average $PM_{2.5}$ concentration is predicted to be 4.9% of the daily average limit value.
- The predicted highest CO hourly average concentration is 13.0 µg/m³. This is low when compared with the NAAQS limit value of 30 000 µg/m³. The predicted concentration is 0.04% of the national standard.
- There are no NAAQS for Non-methane volatile organic compound (NMVOCs). However, the highest predicted hourly average NMVOC concentration of 1.6 µg/m³ is still lower than the annual average NAAQS limit value for benzene of 5 µg/m³.

The predicted impact of these air pollutants using both the results from SCREEN3 and SCIPUFF are shown to be well below the respective NAAQS limit values.

Given the offshore location of the licence area, air emissions are expected to disperse rapidly and there is no potential for accumulation leading to any detectable long-term impact on air quality. The impact of the estimated operational emissions from the proposed project is considered to be **regional** (although localised at any one time in the case of the project vessels and helicopter), and of **short-term duration** (i.e. 6 months for vessels / drilling unit; 7 days per well test) and **medium intensity** (moderate change, disturbance or discomfort caused to receptors) for project-related traffic to all ports and onshore logistic base alternatives. Thus, the impact **magnitude** (or consequence) for air quality is, therefore, considered to be **low**.

Impact Significance

Based on the **medium sensitivity** of receptors and the **low magnitude**, the potential impact on the air quality and greenhouse gas emissions is considered to be of **low significance** without mitigation for all activities and all the onshore logistic base alternatives.

Identification of Mitigation Measures

In addition to compliance with MARPOL 73/78 Annex VI, the following measures will be implemented to reduce emissions at the source:

No.	Mitigation measure	Classification
1	Implement a maintenance plan to ensure all diesel motors and generators receive adequate maintenance to minimise soot and unburnt diesel released to the atmosphere.	Avoid/reduce at source
2	Plan drilling operations efficiently. Optimise rig positioning, rig movement and the logistics (number of trips required to and from the onshore logistics base) in order to lower fuel consumption.	Avoid/reduce at source
3	Ensure no incineration (subject to obtaining an atmospheric emissions licence) of waste occurs within the port limits.	Avoid
4	The following pollution prevention and control measures are proposed for gas flaring[47]:	Avoid/reduce at source
	4.1 Optimise well test programme to reduce flaring as much as possible during the test	
	4.2 Commence with well testing during daylight hours, as far as possible. There is better dispersion potential during the day, as well as to ensure good combustion conditions and no hydrocarbon 'drop-out.'	
	4.3 Use a high-efficiency burner for flaring to maximise combustion of the hydrocarbons in order to minimise emissions and hydrocarbon 'drop-out' during well testing.	
5	Monitoring: • Monitor flare (continuous) for any malfunctioning, interruption, etc. • Monitor the volume of fuel consumed and estimate associated air emissions from fuel combustion after completion of operations.	-
6	Align Project GHG reporting with national policy. For GHG, report CO_2, CH_4 and N_2O levels (calculated based on Tier 2 or 3 methodologies) annually via SAGERS as required in terms of NEM: AQA for oil and gas exploration activities (Code 1B2) under Annexure 1 of the amended Regulations.	-
7	Submit an annual Carbon Tax environmental levy in July of each year after operations commence	-

Residual Impact Assessment

This potential impact cannot be eliminated as project vessels will generate emissions during operations and flaring (if undertaken). With the implementation of the mitigation measures, the intensity and magnitude of the air quality impact reduces to low and very low, respectively. Thus, the residual impact reduces to **VERY LOW significance**.

Additional Assessment Criteria

Since air emissions will disperse rapidly and there is no potential for accumulation, the impact of air quality is considered to be **reversible**. Due to the implementation of the project controls, namely compliance with MARPOL 73/78 standards, the mitigation potential is **low to medium** and the loss of resource is **low**.

[47] Based on the International Finance Corporation's (IFC) Environmental, Health and Safety Guidelines for offshore oil and gas development, April 2007.

TABLE 9-2: IMPACT OF ATMOSPHERIC POLLUTANTS ON AIR QUALITY

Project Phase:	**Mobilisation, Operation and Decommissioning**	
Type of Impact	**Direct and Indirect**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**MEDIUM**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**LOW**	**VERY LOW**
Intensity	MEDIUM	LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	**LOW**	**VERY LOW**
Probability	**POSSIBLE**	**POSSIBLE**
Confidence	**MEDIUM**	**MEDIUM**
Reversibility	**REVERSIBLE**	**REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**LOW - MEDIUM**
Cumulative potential	**POSSIBLE**	**POSSIBLE**

9.1.1.2 Impacts of Greenhouse Gas (GHG) Emissions and Climate Change Aspects

Potential Impact Description

Some of the gaseous pollutants released from the project vessels, helicopters and well tests could contribute to global GHG emissions. The release of GHG includes mainly carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). GHGs are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H_2O), CO_2, N_2O, CH_4 and ozone (O_3) are the primary GHG in the Earth's atmosphere. The effect of climate change is related to changing atmospheric GHG concentrations, increased temperatures, changing weather patterns and sea level rise (**indirect negative** impact). In order to evaluate the significance of GHG emissions, a Climate Change and Air Emissions Impact Assessment was undertaken (refer to Appendix 15 in Volume 3). The impact assessment is summarised in Table 9-4.

Sensitivity of Receptors

Refer to Section 9.1.1.1 for a description of receptors sensitivity. Additionally, a rise in sea level will have a major effect on the communities along the coastline in the region, especially those located in low lying areas in the near- and far-future; the likely major negative effect associated with sea level rise would be the change in tides and storm events. The project contribution to global GHG emissions is difficult to evaluate, but the sensitivity on receptors is considered as **medium** at this scale.

Impact Magnitude (or Consequence)

The calculated CO_2-e emissions from a single well drilling campaign and well testing campaign (two DST) are summarised in Table 9-3, estimating 59 859 tonnes (59.859 kt). Therefore, **for a maximum five successful wells with tests (worst-case), the total GHG emission for the proposed project would be 299.295 Kt.** The drilling unit constitutes approximately 67% of the GHG emissions, with flaring approximately 15%. Vessels and helicopter contribute about 18% of the total emissions.

TABLE 9-3: SUMMARY OF ESTIMATED GHG EMISSIONS FOR A SINGLE APPRAISAL WELL WITH TESTS

Source Group	GHG Emission per Well [tonne]			Total CO_2-e [tonne per well]
	CO_2	CH_4	N_2O	
Drilling unit	39 938	1.55	0.3	40 066
Vessel Exhausts	10 783	0.98	0.3	10 888
Helicopter Transport	116	0.005	0.001	116
Flaring	8 760	0.4	0.07	8 789
Total	**59 598**	**3**	**1**	**59 859**

Based on the published 2017 National GHG annual Inventory, the total CO_2-e emissions from the **proposed project, assuming five successful appraisal wells with tests, would contribute approximately 0.07% to the 2017 South African "energy" sector total of 0.41 Gt and represents a contribution of 0.06% to the National GHG inventory total of 0.51 Gt.**

Since the project activities are of a temporary nature and expected to be completed in the near future, although over a multi-year period, physical risks of climate change and changes in meteorological parameters are not expected to have a significant impact on the project itself or onshore community. Additionally, TEEPSA has access to historic and live oceanographical and meteorological data that will enable it to track, anticipate and plan for normal and extreme weather events. Thus, the financial risks associated with project climate change adaptation risks are considered to be a non-issue.

The GHG threshold adopted in this assessment is based on the classification of projects by the European Bank for Reconstruction and Development (EBRD) in which projects contributing more than 0.1 Mt CO_2-e (or 0.0001 Gt CO_2-e) per year are defined to have significant GHG emissions[48] (EBRD 2019). Although the Project's combined GHG emissions of 299.295 kt (or approximately 0.3 Mt) for all five wells is above this threshold, this assumes all wells would be drilled in a single year. **As it is more likely that TEEPSA will drill only one well in a year, the annual GHG emission total will thus be 0.06 Mt CO_2-e.** This is less than the 0.1 Mt CO_2-e threshold and, therefore, considered to have a **low intensity**. The impact is of **international** extent, but of **short-term** duration. Thus, the **magnitude** (or consequence) of impact of these GHG is considered to be **low**.

Impact Significance

Based on the **medium sensitivity** of receptors and the **low magnitude**, the potential impact of GHG emissions is considered to be of **low significance** without mitigation for all activities and all the port and onshore logistic base alternatives.

[48] As per the EBRD's Environmental and Social Policy, projects leading to a relative emissions change (either increase or decrease) higher than 25 kilotonnes CO_2-e annually are subject to mandatory GHG assessment. The EBRD approach is available at: https://www.ebrd.com/documents/admin/ebrd-protocol-for-assessment-of-greenhouse-gas-emissions.pdf.

Identification of Mitigation Measures

Climate change management includes both mitigation and adaptation. The main aim of mitigation is to stabilise or reduce GHG concentrations as a result of anthropogenic activities, that is achievable by lessening emissions and/or enhancing sinks through human intervention. The main means to minimise GHG emissions from the project would be to lower fuel use (e.g., optimise vessel operations/logistics and ensuring the use of efficient equipment) and limit flaring. Refer to Section 9.1.1.1 for recommended measures to reduce emissions.

Residual Impact Assessment

This potential impact cannot be eliminated as project vessels will generate emissions during operations and burning/flaring (if undertaken). With the implementation of the proposed mitigation the intensity would be reduced to very low. Thus, the residual impact would reduce to **low magnitude** and of **VERY LOW significance**.

Additional Assessment Criteria

The impact of GHG emissions and Climate Change is considered to be **partially reversible**. Due to the implementation of the project controls, namely compliance with MARPOL 73/78 standards and mitigation measures, the mitigation potential is **low** and the loss of resource is **low**.

TABLE 9-4: IMPACT OF PROJECT CONTRIBUTION TO GHG EMISSIONS

Project Phase:	**Mobilisation, Operation and Decommissioning**	
Type of Impact	**Indirect**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**MEDIUM**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**LOW**	**VERY LOW**
Intensity	LOW	VERY LOW
Extent	INTERNATIONAL	INTERNATIONAL
Duration	SHORT TERM	SHORT TERM
Significance	**LOW**	**VERY LOW**
Probability	**POSSIBLE**	**POSSIBLE**
Confidence	**MEDIUM**	**MEDIUM**
Reversibility	**PARTIALLY REVERSIBLE**	**PARTIALLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**LOW**
Cumulative potential	**LIKELY**	**LIKELY**

9.1.2 Routine Operational Discharges to Sea

9.1.2.1 Impacts on Marine Ecology/Environment

Source of Impact

The project activities that will result in an impact on marine ecology/environment from a reduction of water quality from routine discharges to the sea from vessels are:

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
Demobilisation	Transit of drilling unit and support vessels from drill site
* Note: drilling discharges do not fall under the normal vessel operation, but under drilling operations (see Section 9.2.2).	

These activities and their associated aspects are described below:

- Galley wastes, comprising mostly of biodegradable food waste, generated on board the project vessels will be discharged overboard. The daily discharge from a drilling unit is typically about 0.2 m^3 (CCA & CSM, 1999).
- Machinery space or bilge water drainage will be occasionally discharged after treatment. Bilge water is drainage water that collects in a ship's bilge space (the bilge is the lowest compartment on a vessel, below the waterline, where the two sides meet at the keel).
- Grey water and sewage will be treated and discharged intermittently throughout operations, and will vary according to the number of persons on board. The treated sanitary effluents discharged into the sea are estimated at around 200 litres per person per day.
- Deck drainage consists of liquids from rainfall, sea spray, deck and equipment washing (using water and an approved detergent), and any spillages (chemical or fuel). Contaminated or hazardous deck drainage is collected and directed into sump tanks on board for treatment prior to discharge to ensure MARPOL compliance. Deck drainage will be variable depending on the vessel characteristics, deck activities and rainfall amounts.
- Cooling waters and freshwater surplus generated by the water supply system (including brine) are likely to contain a residual concentration of chlorine (generally less than 0.5 mg/l for freshwater supply systems).

Potential Impact Description

The routine liquid and solid discharges to sea could create local reductions in water quality, both during transit to and within the area of interest for drilling. Deck and machinery space drainage may result in small volumes of oils, detergents, lubricants and grease, the toxicity of which varies depending on their composition, being introduced into the marine environment. Sewage and galley waste will place a small organic and bacterial loading on the marine environment, resulting in an increased biological oxygen demand.

These discharges will result in a local reduction in water quality, which could impact marine fauna (**indirect negative** impact) in a number of different ways:

- Physiological effects: Ingestion of hydrocarbons, detergents and other waste could have adverse effects on marine fauna and marine food chain, which could ultimately result in mortality.
- Increased food source: The discharge of galley waste and sewage will result in an additional food source for opportunistic feeders, speciality pelagic fish species.
- Increased predator - prey interactions: Predatory species, such as sharks and pelagic seabirds, may be attracted to the aggregation of pelagic fish attracted by the increased food source.

The impact assessment is summarised in Table 9-5.

Project Controls

Contractors will ensure that the proposed exploration campaign is undertaken in compliance with the applicable requirements in MARPOL 73/78, as summarised below.

- The discharge of biodegradable food wastes (this excludes cooking oil and grease which will be shipped to shore for treatment / disposal) 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 grinding can occur greater than 12 nm from the coast when the vessel is sailing. 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 ensure 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 certified sewage treatment plant providing primary settling, chlorination before discharge of treated effluent.
    - The discharge depth is variable, depending upon the draught of the project vessels at the time, but will be in accordance with MARPOL 73/78 Annex IV.
    - Discharge of sewage beyond 12 nm requires no treatment provided that the sewage is discharged at a moderate rate when the ship is *en route* and proceeding at not less than 4 knots. 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 proceeding *en route* at a speed not less than 4 knots.
- Sewage and grey water 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 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 ensure 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.).

Sensitivity of Receptors

The operational waste discharges from the activities described above would primarily take place at the drill site(s) and along the route taken by the support vessels between the drill site(s) and Cape Town or Saldanha Bay. The area of interest for drilling is located 60 km offshore at its nearest point and far removed from coastal MPAs and any sensitive coastal receptors (e.g., key faunal breeding/feeding areas, bird or seal colonies and nursery areas for commercial fish stocks). There is also no overlap of the area of interest with offshore MPAs or EBSAs. The closest MPA (Brown’s Bank Corals – western section) is located approximately 12 km east of the area of interest, whereas the Browns Bank EBSA is located 4 km east at its closest point. Discharges could also directly affect migratory pelagic species transiting through the drill area. Vessel discharges *en route* to the onshore supply base in Cape Town or Saldanha bay could result in discharges closer to shore, thereby potentially having an environmental effect on the sensitive coastal environment.

The taxa most vulnerable to routine operational discharges are pelagic seabirds, turtles, and large migratory pelagic fish and marine mammals. Some of the species potentially occurring in the drill area, are considered regionally or globally ‘Critically Endangered’ (e.g., southern bluefin tuna, leatherback turtles and blue whales), ‘Endangered’ (e.g., Black-Browed and Yellow-Nosed Albatross, whale shark, shortfin mako shark, fin and sei whales), ‘Vulnerable’ (e.g., bigeye tuna, blue marlin, loggerhead turtles, oceanic whitetip shark, dusky shark, great white shark, longfin mako and sperm, Bryde’s and humpback whales) or ‘Near Threatened’ (e.g., striped marlin, blue shark, longfin tuna/albacore and yellowfin tuna).

Although species listed as globally 'Endangered' or 'Critically Endangered' may potentially occur in the area, compliance with MARPOL 73/78 will ensure reduced discharges and reduced sensitivity of marine fauna to these discharges. In addition, the area of interest is located in a main marine traffic route and thus is in an area already experiencing increased vessel operational discharges. Thus, the overall sensitivity of receptors to operational discharges is considered to be **medium**.

Impact Magnitude (or Consequence)

The contracted project vessels and drilling unit will have sewage treatment systems, oil/water separators and food waste macerators to ensure compliance with MARPOL 73/78 standards. Compliance with MARPOL 73/78 means that intermittent operational discharges introduce relatively small amounts of nutrients and organic material to oxygenated surface waters, which will result in a minor contribution to local marine productivity and possibly of attracting some opportunistic feeders. The intermittent discharge of sewage is likely to contain a low level of residual chlorine following treatment, but this is expected to have a minimal effect on seawater quality given the relatively low total discharge and taking into account dilution in the surface waters.

Furthermore, the area of interest is suitably far removed from sensitive coastal receptors (>60 km) and the dominant wind and current direction will ensure that any discharges are rapidly dispersed north-westwards and away from the coast. The transit route to the area of interest overlaps with the Table Mountain National Park MPA; however, the habitat and biota are unlikely to be impacted by intermittent surface discharges, which rapidly disperse to very low concentrations. There is no potential for accumulation of substances discharged leading to any detectable long-term impact.

Due to the distance offshore, it is only likely to be pelagic species of fish, birds, turtles and cetaceans that may be affected by the discharges, some of which are species of conservation concern, but they are unlikely to respond to the minor changes in water quality resulting from vessel discharges. The most likely animal to be attracted to food source releases from project vessels / drilling unit will be large pelagic fish species, such as the highly migratory tuna and billfish, as well as sharks and odontocetes (toothed whales). Pelagic seabirds that feed primarily by scavenging would may also be attracted.

A number of other types of wastes generated during the exploration campaign will not be discharged at sea, but will be transported to shore for disposal at a licensed waste management facility approved by TEEPSA. The disposal of all waste onshore will be fully traceable.

Based on the relatively small discharge volumes and compliance with MARPOL 73/78 standards, offshore location, high energy sea conditions and dominant wind / current direction, the potential impact of normal routine operational discharges from the drilling unit and project vessels will be of **very low intensity, short-term duration** and **regional** in extent (although localised at any one time around the project vessels) for all onshore logistic base alternatives. Thus, the **magnitude** (or consequence) is, therefore, considered to be **very low**.

Impact Significance

Based on the **medium sensitivity** of receptors and the **very low magnitude**, the potential impact on the marine fauna is considered to be of **very low significance** without mitigation.

The majority of these discharges are not unique to the project vessels, but common to the numerous vessels that operate in or pass through South African coastal waters on a daily basis.

Identification of Mitigation Measures

In addition to compliance with MARPOL 73/78 standards, the other project controls and their monitoring, the following measures will be implemented to reduce discharges to the sea at the source:

No.	Mitigation measure	Classification
1	Prohibit operational discharges when transiting through the Table Mountain National Park and Robben Island offshore MPAs and Cape Canyon and Seas of Good Hope EBSA.	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	Implement leak detection and maintenance programmes for valves, flanges, fittings, seals, hydraulic systems, hoses, etc.	Avoid/reduce at source
4	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
5	Use a low-toxicity biodegradable detergent for the cleaning of the deck and any spillages.	Reduce at source

Residual Impact Assessment

This potential impact cannot be eliminated because the project vessels and drilling unit will generate routine discharges during operations. The implementation of the few minor mitigation measures will not significantly change the discharges and thus the intensity, extent or duration of the impact. Thus, the residual impact will remain of **very low magnitude** and **VERY LOW significance**.

Additional Assessment Criteria

The impact is **fully reversible** once exploration actives are complete and the discharge of waste ceases. Due to the implementation of the project controls, namely compliance with MARPOL 73/78 standards, the remaining mitigation potential is **very low**, the loss of resource is **low**, and the cumulative potential is **unlikely**.

TABLE 9-5: IMPACTS ON MARINE ECOLOGY/ENVIRONMENT FROM OPERATIONAL DISCHARGES TO SEA

Project Phase:	**Mobilisation, Operation and Decommissioning**	
Type of Impact	**Indirect**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**MEDIUM**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	VERY LOW	VERY LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	**VERY LOW**	**VERY LOW**
Probability	**LIKELY**	**LIKELY**
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**VERY LOW**
Cumulative potential	**UNLIKELY**	**UNLIKELY**

9.1.3 Discharge of Ballast Water from Drilling Unit and Vessels / Equipment Transfer

9.1.3.1 Impact on Marine Biodiversity

Source of Impact

The project activities that will result in the discharge of ballast water and vessel / equipment transfer, and potential introduction of alien invasive species are:

Project phase	Activity
Mobilisation	Transit of vessels to drill site and discharge of ballast water
	Discharge of ballast water by drill unit (and/ possibly support vessels)
Operation	N/A
Demobilisation	N/A

De-ballasting of the drilling unit may be undertaken during transit to or once at the drill site. This could introduce non-native species into the area, especially if the drilling unit is arriving from another country abroad. Similarly, the drilling unit (and possibly other project vessels) and the use of subsea equipment from other regions (excluding local or national translocations) also provides for the potential translocation of introduced or alien species that are attached to hulls and infrastructure that have been at sea for any length of time.

Potential Impact Description

Depending on where the ballast water is loaded, it may contain larvae, cysts, eggs and adult marine organisms from other regions. Thus, ballasting and de-ballasting of the drilling unit and project vessels could lead to the introduction of exotic species and harmful aquatic pathogens to the marine ecosystem. Invasive marine 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 and ecosystem function (**indirect negative** impact). The impact assessment is summarised in Table 9-6.

Project Controls

Ballast water discharged will follow the requirements of the International Maritime Organisation's (IMO) 2004 International Convention for the Control and Management of Ships' Ballast Water and Sediments. By establishing standards and procedures for the management and control of ships' ballast water and sediments, the Convention aims to prevent the spread of harmful aquatic organisms from one region to another. It stipulates that all vessels must implement a Ballast Water Management Plan, which includes a detailed description of the actions to be taken to implement the Ballast Water Management requirements. All ships using ballast water exchange should, whenever possible, conduct such exchange at least 200 nm (± 370 km) from the nearest land and in water of at least 200 m depth when arriving from a different marine region. 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 (± 93 km) from the nearest land and preferably in water at least 200 m in depth. Ships will also have a Ballast Water Record Book to record when ballast water is taken on board; circulated or treated for Ballast Water Management purposes; and discharged into the sea. Project vessels will comply with these requirements.

Sensitivity of Receptors

The discharge of ballast water from the drill rig and possible support vessels would take place *en route* to or in the vicinity of the area of interest, but at least 93 km (so more than 200 water depth) from the coast as per the

IMO requirements, far removed from any sensitive coastal receptors (e.g., sessile benthic invertebrates, endemic neritic and demersal fish species). In addition, due to the water depths in the area of interest (700 m to 3 200 m), colonisation by invasive species on the seabed from de-ballasting or hull fouling is considered unlikely. Thus, the sensitivity of coastal and benthic receptors in the offshore waters of Block 5/6/7 is considered **very low**.

Impact Magnitude (or Consequence)

Shipping has always been the primary pathway for the transfer of marine alien species from one region to another (Hewitt *et al.,* 1999; Ruiz *et al.,* 2000; Ruiz & Carlton, 2003). The principal vectors responsible for transfer of alien invasive species are ballast water and external hull fouling (Carlton, 1987, 1999; Hewitt *et al*., 2009).

The drilling unit, and possibly other project vessels, will more than likely have spent time outside of South Africa's EEZ prior to commencing drilling activities. This exposure to foreign water bodies and possible loading of ballast water increases the risk of introducing invasive or non-indigenous species into South Africa waters. The risk of this impact is, however, significantly reduced due by the implementation of IMO ballast water management measures. The risk is further reduced due to the offshore location of the area of interest and dominant wind / current direction, which will ensure that any invasive species drift mainly in a north-westerly away from the coast. In addition, the water depths in the area of interest (700 m to 3 200 m) will ensure that colonisation of invasive species on the seabed is unlikely. De-ballasting in the area of interest, complying with IMO requirements, will thus not pose an additional risk to the introduction of invasive species.

In terms of hull fouling, the area of interest is located in the main traffic routes that pass around southern Africa (see Figure 7-93). Thus, the introduction of invasive species into South African waters due to hull fouling of project vessels is unlikely to add to the current risk that exists due to the numerous vessels that operate in or pass through South African coastal waters on a daily basis.

Considering the remote location of the area of interest and compliance with the IMO guidelines for ballast water, the impact related to the introduction of alien invasive marine species is considered to be of **medium intensity** in the **short-term** (due to invasive species not being able to establish) and of **regional extent**. Thus, the **magnitude** (or consequence) is considered to be **low**.

Impact Significance

Based on the **very low sensitivity** of receptors and the **low magnitude**, the potential impact on the marine biodiversity is considered to be of **very low significance** without mitigation.

Identification of Mitigation Measures

In addition to compliance with the requirements of the IMO 2004 Ballast Water Management Convention, the following measures will be implemented to reduce and manage the potential introduction of alien species in ballast water and hull or equipment fouling:

No.	Mitigation measure	Classification
1	Avoid the unnecessary discharge of ballast water.	Reduce at source
2	Use filtration procedures during loading in order to avoid the uptake of potentially harmful aquatic organisms, pathogens and sediment that may contain such organisms.	Avoid/reduce at source

No.	Mitigation measure	Classification
3	Ensure that routine cleaning of ballast tanks is carried out, where practicable, 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.	Avoid/reduce at source
4	Ensure all equipment (e.g., drill string, wellhead, BOP, etc.) that has been used in other regions is thoroughly cleaned prior to deployment.	Avoid/reduce at source

Residual Impact Assessment

This potential impact cannot be eliminated because the drilling unit (and possibly other project vessels) will more than likely have spent time outside of South African's EEZ prior to drilling and may need to de-ballast. With the implementation of the mitigation measures, which would reduce the intensity of the impact to low, the residual impact will reduce to **very low magnitude** and of **NEGLIGIBLE significance**.

Additional Assessment Criteria

The impact is considered to be **unlikely**, but **irreversible** if it does occur. The mitigation potential is **low**, the loss of resource is **low**, and the cumulative potential is **unlikely**.

TABLE 9-6: IMPACT ON MARINE BIODIVERSITY FROM BALLAST WATER DISCHARGE AND HULL FOULING

Project Phase:	**Mobilisation**	
Type of Impact	**Indirect**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**VERY LOW**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**LOW**	**VERY LOW**
Intensity	MEDIUM	LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	**VERY LOW**	**NEGLIGIBLE**
Probability	**UNLIKELY**	**UNLIKELY**
Confidence	**MEDIUM**	**MEDIUM**
Reversibility	**IRREVERSIBLE**	**IRREVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**LOW**
Cumulative potential	**UNLIKELY**	**UNLIKELY**

9.1.4 Noise from Helicopters

9.1.4.1 Impact on Coastal and Marine Fauna

Source of Impact

Helicopter activities will increase the ambient airborne noise levels in the following Project phase:

Project phase	Activity
Mobilisation	N/A
Operation	Operation of helicopters between drilling unit and Cape Town
Demobilisation	N/A

Crew transfers by helicopter from Cape Town to the drilling unit will generate noise in the atmosphere. Noise source levels from helicopters are expected to be approximately 109 dB re 1µPa at the most noise-affected point (SLR 2019).

Potential Impact Description

Elevated airborne noise levels from helicopters may disturb faunal species resulting in behavioural changes or displacement from important feeding or breeding areas (**direct negative** impact). The impact assessment is summarised in Table 9-7.

Project Controls

TEEPSA will ensure that the contractors undertake the drilling operation in a manner consistent with good international industry practice and BAT.

All whales and dolphins are given protection under South African Law. The Marine Living Resources Act, 1998 (No. 18 of 1998) states that no whales or dolphins may be harassed[49], killed or fished. No vessel or aircraft may 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.

The operation of helicopters aircraft is governed by the Civil Aviation Act, 2016 (No. 6 of 2016) and associated regulations.

Sensitivity of Receptors

The helicopter operations will take place in the area of interest and along the route between the drill site and Cape Town, which has a commercial airport where a lot of ambient noise already exists on a daily basis. Although the area of interest is located approximately 60 km offshore at its closest point, the flight path between the drilling unit area and Cape Town will would potentially cross over offshore and coastal MPAs, and any sensitive coastal receptors (e.g., key faunal breeding/feeding areas, bird or seal colonies and nursery areas for commercial

[49] In the Regulations for the management of boat-based whale watching and protection of turtles as part of the Marine Living Resources Act of 1998 the definition of “harassment” is given as “behaviour or conduct that threatens, disturbs or torments cetaceans”.

fish stocks). In addition, migratory pelagic species transiting through the area of interest may also be directly affected.

The taxa most vulnerable to disturbance by helicopter noise are pelagic seabirds (except where the flight path crosses the coastal zone), turtles, and large migratory pelagic fish and marine mammals. Some of the species potentially occurring in the area of interest are considered regionally or globally 'Critically Endangered' (e.g., southern bluefin tuna, leatherback turtles and blue whales), 'Endangered' (e.g., Black-Browed and Yellow-Nosed Albatross, whale shark, shortfin mako shark, fin and sei whales), 'Vulnerable' (e.g., bigeye tuna, blue marlin, loggerhead turtles, oceanic whitetip shark, dusky shark, great white shark, longfin mako and sperm whale, Bryde's and humpback whales) or 'Near Threatened' (e.g., striped marlin, blue shark, longfin tuna/albacore and yellowfin tuna). Although species listed as 'Critically Endangered' or 'Endangered' may potentially occur in the area of interest, due to their extensive distributions their numbers are expected to be low.

In addition, seabirds and seals in breeding colonies and roosts along coast could be impacted where the flight path crosses the coastal zone. Some of the seabirds roosting and nesting along the coast are listed by the IUCN as 'Endangered' (e.g., African Penguin, Bank Cormorant, Cape Cormorant and Cape Gannet), 'Near threatened' (e.g., African Black Oystercatcher and Crowned Cormorant) or 'Vulnerable' (e.g., Damara Tern).

The overall sensitivity of receptors to noise from helicopters is considered to be **high**.

Impact Magnitude (or Consequence)

Transportation of personnel to and from the drilling unit by helicopter is the preferred method of transfer. It is estimated that there could be up to four trips per week between the drilling unit and the helicopter support base at Cape Town (i.e. up to 68 trips per well over a 4-month period). The helicopters can also be used for medical evacuations from the drilling unit to shore (at day- or night-time), if required.

Helicopters flying between the drilling unit and airport may fly over sensitive receptors, such as bird and seal colonies or breeding/calving cetaceans. The noise generated by the helicopters may temporarily disturb marine fauna, which may result in the abandonment of nests or young, injury to individuals or impact breeding or roosting activities. The nearest seabird colonies to Cape Town International Airport are on Robben Island, at Boulders Beach and on Seal Island in False Bay, all of which are IBAs and provide a vital breeding habitat. The Boulders Beach and Seal Island colonies fall within the potential flight paths between the Cape Town International Airport and the area of interest (see Figure 9-1). Sensitivity of birds to aircraft disturbance is not only species specific, but generally lessened with increasing distance or if the flight path is off to the side and downwind. Low altitude flights over bird breeding colonies could result in temporary abandonment of nests and exposure of eggs and chicks leading to increased predation risk.

The frequency of aircraft engine noise emissions also overlaps with the hearing ranges of seals and are likely to receive both acoustic and visual cues from aircraft flyovers. Seals may experience severe disturbance from aircrafts usually reacting by showing a startle response and moving rapidly into the water. Although any observed response is usually short-lived, disturbance of breeding seals can lead to pup mortalities through abandonment or injury by fleeing, frightened adults. The seal colony at Seal Island in False Bay and the non-breeding colony at Duikerklip near Hout Bay lie within the direct flight path from Cape Town airport to the centre of the area of interest for drilling.

Available data indicate that the expected frequency range and dominant tones of sound produced by helicopters overlap with the hearing capabilities of most odontocetes and mysticetes. Reactions to aircraft flyovers range from no or minimal observable behavioural response, to avoidance by diving, changes in direction or increased speed of movement away from the noise source, separation of cow-calf pairs, increased surface intervals and dramatic behavioural changes including breaching and lobtailing, and active and tight clustering behaviour at the surface. Thus, low altitude flights (especially near the coast) can have a significant disturbance impact on cetaceans during their breeding and mating season. The level of disturbance will 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.

Southern Right whales migrate to the southern Africa subcontinent to breed and calve, where they tend to have an extremely coastal distribution mainly in sheltered bays. Winter concentrations have been recorded all along the southern and eastern coasts of South Africa, with the most significant concentration currently on the South Coast between Cape Town and Gqeberha (Port Elizabeth). They typically arrive in coastal waters off the South Coast between June and November, although animals may be sighted as early as April and as late as January. When moving from the South Coast breeding ground directly to the West Coast feeding ground, Southern Right whales would move through Block 5/6/7, with a clear peak in numbers on the West Coast (Table Bay to St Helena Bay) between February and April. When departing from the feeding grounds animals take a direct south-westward track, thereby crossing the northern portion of Block 5/6/7. Several hundreds of right whales can thus be expected to pass through Block 5/6/7 when migrating southwards from the feeding areas between April and June. Southern right calving and nursing activities off the Cape Peninsula would thus fall within the direct flight path to the area of interest for drilling. Smaller cetaceans in the area include the common dolphin and dusky dolphin both of which can occur in large group sizes. The level of disturbance of cetaceans by aircraft depends 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.

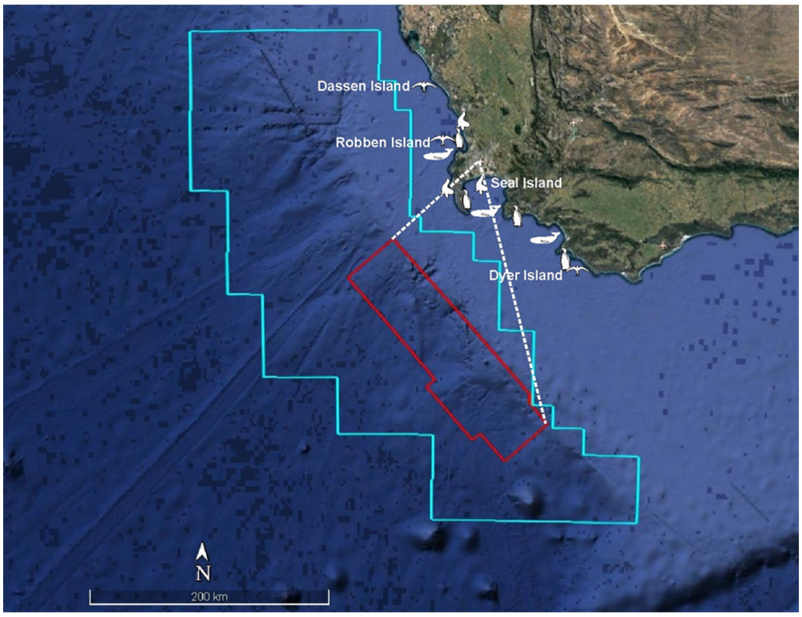


FIGURE 9-1: AREA OF POTENTIAL FLIGHT PATHS (WITHIN DASHED WHITE LINES) FROM CAPE TOWN INTERNATIONAL AIRPORT TO THE AREA OF INTEREST FOR PROPSOED RILLING (RED POLYGON), INDICATING LOCATION OF SEAL AND BIRD COLONIES

Source: Pisces 2022

Indiscriminate low altitude flights over whales, seals, seabird colonies and turtles by helicopters used to support the drilling unit could have an impact on behaviour and breeding success. Although exposure will be limited to up to four trips per week over the four-month drill **duration (short-term)** per well and be of a temporary nature while the helicopter passes overhead (although **regional in extent**), indiscriminate or direct low altitude flying over seabird and seal colonies or breeding cetaceans could impact fauna behaviour and breeding success. Although level of impact will 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 at the time, **intensity** is considered to be **low** for the populations as a whole. Thus, the **magnitude** (or consequence) is considered to be **very low**.

Impact Significance

Based on the **high sensitivity** of receptors and the **very low magnitude**, the potential impact of helicopter noise on the marine fauna is considered to be **low significance** without mitigation.

Identification of Mitigation Measures

The following measures will be implemented for helicopter activities:

No.	Mitigation measure	Classification
1	Ensure that all flight paths avoid the False Bay (Seal Island and Boulders Beach) and Robben Island seal and penguin colonies.	Avoid/abate on site
2	Maintain a flight altitude of at least 1 000 m during flight, except when taking off and landing or in a medical emergency.	Avoid/abate on site
3	Avoid extensive low altitude (<762 m or 2 500 ft and within 1 nm of the shore) coastal flights by ensuring that the flight path is perpendicular to the coast, as far as possible.	Avoid/abate on site
4	Brief of all pilots on the ecological risks associated with flying at a low altitude along the coast or above marine mammals.	Avoid/abate on site

Residual Impact Assessment

The generation of noise from helicopters cannot be eliminated if helicopters are required for crew changes. The proposed mitigation, specifically maintaining the regulated altitude over the coastal zone and flying perpendicular to the coast would reduce the intensity of the impact to very low, but the residual impact will remain of **very low magnitude** and of **LOW significance**.

Additional Assessment Criteria

The residual impact is considered to be **unlikely** with mitigation as most of sensitive receptors would be avoided and **fully reversible** after the helicopter operations cease. The mitigation potential is **low**, the loss of resource is **low**, and the cumulative potential is **possible**.

TABLE 9-7: IMPACT ON COASTAL AND MARINE FAUNA FROM HELICOPTER NOISE

Project Phase:	**Operation**	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**HIGH**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	LOW	VERY LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	**LOW**	**LOW**
Probability	**POSSIBLE**	**UNLIKELY**
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**LOW**
Cumulative potential	**POSSIBLE**	**POSSIBLE**

9.1.5 Lighting from Drill Unit and Vessels

9.1.5.1 Impact on Marine Fauna

Source of Impact

The project activities likely to result in increased ambient lighting are:

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 vessels between the drilling unit and port
Demobilisation	Transit of drilling unit and support vessels from drill site

The operational lighting of the drilling unit and project vessels during transit and operation can be a significant source of artificial light in the offshore environment increasing the ambient lighting in offshore areas.

Potential Impact Description

The strong operational lighting used to illuminate the project vessels – and especially the drill unit - at night will increase ambient lighting in offshore areas. Increased ambient lighting may disturb and disorientate pelagic seabirds feeding in the area (**direct negative** impact). Operational lights may also result in physiological and behavioural effects on fish and cephalopods (**direct negative** impact), as these maybe drawn to the lights at night where they maybe more easily preyed upon by other fish and seabirds. The impact assessment is summarised in Table 9-8.

Project Controls

TEEPSA will ensure that the contractors undertake the drilling operation in a manner consistent with good international industry practice and BAT.

Sensitivity of Receptors

Refer to Section 9.1.2.1 for a description of receptor sensitivity. Although species listed as globally Endangered or Critically Endangered may potentially occur in the area, the area of interest is located in a main marine traffic route and thus is in an area already experiencing increased operational lighting. Thus, the overall sensitivity of receptors to vessel lighting is considered to be **medium**.

Impact Magnitude (or Consequence)

Drilling activities would be undertaken in the offshore marine environment, greater than 60 km from the shore at its closest point 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 coastal species (African Penguins recorded as far as 60 km offshore and Cape Gannets up to 140 km offshore) and pelagic species (pelagic seabirds, marine mammals and fish) transiting through the area of interest, as well as coastal species during vessel transit to port. 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 drilling unit or vessels at night may disturb and disorientate pelagic seabirds feeding in the area. Potential attraction may increase during fog when greater illumination is caused by refraction of light by moisture droplets.

Operational lights may also result in physiological and behavioural effects of 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. As seals are known to forage up to 220 km offshore, the area of interest, therefore, fall within the foraging range of seals from the South-West Coast colonies on the Cape Peninsula (Duiker Klip) and in False Bay, about 72 km and 102 km inshore of the area of interest, respectively. Odontocetes are also highly mobile, supporting the notion that various species are likely to occur in the area of interest and thus potentially be attracted to the area.

Although little can be done on the drilling unit to prevent seabird collisions, reports of collisions or death of seabirds on vessels are rare, possibly due to the drilling unit being stationary. It is expected that seabirds and marine mammals in the area will become accustomed to the presence of the project vessels within a few days. Since the area of interest is located in a main marine traffic route that passes around southern Africa, which experiences high vessel traffic, animals in the area should be accustomed to vessel traffic and associated lighting.

As the area of interest is located in a main marine traffic route, the **intensity** of impact is expected to be **low**. The extent of impact is **site specific** (for the drilling unit) to **regional** (although limited to the local visual stimulus of the drilling unit or project vessels at any one time), while the duration will be **short-term** (three to four months) for all activities from any of the onshore logistic base alternatives. Thus, the **magnitude** (or consequence) is considered to be **very low**.

Impact Significance

Based on the **medium sensitivity** of receptors and the **very low magnitude**, the potential impact on the marine fauna is considered to be **very low significance** without mitigation.

The impact of lighting is not unique to the project vessels, but common to the numerous vessels that operate in or pass through South African coastal waters on a daily basis.

Identification of Mitigation Measures

The following measures will be implemented to mitigate lighting impact:

No.	Mitigation measure	Classification
1	Reduce the lighting on the drilling unit and project vessels to a minimum compatible with safe operations whenever and wherever possible.	Avoid/reduce at source
2	Position light sources, if possible and consistent with safe working practices, 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 box) for subsequent release during daylight hours.	Repair or restore
4	Report ringed/banded birds to the appropriate ringing/banding scheme (details are provided on the ring).	Repair or restore

Residual Impact Assessment

The use of lighting on the drilling unit and project vessels cannot be eliminated due to safety, navigational and operational requirements. With the implementation of the few minor mitigation measures, which would reduce the intensity of the impact to very low, the residual impact remains of **VERY LOW significance**.

Additional Assessment Criteria

The impact is **fully reversible** after the vessel operations cease. The loss of resource is **low** and the cumulative potential is **possible** as the area of intertest is located in a main traffic route.

TABLE 9-8: IMPACT ON MARINE FAUNA FROM VESSEL AND DRILL UNIT LIGHTING

Project Phase:	**Mobilisation, Operation and Decommissioning**	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**MEDIUM**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	LOW	VERY LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	**VERY LOW**	**VERY LOW**
Probability	**POSSIBLE**	**POSSIBLE**
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**VERY LOW**
Cumulative potential	**POSSIBLE**	**POSSIBLE**

9.1.6 Impact on Local Coastal Sense of Place

Source of Impact

The project activities that are likely to impact the local sense of place are listed below:

Project phase	Activity
Mobilisation	Establishment of onshore logistics base
Operation	Operation of support vessels to and from port
	Helicopter operation
Demobilisation	N/A

Potential Impact Description

A sense of place is defined by the unique combination of qualities and characteristics – including visual, cultural, social and environmental – that provide meaning to a particular location and value for people that live or visit that location. Exploration operations may be perceived to result in changes to the natural environment or the local sense of place (**direct negative** impact). The impact assessment is summarised in Table 9-9.

Significant local public interest in the proposed exploration activities could happen with the potential it has to disrupt local tourism or the tourism appeal of Cape Town. Media reports suggest that such interest will include:

- Concerns regarding any bad press or negative perceptions generated via social media that may impact on both domestic and international tourism and Cape Town as a tourism destination.
- Misinformation that the exploration activities are undertaken near to the shore, impacting on local coastal views and generating negative value for existing and future residential development.

Project Controls

None.

Sensitivity of Receptors

The receptors in the context of potential changes in the sense-of-place is considered to be the entire South-West Coast, and particular Cape Town (preferred alternative) or Saldanha Bay as the likely logistics bases. Cape Town is a major metropolitan area and, therefore, they are considered to have **very low sensitivity** with respect to a change in sense of place related to exploration activities. A similar argument would apply to Saldanha Bay given it occupies a position as an industrialised port town.

Impact Magnitude (or Consequence)

Cape Town has historically been, and continues to be, associated with the tourism sector - all driven by the local / national and international appeal of Cape Town including its moderate climate, outstanding natural coastal beauty, relative affordability, and a well-run municipality. Saldanha Bay, occupying a position associated with West Coast tourism has a similar, albeit less developed, profile.

The proposed project is located more than 60 km offshore and will be a temporary installation. For an observer at the coast at a height of 30 m and 100 m above sea level, the horizon is at a distance of 19.6 km and 36 km, respectively. Thus, the drilling unit will not be visible to any sensitive visual receptors from the coast. A change in sense-of-place of Cape Town or Saldanha Bay is unlikely given that they are major commercial ports, and the project support vessels will generate a negligible increase in port traffic. The presence of the support vessels at

Cape Town or Saldanha Bay is not likely to garner any particular interest, given that numerous vessels of this size and larger operate from the port. The exploration activities will have negligible impact on the local sense of place and coastal tourism given the remote location of the area of interest and limited use of the harbour. As such, the potential actual or perceived change in sense-of-place is considered to be of **very low intensity**, **regional** extent and **short-term** duration. Thus, the **magnitude** (consequence) is **very low**.

Impact Significance

Based on the **very low sensitivity** of receptors and the **very low magnitude**, the potential impact on the local sense of place is of **negligible significance**.

Identification of Mitigation Measures

The following mitigation measures are recommended:

No.	Mitigation measure	Classification
1	Implement a public information and disclosure programme covering all TEEPSA exploration activities to ensure that the public are informed of the exploration activities (specifically onshore and nearshore activities). As part of the public information and disclosure programme, disclose project information via local media and communication channels – e.g., newspaper articles, public notices, newsletters, websites and meetings as required. Focus should be placed on the Saldanha Bay in particular (if selected as the location for onshore logistics base.	Avoid
2	Engage with local community forums, business chambers, tourism offices and other collective organisations on a regular basis in order to disclose information to key stakeholders and draw out any ongoing issues and concerns. Focus should be placed on the Saldanha Bay in particular (if selected as the location for onshore logistics base).	Avoid
3	Establish a functional 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

Residual Impact Assessment

The implementation of the enhancement and mitigation measures will not change the intensity, extent or duration of the impact. Thus, the residual impacts will remain of **NEGLIGIBLE significance**.

Additional Assessment Criteria

The mitigation potential is **very low** and **reversible** due to potential negative perceptions, loss of resource is **low** and the cumulative potential is **probable**.

TABLE 9-9: IMPACT ON LOCAL (COASTAL) SENSE OF PLACE

Project Phase:	**Mobilisation, Operation and Decommissioning**	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**VERY LOW**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	VERY LOW	VERY LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	**NEGLIGIBLE**	**NEGLIGIBLE**
Probability	**UNLIKELY**	**UNLIKELY**
Confidence	**HIGH**	**HIGH**
Reversibility	**REVERSIBLE**	**REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**VERY LOW**
Cumulative potential	**PROBABLE**	**PROBABLE**

9.1.7 Impact on Intangible Cultural Heritage

Source of Impact

The project activities that could impact intangible cultural heritage 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
	Drilling activities, including pre-drilling ROV seabed survey, spudding, discharge of wastes (e.g., cuttings, muds, cement, produced water, etc.), placement of wellhead on the seabed, VSP, flaring, plugging and capping.
Demobilisation	Abandonment of wellhead on seabed (with over-trawlable abandonment cap)
	Transit of drilling unit and support vessels from drill site

Note: the impact on intangible cultural heritage is also applicable to drilling activities (Section 9.2), but is assessed collectively in this section for the entire project. Thus, it is not repeated below for the various drilling activities (e.g., spudding, placement of infrastructure on the seafloors, discharge of cuttings, etc.).

Potential Impact Description

Well drilling will result in the disturbance to the seafloor (including spudding and wellhead placement), various discharges (including cuttings and drilling fluids) and underwater noise. Any impact on the integrity of the coastal and marine ecosystem through disturbance, pollution, noise, etc. could in turn impact various aspects that makes up people's intangible cultural heritage (**indirect negative** impact). The impact assessment is summarised in Table 9-10.

Project Controls

TEEPSA will ensure that the contractors undertake the drilling operation in a manner consistent with good international industry practice and BAT. In addition, contractors will ensure that the proposed exploration drilling is undertaken in compliance with the applicable requirements in MARPOL 73/78.

Sensitivity of Receptors

The sensitivity of the receptor for this assessment has been defined based on the following receptors:

- **Ancestry / spirituality receptor:** Sea is described as 'living' waters and is believed to play a critical role in spiritual and health management in indigenous groups specifically (First Peoples and Nguni). It is considered to be a living organism that forms part of and sustains a balanced ecosystem. Any impact on these 'living' waters may, therefore, impact communication with the ancestors or its use as an emetic or in other ritual practices. The sensitivity of this receptor is medium to high, as it can be mitigated with timely, sustained and relevant healer-diviner and First Peoples' Chief interventions. Rituals are performed according to community or individual needs.
- **Archaeology / Tangible heritage receptor:** The South African coastline has been shaped by human cultural relations and beliefs. The West Coast, South Coast and East coast have archaeologically and culturally significant coastal sites. The sensitivity of this receptor is medium to low (as many sites are onshore and can be mitigated via avoidance of these areas where there are vulnerable archaeological sites).
- **Sense of Place receptor:** The sea provides and enhances unique 'senses of place'. This is the unique, social, aesthetic and cultural value of the place in the sea or next to the sea which may include intangible cultural heritage practices and beliefs. The unique sense of place is determined by specific cultural groups, such as the First Peoples, the Nguni peoples and also those defined as European descendants. The sensitivity of this receptor is medium because normal operations, well managed activities will have minimal affect the sense of place (see Section 9.1.6).
- **Livelihoods receptor:** Certain stakeholder groups display a high regard of the sea due to their spiritual and cultural connection with the ocean and are directly reliant on the ocean and coast for their livelihood (e.g., fishing, shellfish harvesting, leisure, tourism, etc). The sensitivity of this receptor is high because many coastal communities that rely on the ocean and coast for their livelihoods.
- **Natural heritage receptor:** People have a cultural relationship with the ocean and coast and this results in high cultural valuation of nature. Coastal sporting / leisure / tourism activities have become intangible cultural heritage for these communities, since the activities contain strong cultural elements (i.e. social grouping, ritual practices, commensality, unique identity, shared histories, etc.). Any impact on the integrity of the coastal and marine ecosystem could in turn impact people's natural heritage. The sensitivity of this receptor is high since natural and cultural heritages are interdependent. Any pollution or other form of impact on the sea, arising during normal operations may impact natural phenomena (i.e. fish, shellfish, fynbos, mangroves, penguins, beach, etc.).
- **Health receptor:** People use the sea in cultural ways to improve, sustain and restore physical and mental health. Access to a healthy ocean is critical in this regard. Any impact on the ocean may affect the health of coastal communities who regularly access the sea to sustain physical and psychological health. The sensitivity of this receptor is medium, as operations take place far from shore.

The overall sensitivity of receptors during normal operations is assessed to be **medium**.

Impact Magnitude (or Consequence)

The intensity of the impact is considered to be **high** because (1) constitutionally South Africans have the right to culture and cultural expression, (2) there is recent national attention being given to the importance of coastal cultural heritage, and (3) South Africa is globally known for its safeguarding of indigenous rights via both ratified international agreements and domestic law. These facts make cultural heritage visible and make it a sensitive issue for the public. Consistent and substantive effort to include indigenous people and their input in the processes associated with normal operations will lessen the intensity of the impact. The potential impact is of **short-term** duration (3-4 months per well) and of **regional** extent. Thus, the magnitude (or consequence) is considered to be **medium**.

Impact Significance

Based on the **medium sensitivity** of receptors and the **medium magnitude**, the potential impact on intangible cultural heritage is considered to be of **medium significance**.

Identification of Mitigation Measures

The following mitigation measures are recommended:

No.	Mitigation measure	Classification
1	Implement a comprehensive, consistent and regular consultation with indigenous groupings and leadership, as well as those who fall outside this category. The aim of such engagement should ensure open communication, direct communication and consistent communication with stakeholders that may be affected by operations.	Avoid / Abate offsite
2	Implement, where necessary based on the outcome of the consultation process, a ritual event(s) that permits engagement with ancestral spirits and nature to alleviate potential and future negative impacts of non-consultation and poor cultural/nature respect.	Avoid / Abate on site
3	Implement a gender sensitive ritual event in each region that recognizes gendered coastal cultural heritage to permit all genders to articulate their cultural relation with the sea and coast	Abate
4	Adjust the well location to avoid any shipwrecks identified in pre-drilling ROV surveys.	Avoid
5	Establish a functional 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

Residual Impact Assessment

With the implementation of the mitigation measures, which includes appropriate and substantive public participation efforts and the possible implementation of ritual events, the intensity of the impact will reduce to **low** for those community members who accept the mitigation measures, leading to a residual impact of **LOW** significance. The magnitude of the impact could, however, remain medium for those people who are categorically opposed to oil and gas exploration. Thus, for this group, the residual impact will remain of **MEDIUM significance**.

Additional Assessment Criteria

The mitigation potential is **very low** and **partially reversible** due to potential negative perceptions, loss of resource is **low** and the cumulative potential is **likely**.

TABLE 9-10: IMPACT ON INTANGIBLE CULTURAL HERITAGE

Project Phase:	**Mobilisation, Operation and Decommissioning**	
Type of Impact	**Indirect**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**MEDIUM**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**MEDIUM**	**MEDIUM***
Intensity	HIGH	HIGH*
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	**MEDIUM**	**MEDIUM***
Probability	**LIKELY**	**LIKELY**
Confidence	**HIGH**	**MEDIUM**
Reversibility	**PARTIALLY REVERSIBLE**	**PARTIALLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**VERY LOW**
Cumulative potential	**LIKELY**	**LIKELY**

* Although both the intensity and significance reduce to low for those community members who accept the mitigation measures, the intensity, magnitude and significance would not reduce for those people who are categorically opposed to oil and gas exploration.

9.2 DRILLING AND ASSOCIATED ACTIVITIES

Most of the 325 offshore wells drilled in South Africa are located in <250 m water depth on the Agulhas Bank (Sink *et al.* 2019). Apart from Sink *et al.* (2010), who reported significant differences in benthic infaunal assemblages at distances up to 250 m from a well head in approximately 120 m depth off Mossel Bay, there are few studies that have examined the impacts of hydrocarbon infrastructure and well drilling on deepwater benthic communities in South Africa. In their assessment of impacts associated with hydrocarbon exploration, Biccard *et al.* (2018) concluded that the direct and indirect risks associated drilling discharges during exploration well drilling were mostly very low or low, with only the disturbance and/or destruction of hard-bottom communities being high. Due to limited opportunities for sampling, the benthic fauna of the outer shelf, continental slope and beyond into the abyss are very poorly known, and quantitative data on the biota from depths beyond the shelf break are largely lacking.

Although not directly comparable to Southern Africa, 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). These studies provide a good indication of possible impacts to benthic habitats that might be expected in future petroleum exploration and production activities in South Africa. The identified environmental aspects and the related potential impacts are discussed and assessed below using information from the international literature.

9.2.1 Drilling and Placement of Infrastructure on the Seafloor

9.2.1.1 Impact of Physical Seabed Disturbance on Benthic Biota

Source of Impact

The project activities likely to result in impacts to benthic biota as a consequence of the disturbance of seabed sediments are listed below:

Project phase	Activity
Mobilisation	N/A
Operation	Pre-drilling ROV seabed survey
	Spud and start of drilling - Installation of the conductor pipe, wellhead and BOP
	Plug well with cement
	Removal of BOP and installation of wellhead capping
Demobilisation	Placement of an over trawlable cap over wellhead

These activities are described further below:

- During pre-drilling surveys, a ROV will be deployed to obtain video footage of the seabed at the proposed well location. Although the standard operating procedure is not to settle or rest the ROV on the seabed, the ROVs thrusters may stir up the soft or silty sediments when operating close to the seabed. This resuspension of fine sediments will result in localised increases turbidity and could temporarily disturb seabed communities.
- The current well design parameter is to have a wellbore diameter of 42 inch (107 cm) during spudding. The penetration of the seabed by the drill bit will physically disturb a surface area of 0.9 m^2 per well (i.e. 4.5 m^2 cumulatively for 5 wells), and displace deeper sediments into a conical cuttings pile around the wellhead. Casing of the hole and installation of the wellhead and BOP will potentially also result in localised direct disturbance of an area of about 3 m^2 around the well site (i.e. 15 m^2 for 5 wells).
- Wells will be plugged prior to abandonment to isolate hydrocarbon (if any) bearing and / or permeable zones. Excess cement used during plugging will be discarded on the seabed.
- The removal of the BOP, which will include the use of a ROV, may also result in the localised disturbance of the seabed.
- Placement of an over trawlable cap over wellhead on those wells drilled in waters greater than 750 m, covering an area of 27 m^2, will disturb sediments that have been deposited on the seafloor from the riserless drilling operation.

Potential Impact Description

Various drilling activities will result in the direct localised physical disturbance and smothering of sediments, as well as potential changes in sediment characteristics and condition (**direct negative** impact). Any benthic biota present on the seabed and in the sediment in the disturbance footprint will be either completely eliminated or may potentially be disturbed or crushed. Resuspension of seabed sediments by ROV thrusters or other associated activity may also result in increased turbidity near the seabed, potentially with physiological effects on benthic biota communities (**indirect negative** impact). The impact assessment is summarised in Table 9-11.

Project Controls

TEEPSA will ensure that the contractors undertake the drilling operation in a manner consistent with good international industry practice and BAT. This will include limiting the footprint of activities on the seabed to the minimum area necessary.

Based on pre-drilling ROV survey(s), the well(s) will specifically be sited to avoid any sensitive hardgrounds, as the preference will be to have a level surface area to facilitate spudding and installation of the wellhead.

Sensitivity of Receptors

The drilling activities would be undertaken in the offshore marine environment (60 km from the coastline at its nearest point) where the Southeast Atlantic Unclassified Slope Substratum and Upper-, Mid- and Lower Slope ecosystem types have been rated as of 'Least Concern'. Identified CBA1 and CBA2 areas do, however, occur within 5.4% of the area of interest for drilling. These areas are located at the base of the Cape Point Valley (Cape Lower Canyon ecosystem type) and along a section of the Southeast Atlantic mid- and Lower Slope ecosystem types. The Cape Point Valley has been identified as a potential VME feature (Harris *et al*. 2022), which overlaps marginally with the area of interest (see Figure 7-20). The CBAs primarily protect sperm whale and Risso's dolphin distributions, pelagic ecosystem type Bb2 and Southeast Atlantic Lower slope ecosystem, as well as spawning areas for various fish, Leatherback turtle migration routes and distribution ranges of wandering and Atlantic yellow-nosed albatross. The southern portion of the CBA (approximately 1% of area of interest) overlaps with an ammunition dump site where no drilling will take place.

The benthic biota inhabiting unconsolidated sediments of the outer shelf and continental slope are very poorly known, but at the depths of the proposed 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. Epifauna living on the sediment typically comprise urchins, burrowing anemones, molluscs, seapens and sponges, many of which are longer lived and therefore more sensitive to disturbance. No rare or endangered species have been reported or are known from the continental slope unconsolidated sediments. The sensitivity of the benthic communities of unconsolidated sediments is therefore considered low.

In contrast, the benthos of deep-water hard substrata, such as those occurring on the Southeast Atlantic Slope Seamount, Brown's Bank Rocky Shelf Edge and potentially in the submarine canyon systems off the shelf edge, are typically vulnerable to physical disturbance due to their long generation times, and numerous potential VME indicator taxa have been reported for the shelf area off the Western and Southwestern Cape (Atkinson & Sink 2018). Despite their sensitivity to physical disturbance, such VME species are expected to have behavioural and physiological mechanisms for coping with increased turbidity in their near bottom habitats. The area of interest for drilling, however, avoids these sensitive areas, except for marginal overlap with the 'Vulnerable' Cape Canyon habitat. While the sensitivity of such deep-water reef communities is considered high, the area of interest for drilling avoids such known sensitive habitats and the well(s) will specifically be sited to avoid sensitive hardgrounds (ROV survey).

Thus, the overall sensitivity of receptors to physical seabed disturbance, considering the small percentage of the habitats potentially affected, despite the presence of a CBAs, is considered to be **low**.

Impact Magnitude (or Consequence)

Disturbance of sediments during ROV surveys

Any disturbance of benthic biota through increased turbidity and elevated suspended sediment concentrations in near-bottom waters would be of **very low intensity**, and limited to the turbidity plume generated by the ROV thrusters (**site specific**) (a few metres around the ROV and/or ROV flight track). However, in most cases sub-lethal or lethal responses would occur only at concentrations well in excess of those anticipated due to resuspension of sediments by ROV thrusters. Marine communities of continental shelf waters along the South-West Coast can be expected to have behavioural and physiological mechanisms for coping with increased turbidity in their near bottom habitats. Any turbidity effects would be transient only as sediments would redeposit after the ROV has departed the area or after initial spudding. Any impacts would thus persist over the **short-term** (hours) only. Thus, the **magnitude** (or consequence) related to the disturbance of sediments and crushing of biota on seabed related to drilling activities is considered to be **very low.**

Disturbance of sediments during drilling (spudding and associated works)

The immediate effect on the benthos depends on their degree of mobility, with sedentary and relatively immobile species likely to be physically damaged or destroyed during spudding of the well. Depending on their degree of mobility, demersal fish and crustaceans are likely to escape crushing.

Considering the available area of similar habitat on and off the edge of the continental shelf in the Southeast Atlantic Deep Ocean ecoregion and the ‘Least Threatened’ status, and avoidance of possible hardgrounds through the ROV survey (project control), this disturbance of and reduction in benthic biodiversity can be considered of **low intensity**, and limited to the immediate vicinity of the well site (**site specific**). As the wellhead would become colonised by succession communities after abandonment, any impacts to benthic communities would persist over the **short-term** only, resulting in the impact being of **very low magnitude**.

Impact Significance

Based on the **low sensitivity** of receptors by avoiding hardgrounds and the **very low magnitude**, the potential impact on the marine fauna is considered to be of **negligible significance** without mitigation.

Identification of Mitigation Measures

In addition to the project controls, specifically avoiding spudding on any potential hardgrounds (using ROV footage), the following measures will be implemented to mitigate the seabed disturbance impact:

No.	Mitigation measure	Classification
1	Ensure the ROV does not land or rest on the seabed as part of normal operations. Limit the area directly affected by physical contact with infrastructure to the smallest area required.	Avoid / Abate on site

No.	Mitigation measure	Classification
2	Undertake pre-drilling site surveys (with ROV) to ensure there is sufficient information on seabed habitats, including the mapping of sensitive and potentially vulnerable habitats within 1 000 m[50] of a proposed well site.	Avoid / reduce at source
3	If sensitive and potentially vulnerable habitats are detected, adjust the well position accordingly to beyond 1 000 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

Residual Impact Assessment

This potential impact cannot be eliminated due to the necessity for pre-drilling ROV seabed surveys and drilling activities. The proposed mitigation measures would reduce the intensity of the impact from low to very low, but the residual impact remains of **NEGLIGIBLE significance**.

Additional Assessment Criteria

The impacts are **fully reversible** after the operations cease. The loss of resource is **low** and the cumulative potential is **unlikely** due to the short-term and localised nature of the impact.

TABLE 9-11: IMPACT OF DRILLING ACTIVITIES ON BENTHIC BIOTA DUE TO SEABED DISTURBANCE

Project Phase:	**Operation**	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**LOW**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	LOW	VERY LOW
Extent	SITE	SITE
Duration	SHORT TERM	SHORT TERM
Significance	**NEGLIGIBLE**	**NEGLIGIBLE**
Probability	**HIGHLY LIKELY**	**HIGHLY LIKELY**
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**LOW**
Cumulative potential	**UNLIKELY**	**UNLIKELY**

[50] In US territorial waters the set-back distances for sea-surface discharges to hardgrounds is 2 000 ft (610 m) (Cordes *et al*. 2016). In his independent review of the Marine Ecology Study for Exploration drilling in Block ER236 off KwaZulu-Natal, Cordes recommended "*a set-back distance of at least 1 km from any hard ground apparent in bathymetric or 3D seismic surveys for any installations of seafloor infrastructure*". The 1 km set-back recommendation accommodates the area of most deposit determined by the drilling discharge modelling study, which is attributable to the initial riserless discharges, and the area of maximum deposition thickness which extends 179 m from the drill site (Discharge Point 2, Season 2), as well as the area of maximum environmental risk in the sediment, which extends to 150 m from the well site.

9.2.2 Discharge of Cuttings, Drilling Fluid and Cement

Source of Impact

The project activities that will result in accumulation of cuttings, drilling fluid and cement on the seabed are summarised below:

Project phase	Activity
Mobilisation	N/A
Operation	Discharge of drill cuttings and WBM at the well bore during the initial riserless drilling stages
	Discharge of drill cuttings and NADF at sea surface during the risered drilling phase
	Discharge of residual cement during casing installation at the end of the riserless drilling
	Discharge of excess fluids and residual cement during plugging of the wells
Demobilisation	N/A

These activities are described further below:

- The cuttings from the initial (riserless) top-hole sections of the well (drilled with WBMs) are discharged onto the seafloor where they accumulate in a conical cuttings pile around the wellhead. For the proposed well design, an estimated 1 235 t of dry cuttings and 5 140 t of drilling fluid will be discharged per well onto the seafloor during the riserless drilling stage over a period of 7 days (60 hrs in 3 batches plus lag time between operations) (see Table 6-8). Further muds are released from the drilling unit during the displacement phase at the end of the 26″ section. The mud used for displacement is a High Viscous Gel sweeps / KCl Polymer PAD mud, of which releases totalling 100 t would occur over a period of 6 days.
- After a 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. Wells will also be plugged with cement prior to abandonment to isolate hydrocarbon (if any) bearing and / or permeable zones. To ensure effective cementing, an excess of cement is usually used. This excess cement (100 m^3 in the worst case) emerges out of the top of the well onto the cuttings pile.
- During the risered drilling stage, which will be drilled with NADF, an estimated volume of 793 t of cuttings and 113 t of drilling fluid will be discharged per well (see Table 6-8) over a period of approximately 16 days (166 hrs in 3 batches plus lag time between operations). During this drilling stage, the circulated drilling fluid will be cleaned on the drill unit and the cuttings discharged into the sea at least 10 m below sea level.
- Before demobilisation, the wells will 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 wellbore and across any reserve sections.

9.2.2.1 Impact of Cuttings, Drilling Fluid and Cement Discharge on Marine Biota

Potential Impact Description

The discharge of drill cuttings, drilling fluids and residual cement will result in the physical disturbance of the seabed sediments and accumulation on the seabed, as well as result in an increase of sediment in the water column. The potential impacts on marine fauna associated with the discharge of cuttings, drilling fluid and cement include:

- Smothering of seabed habitat and associated benthic biota (Section 9.2.2.1.1). Any benthic biota present on the seabed within the footprint of the discharge may potentially be disturbed or crushed (**direct negative** impact). The impact assessment is summarised in Table 9-12 and Table 9-13.
- Toxicity and bioaccumulation effects on marine fauna (Section 9.2.2.1.2). Benthic biota may also suffer indirect toxicity and bioaccumulation effects due to leaching of potentially toxic additives in water column and sediment (**direct negative** impact). The impact assessment is summarised in Table 9-14 to Table 9-16.
- Increased water turbidity and reduced light penetration resulting in indirect physiological effects on marine fauna or indirect effects on primary productivity in surface waters (**indirect negative** impact) (Section 9.2.2.1.3). The impact assessment is summarised in Table 9-17.
- Reduced physiological functioning of marine organisms due to indirect biochemical effects on sediment surface (**indirect negative** impact) (Section 9.2.2.1.4). The impact assessment is summarised in Table 9-18.

In order to assess these impacts, the expected fall and spatial extent of the deposition of discharged cuttings was investigated in a **Drilling Discharge Modelling Study** (see Appendix 6 and Appendix 9 in Volume 2). This study considers the potential effects of drilling discharges across four seasons from two discharge points in the area of interest, namely **Discharge 1 located 72 km from the coast in 719 m depth** and **Discharge 2 located 155 km from the coast at a depth of 1 357 m** (see Figure 9-2). These locations are representative of the area and conservative (worst-case), as they were selected considering proximity to the coast and sensitive areas (including MPAS, EBSAs and CBAs), water depth, and metocean dataset. The four seasons considered include **Season 1 (December – February), Season 2 (March – May), Season 3 (June – August), and Season (September – November)**.

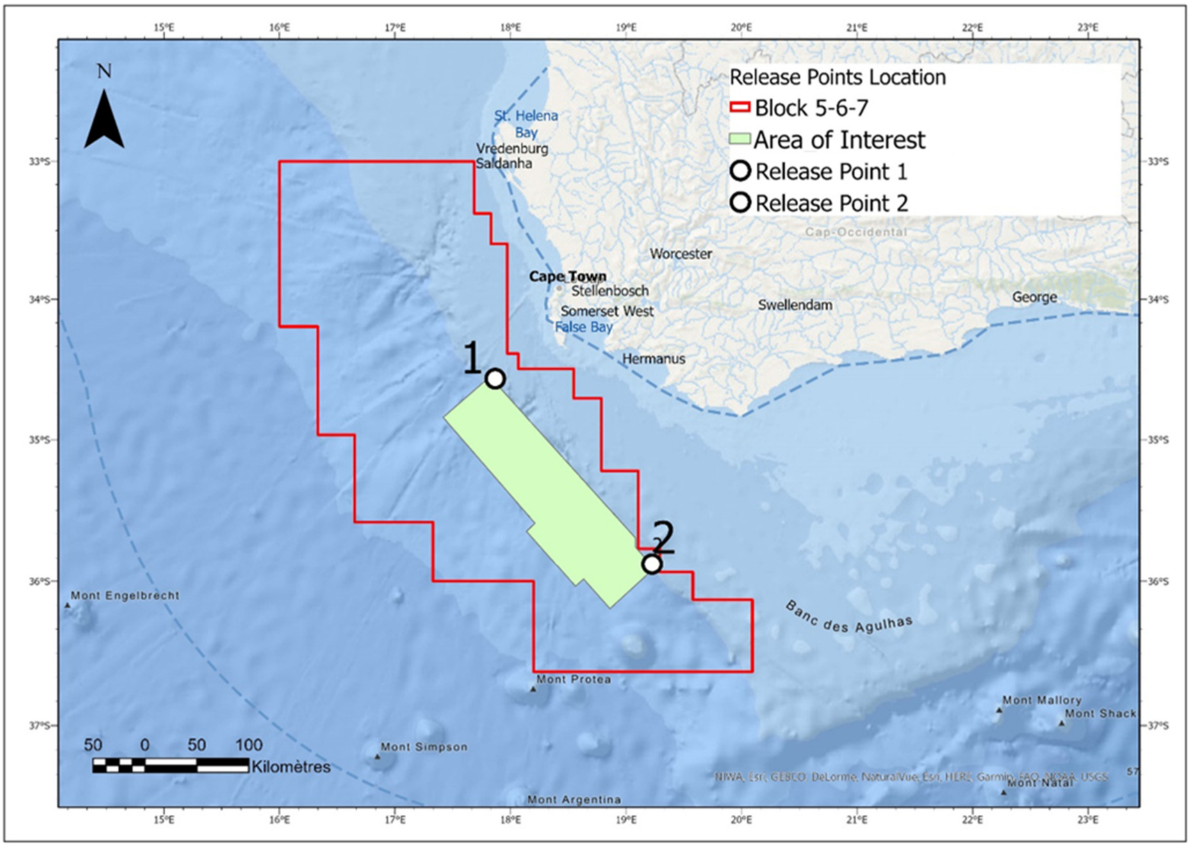


FIGURE 9-2: DISCHARGE POINTS SELECTED FOR THE DRILLING DISCHARGES AND OIL SPILL MODELLING STUDIES

Source: Livas 2022a

Project Controls

In addition to ensuring that the proposed drilling campaign is undertaken in a manner consistent with good international industry practice and BAT, the following controls will be implemented:

- Based on pre-drilling ROV survey(s), the well(s) will specifically be sited to avoid sensitive or potentially vulnerable hardground habitats, as the preference will be to have a level surface area to facilitate spudding and installation of the wellhead.
- Should the WBMs not be able to provide the necessary characteristics for effective drilling during the risered phase, a low toxicity Group III NADF will be used.
- NADF cuttings will be treated offshore to reduce oil content to <6% Oil On Cutting (OOC) and discharged overboard.
- Risered cuttings will be discharged via a caisson at greater than 10 m below surface to reduce dispersion of the cuttings in surface currents.

Sensitivity of Receptors

The drilling activities would be undertaken in the offshore marine environment, more than 60 km offshore, where the Southeast Atlantic Unclassified Slope Substratum and Upper-, Mid- and Lower Slope ecosystem types have been rated as of ‘Least Concern’. Identified CBA1 and CBA2 areas do, however, occur within the area of interest for drilling, covering 5.4% of the area of interest. The biodiversity features specifically protected by these CBAs include sperm whale winter and summer distributions, spawning areas for certain fish and areas of high anchovy egg density, pelagic ecosystem type Bb2 and Southeast Atlantic Lower slope, as well as Leatherback turtle migration routes and the core usage areas of Atlantic Yellow-nosed and Wandering Albatross. The overall sensitivity of these receptors is considered **low** (see Section 9.2.1.1).

In contrast, the benthos of deep-water hard substrata such as those occurring on the Southeast Atlantic Slope Seamount, Brown’s Bank Rocky Shelf Edge and potentially in the submarine canyon systems off the shelf edge and within the area of interest for drilling, are typically vulnerable to disturbance due to their long generation times. Numerous potential VME indicator taxa have been reported for that area (Atkinson & Sink 2018). While the sensitivity of such deep-water reef communities to physical disturbance is considered **high**.

The taxa most vulnerable to increased turbidity and reduced light penetration are phytoplankton. Due to the deep offshore location of the area of interest, the abundance of phytoplankton and pelagic fish and invertebrate fauna is likely to be low. Although higher productivity and localised shelf-edge upwelling occurs within Block 5/6/7, it occurs inshore and to the north of the area of interest for drilling. Thus, surface waters tend to be clearer and less productive as they are beyond the influence of coastal and shelf-edge upwelling. Furthermore, being dependent on nutrient supply, plankton abundance is typically spatially and temporally highly variable and is thus considered to have a low sensitivity. The major spawning areas are also all located on the continental shelf, inshore of the area of interest (see Figure 7-23). Seasonally high abundances of ichthyoplankton (hake, sardine and anchovy eggs and larvae), particularly in late winter and early spring may, however, occur in the inshore portions of the area of interest (see Figure 7-24 and Figure 7-25). Phytoplankton and ichthyoplankton are considered to be of low sensitivity, as any potential overlap of turbid water plumes generated during cutting disposal on phytoplankton and ichthyoplankton production, fish migration routes and spawning areas would be negligible.

Sensitivity of deep-water reefs / hardgrounds, which are considered to have a high sensitivity to physical disturbance, are considered to have a low sensitivity to the effects of turbidity. Although these biota may be more susceptible to increased turbidity, as the area is beyond the interference of natural turbidity (though rivers and sediment suspension by swells), they are expected to have behavioural and physiological mechanisms for coping with increased turbidity in their near bottom habitats. In addition, demersal species in the area of interest may be more tolerant of reduced light considering the deepwater environment.

Overall, the sensitivity to turbidity can be considered **low**.

9.2.2.1.1 Smothering of benthic biota/habitats by cuttings, drilling fluid and cement on seabed

Impact Magnitude (or Consequence)

The primary impact of discharged cuttings, drilling fluid (or mud) and cement is smothering of relatively immobile or sedentary benthic species both directly (e.g., mortality and clogging of feeding mechanisms) and indirectly (e.g., loss of benthic prey items for bottom feeding species, disturbance of migration routes and impact on those species that spawn on the seabed or have a benthic juvenile development stage). These effects on the benthic environment are related to the total mass of drilling solids discharged, which is dependent upon the well depth and the drilling conditions encountered.

The cuttings discharged at the seabed during the spudding of a well will form a highly localised spoil mound around the wellbore, thinning outwards. In contrast, the cuttings discharged from the drilling unit form two plumes as they are discharged. The larger particles and flocculated solids, which constitute approximately 90% of the discharge, settle to the seabed near the wellbore while the fine-grained unflocculated solids and soluble components of the mud (10% of the discharge) are rapidly diluted in the receiving waters and dispersed in the water column at increasing distances from the drill unit (see Figure 9-3) (Neff 2005).

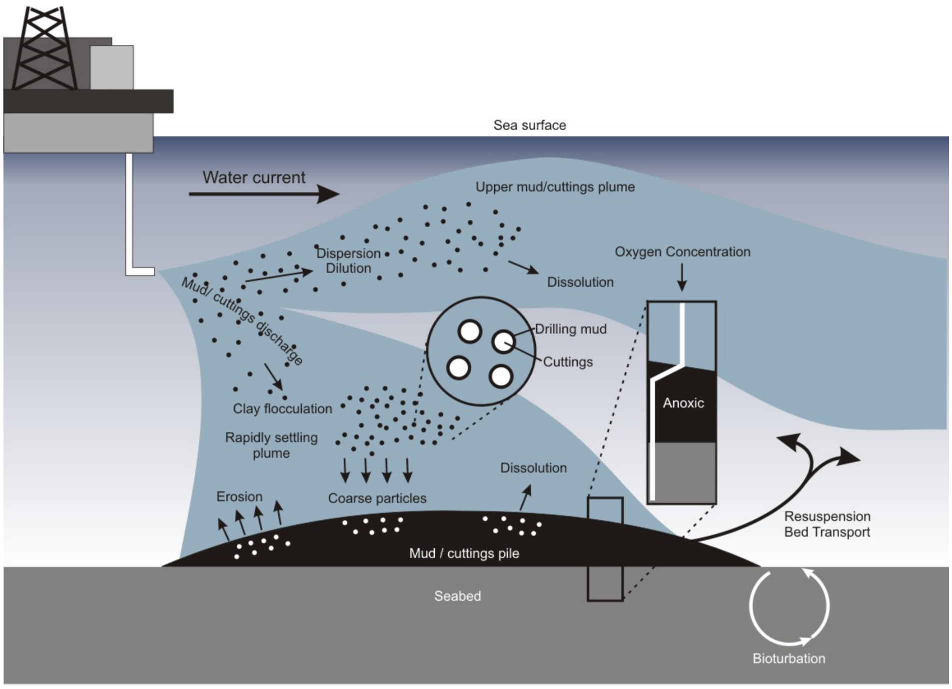


FIGURE 9-3: HYPOTHETICAL DISPERSION AND FATES OF CUTTINGS FOLLOWING DISCHARGE TO THE OCEAN
Source: Neff, 2005

In high energy environments, such as in Block 5/6/7 surface currents are strong (3.34 – 3.87 m/s) (although bottom currents are weaker with less directional variability (Livas 2022a)), 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 & Houghton 1980; Houghton et al. 1980; Bothner et al. 1985; Neff et al. 1989; Daan & Mulder 1993, 1996). Where changes in abundance and diversity of macrofaunal communities were detected in other studies, these were typically restricted to within about 100 m of the discharge, but did not persist much beyond six months after drilling operations had ceased (Chapman et al. 1991; Carr et al. 1996; Currie & Isaacs 2005). In low-energy, deep-water environments, however, the effects of drilling 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. The results of 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 around the wellbore, with fine sediment cover of less than 2 mm thickness likely to extend to approximately 0.5 km from the discharge point (Perry 2005).

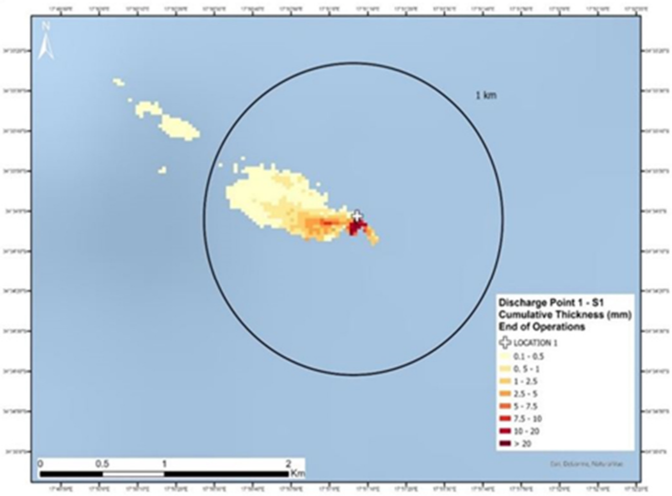
Modelling results:

The results of the cuttings dispersion modelling study undertaken as part of this project (Livas 2022a) largely confirm the reports of international studies that predicted that the effects of discharged cuttings are localised. The cuttings discharged at the seabed during the riserless drilling stage typically create a cone close to the wellbore, thinning outwards. The spatial extent of the cuttings pile depends on the volume of cuttings discharged and the local hydrodynamic regime: in areas with strong currents, the cuttings piles often have an elliptical footprint with the long axis of the ellipse aligned with the predominant current direction (Breuer *et al.* 2004). The worst-case results from the various modelling scenarios for Block 5/6/7 are highlighted below.

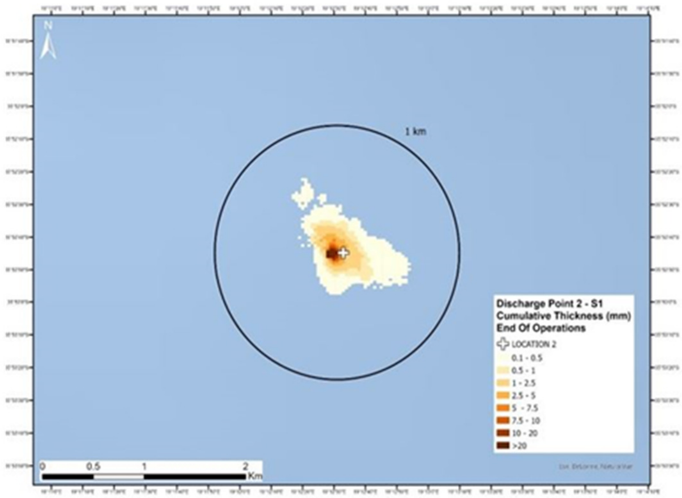
Sediment Deposition (Thickness)

- The cuttings mound around wellbore for Discharge Point 1 at the end of drilling operations (including both the riserless and risered drilling stages) amounts to a maximum depositional thickness of 111.9 cm extending up to 135 m of the discharge point (Season 1), progressively thinning out in a WNW direction to <0.5 mm after 650 m, but extending to a maximum distance of 1.8 km from the discharge in a WNW direction (see Figure 9-4, left). A maximum deposit thickness of 141 cm is reached during Season 2, but extending only 55 m around the wellbore. For Seasons 3 and 4, the maximum thickness deposits are lower and generally less extensive than for the Seasons 1 and 2 (Season 3: max. thickness of 66.1 cm extending to max of 56 m; Season 4: max. thickness of 43.5 cm extending to max of 41 m).
- For Discharge Point 2, the cuttings mound around wellbore at the end of drilling operations amounts to a maximum depositional thickness of 58.8 cm extending westwards up to 144 m from the discharge point (Season 1), progressively thinning out to <0.5 mm after 205 m, but extending to a maximum distance of 580 m from the discharge point (see Figure 9-4, right). For Season 2, the maximum thickness deposits are lower but more extensive than for the Season 1 (49.1 cm extending to max of 179 m). For Seasons 3 and 4, the maximum thickness deposits are slightly lower and less extensive than for the Season 1 (Season 3: max. thickness 58.1 cm extending to max of 132 m; Season 4: max. thickness 57.1 cm extending to max of 130 m).

- Most of the deposit (60%) is attributable to the initial riserless discharges at the seabed from drilling of the top hole sections (42" and 26"), remaining close to the discharge points due to the low current speeds at the seabed.
- At both discharge points, the cuttings deposit thickness >1 mm does not show recovery with time, showing negligible decrease in thickness 10 years after the operations. This can primarily be attributed to weak bottom currents at the well locations.



Max cumulative thickness value: 1 119 mm
Max. Distance: 1 800 m



Max cumulative thickness value: 588 mm
Max. Distance: 580 m

FIGURE 9-4: CUTTINGS THICKNESS DEPOSIT ON THE SEABED AT THE END OF DRILLING OPERATIONS AT (LEFT) DISCHARGE POINT 1 (WORST CASE: SEASON 1) AND (RIGHT) DISCHARGE 2 (WORST CASE: SEASON 1)

Source: Livas 2022a

Grain Size Variation

- As would be expected, the riserless discharges resulted in the greatest variation in grain size in surficial sediments to those originally present, with the maximum grain size recorded at the end of operations in Discharge Point 1 being 1.7 mm (compared to a natural grain size of 0.01 mm) for the 42" section (Worst case: Season 4), but confined to a maximum distance from the wellbore of no more than 35 m. The variation due to drilling of the risered sections is also significant, with a maximum grain size of 0.24 mm for the 17.5" section, confirmed to within 50 m of Discharge Point 1 (Season 1), but with larger plumes occurring in the WNW and extending up to 2.2 km from the discharge point for the 12.25" section.
- For Discharge Point 2 the maximum grain size recorded was 1.02 mm for the 26" section (Worst case: Season 2), but confined to a centralised area around the wellbore of no more than 125 m. The variation due to drilling of the risered sections is also significant, with larger plumes occurring in the ESE and N directions and extending up to 1.58 km from the discharge point with a maximum grain size of 0.14 mm (for the 17.5" section) extending up to 50 m to the SE from the discharge point.
- Change in grain size around the wellbore associated with the riserless drilling stage are primarily physical, accounting for a maximum of 50% at Discharge Point 1 (Season 2) and 73% at Discharge Point 2 (Season 3).

Ecological impacts in response to cuttings disposal are typically characterised by reduced species diversity, enrichment of opportunistic and/or pollution-tolerant fauna and a loss of more sensitive species. Such community changes are, however, rarely measurable beyond 500 m of the drilled area (Neff *et al.* 1992; Ranger 1993; Montagna & Harper 1996; Schaanning et al. 2008; Sink *et al.* 2010), with recovery of the benthos observed to take from several months to several years after drilling operations had ceased (Husky 2000, 2001a, 2001b; Buchanan *et al*. 2003; Neff 2005; Currie & Isaacs 2005; Netto *et al*. 2010; Gates & Jones 2012; Jones *et al*. 2012). Exceptions to this have, however, been reported especially for sensitive species (reviewed by Ellis *et al.* 2012; Cordes *et al.* 2016).

The effects of smothering on the receiving benthic macrofauna are determined by (1) the depth of burial; (2) the tolerance of species (life habitats, escape potential, tolerance to hypoxia, etc.); (3) the nature of the depositing sediments (type and grain size); and (4) duration of burial.

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; Harvey *et al.* 1998; Blanchard & Feder 2003). 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 depends on the nature of the deposited non-native sediments. Although there is considerable variability in species response to specific sediment characteristics, higher mortalities have been recorded when the deposited sediments have a different grain-size composition from that of the receiving environment, which will 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. Provided the sedimentation rate of incidental deposition is not higher than the velocity at which the organisms can move or grow upwards, such deposition may not have negative effects.

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). In the case of sedentary and relatively immobile species that occur in waters beyond the influence of aeolian and riverine inputs (such as offshore waters in the area of interest), they will be more susceptible to smothering. However, deep-water fauna inhabiting unconsolidated sediments usually comprise fast-growing species that are able to rapidly recruit into disturbed areas. In contrast, **the benthos associated with hard substrata (e.g., Browns Bank Rocky Shelf Edge ecosystem type, which occurs inshore of the area of interest) is typically vulnerable to disturbance due to their long generation times. It is, however, important to note that the cuttings depositional footprints, extends to a maximum of 1.8 km from the discharge point in a WNW direction (Discharge Point 1) and 0.79 km spreading in a NW, SSW and E direction (Discharge Point 2), is directed away from the Browns Bank Rocky Shelf Edge (Brown's Bank EBSA) by the prevailing currents.** Although the depositional footprint avoids the Browns Bank Rocky Shelf Edge, the CBA in the area of interest, which protects the South Atlantic Lower slope habitat (although of 'Least concern'), may be affected. **Sensitive communities may also be expected on the Southeast Atlantic Slope Seamount (to the south of the area of interest) and the 'Vulnerable' Cape Canyon habitat, which marginally overlaps with the area of interest.** 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 life-strategies of organisms are 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 and kingklip; all of which spawn inshore of the area of interest for drilling (see Figure 7-23) and potential depositional footprints of discharges, which extend to a maximum of 1.8 km from the discharge point in a WNW direction) may be negatively affected by the smothering effects of drill cuttings.

The disturbance of and reduction in benthic biodiversity due to smothering following cementing would result in no additional impact as the cement will be discharged in an area already affected by drill cuttings in the near vicinity of the wellbore.

<u>Smothering of unconsolidated sediments magnitude</u>: The smothering effects resulting from the discharge of drilling solids at the wellbore (riserless drilling stage) is assessed to have an impact of **medium intensity** on the benthic macrofauna of unconsolidated sediments in the cuttings footprint due to the higher deposit thickness and grain size variation associated with riserless discharges. Mortality of most fauna can be expected if deposit thickness of drilling solids at the well bore is >30 mm, which is expected to occur only within a few metres around the well bore. Discharges from the drilling unit would have a **low intensity** impact, as the depositional footprint would have a considerably lower deposit thickness, but be spread over a larger area (although outside of key spawning areas). Some biota will be smothered, but many will be capable of burying up through the deposited drilling solids. For the discharge of drilling solids at the wellbore the impact is highly localised (**site specific** deposition of >5 mm confined to <100 m from the well bore per well), whereas discharges from the drilling unit would have **local** impacts (up to 2 km to the WNW from the drilling unit per well). Since the model predicts that physical changes to the sediment structure within the deposition footprint would persist for over 10 years, recovery of benthic communities to functional similarity is expected to occur within the **long-term** (5 - 25 years). The impact from riserless and risered drilling is assessed to be of **medium magnitude** (or consequence) for all five wells regardless of season.

<u>Smothering of sensitive hard substrata magnitude</u>: Considering the avoidance of possible hardgrounds through the ROV survey (project control), the wells would be sited in unconsolidated sediments beyond the shelf edge and outside the Brown's Bank EBSA (Browns Bank Rocky Shelf Edge ecosystem). Although modelling shows that the deposition footprint, which extends primarily in a WNW-NW direction away from a drill site, avoids these sensitive ecosystem types, the cuttings footprint could overlap with as yet unmapped vulnerable communities on hardground within the CBAs located within the area of interest. The riserless drilling stage, which results in the majority of the deposit (60%), is unlikely to impact sensitive hardgrounds. Should the cuttings footprint (from discharge at the surface during risered drilling) overlap with unknown vulnerable communities on hard substrates the smothering effects would potentially have a **localised** impact (limited to a maximum distance of 1.8 km to the NW of the well site) of **high intensity** due to the sensitivity of long-lived, slow-growing biota to physical disturbance. Recovery would only be expected over the **long-term** due to the persistence of physical changes and the long generation times of vulnerable hard-ground communities. Should the impact occur, it can be considered to be of **high** magnitude for up to 5 wells regardless of season.

Impact Significance

In unconsolidated sediments, based on the **low sensitivity** of receptors and the **medium magnitude**, the potential impact on the marine benthic biota is considered to be of **low significance**. On hardgrounds, based on the **high sensitivity** of receptors and the **high magnitude**, the potential impact on the marine benthic biota is considered to be of **high significance**.

Identification of Mitigation Measures

The following measures will be implemented to reduce and manage the potential smothering impact on hardgrounds:

No.	Mitigation measure	Classification
1	Undertake pre-drilling site surveys (with ROV) to ensure there is sufficient information on seabed habitats, including the mapping of sensitive and potentially vulnerable habitats within 1 000 m of a proposed well site.	Avoid / reduce at source
2	Ensure that, based on the pre-drilling site survey and expert review of ROV footage, well sites are not located within a 1 000 m radius of any sensitive and potentially vulnerable habitats (e.g., hardgrounds), species (e.g., cold corals, sponges) or structural features (e.g., rocky outcrops)	Avoid / reduce at source
3	If sensitive and potentially vulnerable habitats are detected, adjust the well position accordingly to beyond 1 000 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
4	Monitor (using ROV) cement returns and if significant discharges are observed on the seafloor terminate cement pumping.	Reduce at source

Residual Impact Assessment

This potential impact cannot be eliminated due to the nature of the drilling approach and the need for and nature of the cuttings discharge. As no mitigation is proposed for communities in unconsolidated sediments (except when monitoring and minimising the discharge of cement), the residual impacts would remain of **LOW significance**. For vulnerable hard seabed communities, however, the implementation of the above-mentioned mitigation measures, would lower the intensity and duration (although still long term) of the impacts. Thus, the residual impact on hardgrounds would reduce to **MEDIUM significance**.

Additional Assessment Criteria

The impact is **partially reversible** after drilling operations cease. The loss of resource is **low** with mitigation and the cumulative potential is **unlikely**. As pre-drilling ROV surveys would reveal the presence of hardgrounds and TEEPSA will actively avoided known vulnerable seabed communities by >1 000 m, the probability of such occurring in the area of interest for discharges from the drilling unit is **unlikely**.

TABLE 9-12: IMPACT ON BENTHIC COMMUNITIES (UNCONSOLIDATED SEDIMENTS) AS A RESULT OF SMOTHERING FROM THE DISCHARGE OF CUTTINGS, DRILLING FLUIDS AND CEMENT

Project Phase:	**Operation**	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**LOW**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**MEDIUM**	**MEDIUM**
Intensity	MEDIUM	MEDIUM
Extent	LOCAL	LOCAL
Duration	LONG TERM	LONG TERM
Significance	**LOW**	**LOW**
Probability	**DEFINITE**	**DEFINITE**
Confidence	**HIGH**	**HIGH**
Reversibility	**PARTIALLY REVERSIBLE**	**PARTIALLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**LOW**
Cumulative potential	**UNLIKELY**	**UNLIKELY**

TABLE 9-13: IMPACT ON BENTHIC COMMUNITIES (HARDGROUND SUBSTRATES) AS A RESULT OF SMOTHERING FROM THE DISCHARGE OF CUTTINGS FROM THE DRILLING UNIT

Project Phase:	**Operation**	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**HIGH**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**HIGH**	**MEDIUM**
Intensity	HIGH	MEDIUM
Extent	LOCAL	LOCAL
Duration	LONG TERM	LONG TERM
Significance	**HIGH**	**MEDIUM**
Probability	**POSSIBLE**	**UNLIKELY**
Confidence	**HIGH**	**HIGH**
Reversibility	**PARTIALLY REVERSIBLE**	**PARTIALLY REVERSIBLE**
Loss of Resources	**HIGH**	**LOW**
Mitigation Potential	**-**	**HIGH**
Cumulative potential	**UNLIKELY**	**UNLIKELY**

9.2.2.1.2 Toxicity and bioaccumulation effects on marine fauna

Impact Magnitude (or Consequence)

Cement: Various chemical additives are used in the cementing programme to control its properties, including setting retarders and accelerators, surfactants, stabilisers and defoamers. The formulations are adapted to meet the requirements of a particular well. The chemical additive 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.

Drilling fluids: Although the cuttings themselves are generally considered to be relatively inert, the drilling muds 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. The effects may be of significance in terms of:

- Chronic accumulation of persistent contaminants in the marine environment;
- Acute or chronic effects on biota, including effects on productivity; and
- Acute or chronic effects on other biota (i.e. indirect effects on biodiversity).

WBMs would be used to drill the first 1 070 m riserless section of each well. This drilling fluid would be discharged at the seabed together with the drill cuttings. WBMs are generally assumed to be less toxic than NADFs, causing only marginal effects on the benthos resulting mainly from sedimentation (Ellis *et al.* 2012). Typically, the major ingredients that make up over 90% of the total mass of the WBMs are fresh or seawater, the barium sulphate (barite) (or more recently ilmenite) (weighting agents), bentonite clay (viscosifier), lignite, lignosulphonate, and caustic soda (pH control). 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 in Section 9.2.1.1 above. However, some WBMs, particularly those containing glycols or organic long chain screen blinding 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. The zone of biological effects on benthic community diversity and abundance ranged from 0.1 to 1 km for both water and synthetic fluids (Paine *et al.* 2014).

For the risered sections, NADF containing primarily barite (71%) and a suite of chemicals (refer to Drilling Discharges Modelling in Appendix 6, Volume 2) may be used that provide properties such as shale inhibition (reducing the hydration, swelling and disintegration of clays and shales) and degree of lubrication. Although mostly biodegradable, a number of these chemicals (e.g., INVERMUL NT and EZ MUL NT) are considered potentially hazardous to the marine environment. NADF cuttings tend to aggregate once discharged and thus disperse less readily resulting in a smaller area but thicker deposition on the seabed. 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; IOGP 2003). The potential for significant bioaccumulation of NADFs in aquatic species is unlikely due to their extremely low water solubility and consequent low bioavailability (IOGP 2003). However, certain hydrocarbons are known to have tainting effects on fish and shellfish.

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 down current from the discharge (OSPAR 2008).

Modelling results:

Toxicity effects may occur in the seabed sediments and in the water column. The worst-case results from the various modelling scenarios for Block 5/6/7 are highlighted below.

Environmental Risk - Sediments

- The risk related to the sections drilled with the riser is much higher than the potential risk induced by the riserless sections (which has a negligible impact and is physical rather than chemical). The sediment environmental risk of the sections drilled with a riser is more chemical than physical, due to EZ MUL NT (mostly fatty acid component of the product), responsible for 56% of the total risk, and INVERMUL NT (mostly the fatty acid component too), responsible of 41% of the total risk.
- The risered sections of the well represent a significant risk above the threshold at which 5% of the species in the ecosystem are likely to be affected. This risk is primarily associated with the chemicals from the drilling muds remaining in the sediments. There is no trace of risk due to the riserless section discharges. The drill cuttings discharge model calculates a maximum risk of 99.9 % (99.9% of species at risk) during the discharge of the 17 ½" section, 150 m W of Discharge Point 1 and 90 m W of Discharge Point 2 at the end of operations. This risk remains at 99.4% and 97% for the same point 10 years after the operations for Discharge Points 1 and 2, respectively, emphasising the slow recovery of seabed impacts at such depths under low current conditions. However, this risk remains highly localised.
- The maximum distance from the discharge point at which a significant cumulative risk was calculated at the end of the drilling operations is up to 5 km NW of Discharge Point 1 (Season 1) (see Figure 9-5) and 4.6 km NW of Discharge Point 2 (Season 3) (see Figure 9-6). As would be expected, the risk is not centralised around each discharge point, and is orientated towards the NW (Discharge Point 1) and E and NW (Discharge Point 2) in the direction of the prevailing current, illustrating the strong influence of surface currents on drill cuttings dispersion and redeposition on the seabed. Ten years after operations the footprint for significant cumulative risk for Discharge Point 1 (Season 1) reduces to 2.1 km NW (Discharge Point 1) and 1.5 km NW (Discharge Point 2).

Contaminant concentrations - Sediments[51]

- At Discharge Point 1, contaminant concentrations in the sediment as a result of drilling the riserless sections with WBMs are negligible and the plumes are directed towards the SE and S to a maximum distance of 2 km from the well bore due to the prevailing bottom currents. At Discharge Point 2, contaminant concentrations in the sediment as a result of riserless drilling are more substantial and the plumes are directed towards the NW to a maximum distance of 8 km from the well bore.

[51] This differs from the environmental risk described above, as it provides the actual predicted concentrations of various constituents in the sediments.

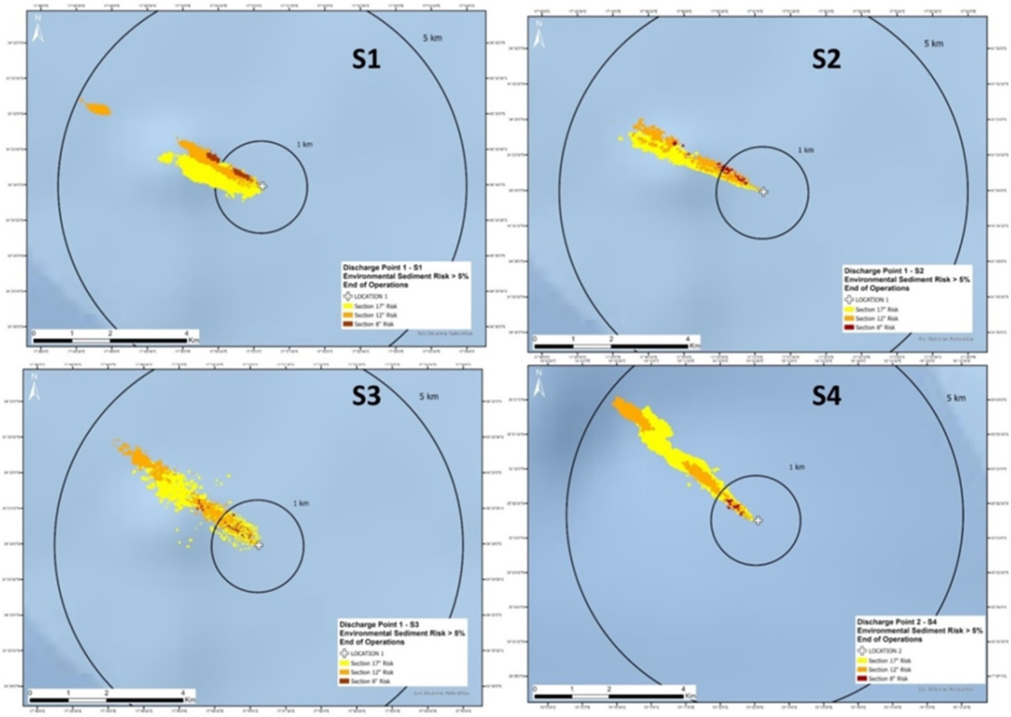


FIGURE 9-5: MAXIMUM POTENTIAL RISK IN THE SEDIMENT AT THE END OF THE DRILLING OPERATIONS FOR ALL FOUR SEASONS AT DISCHARGE POINT 1

Source: Livas 2022a

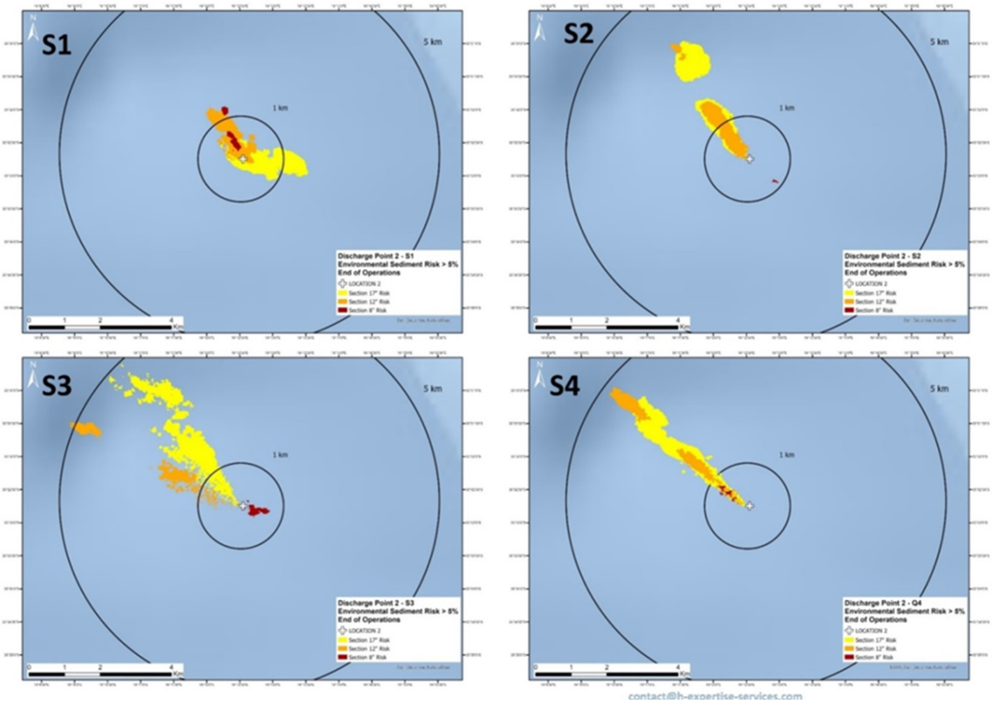


FIGURE 9-6: MAXIMUM POTENTIAL RISK IN THE SEDIMENT AT THE END OF THE DRILLING OPERATIONS FOR ALL FOUR SEASONS AT DISCHARGE POINT 2

Source: Livas 2022a

- For the riser section, cuttings and NADFs would be released in three pulses near the sea surface from the drilling unit. The north-westerly currents prevailing during the drilling of the risered sections would result in the discharges experiencing greater dispersion as they settle through the water column resulting in an elongated, patchy deposit that extends from the well bore in the direction of the prevailing currents. Risered cuttings discharges would therefore affect the entire water column. However, once the cuttings have settled, the concentrations of contaminants released in the muds would contribute to environmental risk in the surficial sediments around the well bore. For total discharges during the risered sections, the maximum distance at risk in the sediments extends in patches out to a maximum of 6.7 km from Discharge Point 1 (see Figure 9-7) and 5.2 km from Discharge Point 2 (see Figure 9-8).
- The maximum concentrations of the weighting agents in the cuttings (barite and bentonite) at the end of operations are high (Discharge 1: 2.75 g/l in Season 1; Discharge 2: 5.2 g/l in Season 2), but remain localised to within <50 m of the discharge point. Depositional footprints for the weighting agents extend up to a maximum of 2.1 km from the well bore in a NW direction for Discharge 1 (Season 1) (see Figure 9-7), and 1.3 km in a NW direction for Discharge 2 (Season 1) (see Figure 9-8).
- In the case of the chemical constituents of the NADF used for the risered sections, the highest risk to the sediments is posed by the fatty acid in the EZ MUL NT and in the INVERMUL NT. For Discharge 1 the maximum concentrations are 1.4 g/l extending in a WNW direction to a maximum distance of 3.9 km (Season 1), with the maximum concentrations of 0.13 g/l during discharges from the 8.5″ extending up to 4.8 km from the well bore (see Figure 9-7). Although concentrations are lower than for the weighting agents, their high Predicted No Effect Environmental Concentration (PNEC) values results in these constituting a far greater risk to the environment than the weighting agents.
- For Discharge 2, the maximum concentration of EZ MUL NT reached is 0.55 g/l with the plume extending up to 4.5 km from the well bore in a north-westerly direction (Season 1) (see Figure 9-8). The maximum concentration reached was 1.4 g/l during Season 2.
- A further two pulses in environmental risk occur due to the discharge of KCl-WBMs during well logging and plugging. Although these discharges do constitute a risk to the water column, in most cases the risk falls well below the threshold at which 5% of the species in the ecosystem are likely to be affected. Risks to the seabed are not attained during these discharges due to the rapid dilution and dispersion of the chemicals and particulates in the prevailing currents.
- During drilling of the risered sections with NADFs, the main contributors to the ecological risk in the sediments are chemical rather than physical as was the case with the riserless section using WBMs. The chemical risks accounted for a maximum of 57% - 58% during: Season 3). The maximum risk due to liquid chemicals in the sediments (due to discharge of EZ MUL NT and INVERMUL NT) amounted to 98% - 99% for all seasons.
- The cuttings modelling study identified that the maximum total discharge concentrations predicted near the seabed at the end of drilling operations amounted to between 4 500 g/l (Season 4) and 14 000 g/l at Discharge 1 (Worst case: Season 2) and between 3 000 g/l (Season 1) and 4 500 g/l (Worst case: Season 4) at Discharge 2. Seasonal variations are evident depending on variations in seabed currents, which result in the overall maximum footprint for cumulative deposition (i.e. combined deposition from riserless and risered phases) not being centralised around the discharge point, as described above.
- The maximum cuttings discharge concentrations at the seabed at the end of drilling operations amounted to between 4 300 g/l (Season 4) and 13 000 g/l at Discharge 1 (Worst case: Season 2) and between 2 750 g/l (Season 1) and 3 800 g/l (Worst case: Season 3) at Discharge 2.

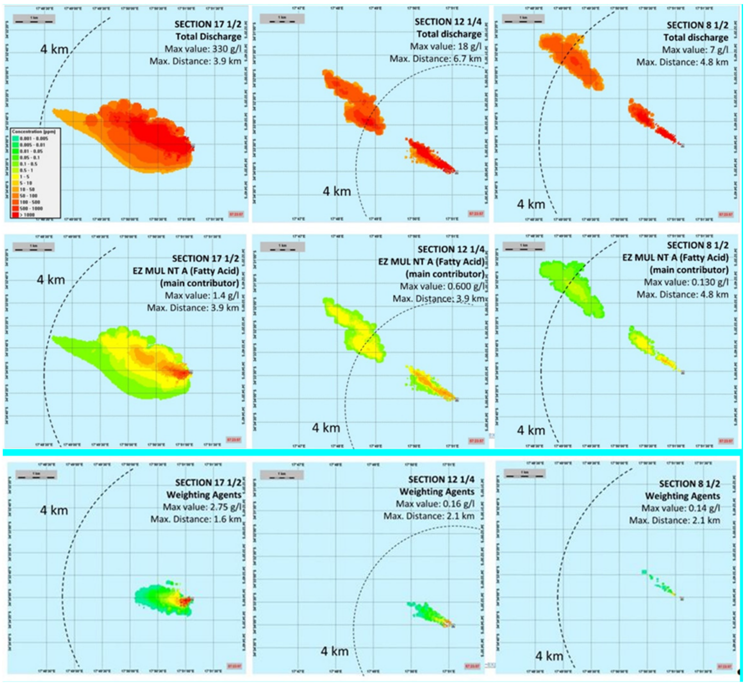


FIGURE 9-7: CONCENTRATIONS OF TOTAL DISCHARGE (TOP), EZ MUL NT (MIDDLE) AND WEIGHTING AGENTS (BOTTOM) IN THE SUPERFICIAL LAYER OF SEABED SEDIMENTS AT THE END OF RISERED DRILLING OPERATIONS AT DISCHARGE 1 (WORST CASE: SEASON 1)

Source: Livas 2022a

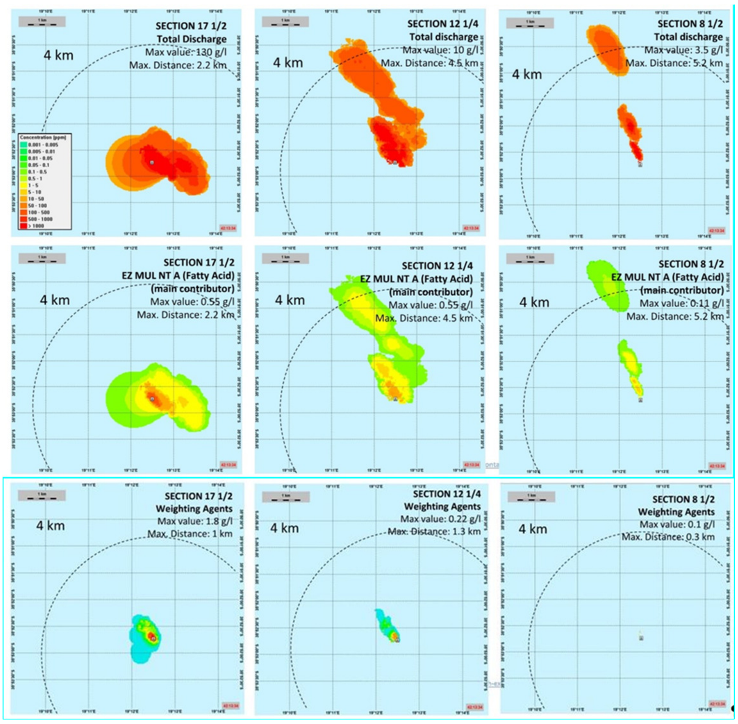


FIGURE 9-8: CONCENTRATIONS OF TOTAL DISCHARGE (TOP), EZ MUL NT (MIDDLE) AND WEIGHTING AGENTS (BOTTOM) IN THE SUPERFICIAL LAYER OF SEABED SEDIMENTS AT THE END OF RISERED DRILLING OPERATIONS AT DISCHARGE 2 (WORST CASE: SEASON 1)

Source: Livas 2022a

Environmental Risk - Water Column for riserless sections

- The cuttings modelling study for the current project (Livas 2022a) identified that concentrations of contaminants in the water column that may pose a risk to benthic biota released during the riserless drilling stages at Discharge 1 are restricted to 20 m above and 10 m below the modelled discharge point (690 m depth), following the seabed slope. Additives released into the water column above the seabed during the riserless drilling stages will therefore remain near the seabed and spreading in the direction of the prevailing currents. The maximum distances from the discharge with a significant environmental risk[52] was up to 18 km in a SW direction, although the area at risk is not centred around the discharge point, but also spread in a S, SW and WNW direction thereby showing the effect of water column currents near the seabed on the dispersion of drill cuttings and drilling muds (see Figure 9-9). For Season 2 and 4: the calculated risk in the water column is mainly observed towards the NW direction, spreading from 24 km (Season 4) to 31 km (Season 2). Current speed is higher during Season 3 (until 0.27 m/s) leading to a calculated risk spreading further from the discharge point (52 km towards the NW and towards the Cape Canyon and Associated Islands EBSA and its associated CBAs, which is approximately 80 km north of the area of interest).
- For Discharge 2, concentrations of contaminants in the water column that may pose a risk to benthic biota are restricted to 12 m above and 3 m below the modelled discharge point (1 367 m). The maximum distances from the discharge with a significant environmental risk up 7.5 km, spreading in a NW direction (see Figure 9-10). For Season 2 and 4: the calculated risk in the water column for Season 2 and Season 4 is mainly observed towards the NW direction, spreading from 5.4 km (Season 4) to 8.5 km (Season 2). Current speed is higher during Season 3 (until 0.18 m/s) leading to a calculated risk spreading further from the discharge point (8.5 km towards the NW).
- The cumulative risks[53] in the water column above the seabed illustrated in Figure 9-9 and Figure 9-10 are short-term, however, being concentrated around the discharge point and decreasing rapidly with distance as the plume dilutes.
  - For Discharge 1, the worst-case scenario for the percentage of time with a significant risk above 5% was for Season 1 where a maximum risk extended up to 1.7 km from the wellbore for 4.5 days, with the risk duration decreasing rapidly with distance to <24 hrs at a maximum of 13.8 km to the SW of the discharge.
  - For Discharge 2 in deeper water, where near bottom currents are weaker, the worst-case scenario for the percentage of time with a significant risk above 5% was again for Season 1 where a maximum risk extended up to 1.0 km from the wellbore for 7.5 days, with the risk duration decreasing rapidly with distance to <24 hrs at a maximum of 6.2 km to the SSE of the discharge.
- The main contributors to the environmental risk in the water column during the riserless drilling stages are barite and bentonite with a total for the sum of these two of 53% to 65% of contribution. Particulate barite is almost insoluble and non-biodegradable, and thus essentially inert toxicologically to marine organisms having primarily a physical effect, although recent studies have identified that responses of

[52] A significant risk corresponds to a calculated concentration in the environment (exceeding the predicted no effect concentration to a level likely to potentially impact 5% of species in a typical ecosystem.

[53] The cumulative risk is based on an environmental risk of >5% being achieved at any time during the calculation by the model.

benthic communities to high concentrations of barite may be due to factors other than just physical disturbance (Trannum *et al.* 2010). The other two main contributors during the riserless stage are caustic soda and potassium chloride, both of which have chemical effects and which together contribute between 18% and 22% to the risk in the water column near the seabed.

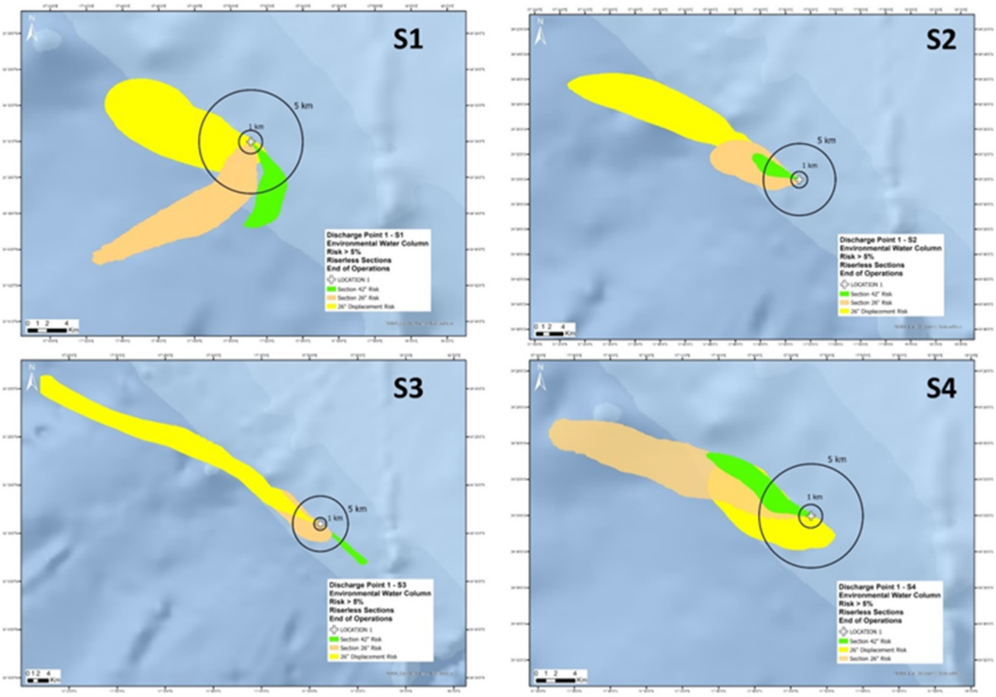


FIGURE 9-9: CUMULATIVE SIGNIFICANT ENVIRONMENTAL RISK IN THE WATER COLUMN NEAR THE SEABED DURING DRILLING OF THE RISERLESS SECTIONS AT DISCHARGE POINT 1 FOR ALL THE SEASONS

Source: Livas 2022a

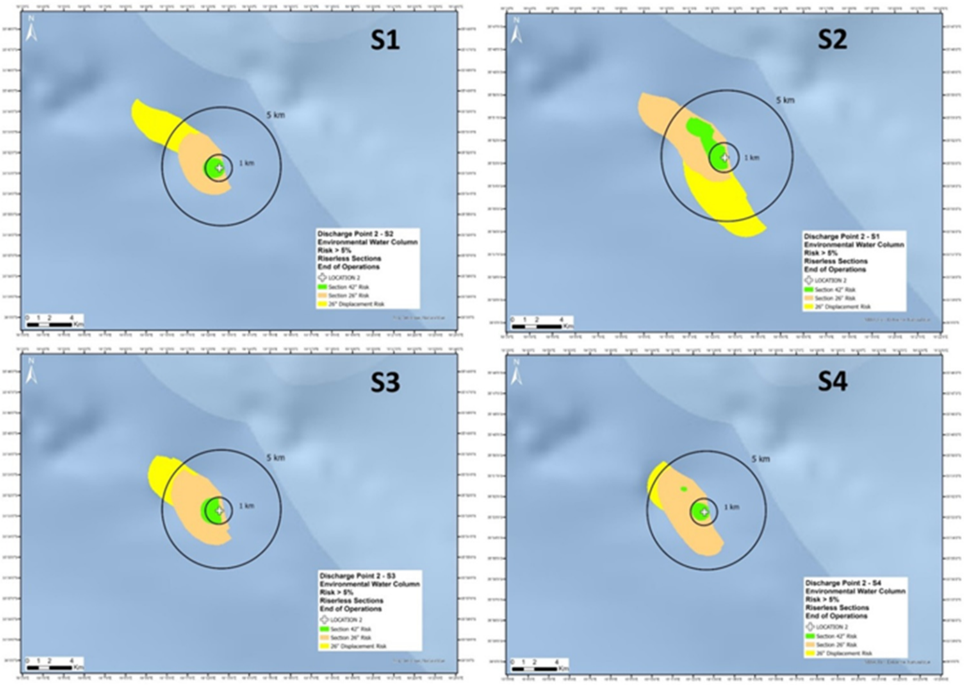


FIGURE 9-10: CUMULATIVE SIGNIFICANT ENVIRONMENTAL RISK IN THE WATER COLUMN NEAR THE SEABED DURING DRILLING OF THE RISERLESS SECTIONS AT DISCHARGE POINT 2 FOR ALL THE SEASONS

Source: Livas 2022a

Environmental Risk - Water Column for risered sections

Using NADFs during the risered stages increases the contaminant contributions in the muds significantly, producing a footprint throughout the entire water column due to dispersion and dilution of the drilling fluid additives following release of drilling cuttings from the drilling unit. The cumulative significant environmental risks in the water column for the risered discharges at Discharge 1 and Discharge 2 are shown in Figure 9-11 and Figure 9-12.

- Maximum distances of the plume with significant risk during risered drilling discharge are 23 km (Worst case: Season 2 and 3) and 25.6 km (Worst case: Season 3) in a NW direction at Discharge 1 and Discharge 2, respectively. The maximum distances at risk around the discharge point varies depending on variability in water column currents with season.
- Modelling results indicate that during risered drilling surface currents ensure that plumes are rapidly diluted and dispersed (few hours) and are not detectable beyond the cessation of drilling operations. Chemical footprints are therefore ephemeral only. As was the case near the seabed, the area at risk in the water column is not centred around the discharge point but extends in the direction of the prevailing currents.
  - At Discharge 1 the plume spreads from W to NW for the 17 ½" section discharge and NW for the 12 ¼" and 8 ½" sections, with seasonal variability being evident. The worst-case scenario for the percentage of time with a significant risk above 5% was for Season 4 where a maximum risk extended up to 1.3 km from the wellbore for 7.2 days, with the risk duration decreasing rapidly with distance to <24 hrs at a maximum of 4.4 km away from the discharge.
  - At Discharge 2 the plume spreads from NW to NNW for the 17 1/2" section discharge, from W to N for the 12 ¼" section, and towards the NNW for the 8 ½" section. The worst-case scenario for the percentage of time with a significant risk above 5% was for Season 2 where a maximum risk extended up to 3.1 km from the wellbore for 6 days, with the risk duration decreasing rapidly with distance to <24 hrs at a maximum of 9.5 km away from the discharge.

Similar to the riserless drilling stage, the main contributors to the environmental risk to the water column during the risered stages constitute the particulate compounds (barite and bentonite). Weighting agents and chemicals released into the water column at the surface, result in an environmental risk plume that extends throughout the entire water column, with a maximum calculated risk of 100% close to the release point at the sea surface at both discharge points.

Bioaccessibility of drilling mud components

The disposal of mud into the marine environment and its subsequent effect has been extensively investigated through field and laboratory studies. Several metals (Ba, Cr, Cu, Ni, Pb, and Zn) typically occur in significantly higher concentrations in drilling muds than in uncontaminated marine sediments. Barium (from drilling mud barite) is usually the most abundant metal in WBMs and NADF, and is thus used most frequently as an indicator of drilling muds in sediments (Neff 2005). However, due to the low solubility of barite in seawater and in anoxic marine sediments, a considerable proportion of the associated contaminants are likely to remain within the cuttings pile unless they are disturbed (Breuer *et al* 2004). These metals are thus typically not bioavailable to benthic biota and do not bioaccumulate in the marine food chain (Neff 2005) and thus essentially inert toxicologically to marine organisms. If, however, they do become bioavailable, toxic effects in high concentrations can be expected (Neff 2008; Edge *et al.* 2016).

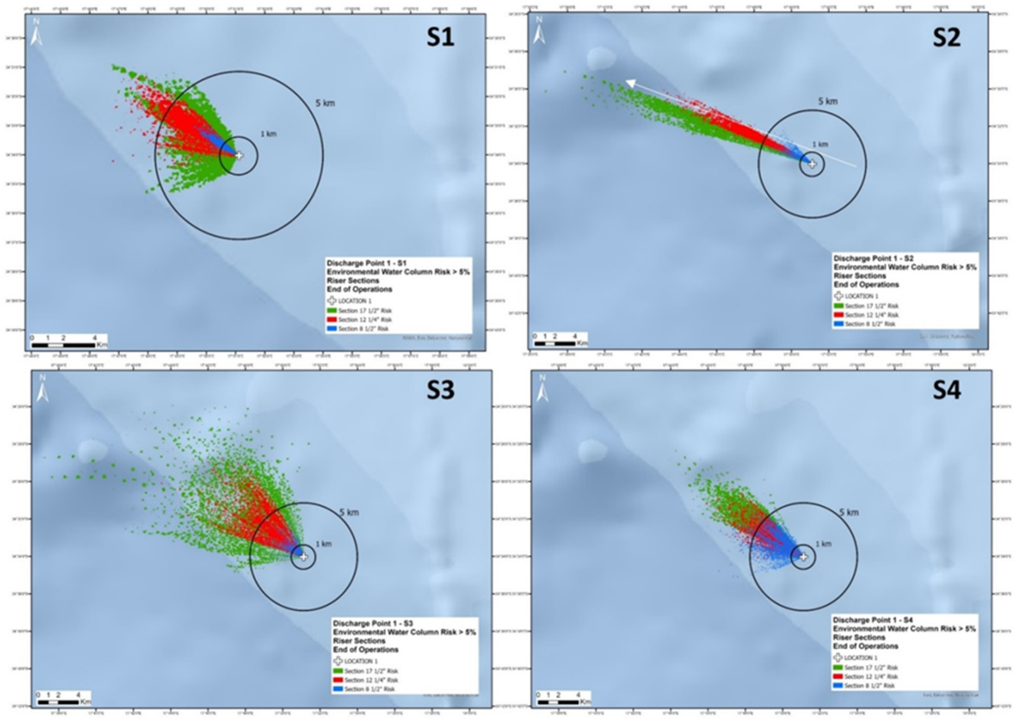


FIGURE 9-11: CUMULATIVE SIGNIFICANT ENVIRONMENTAL RISK IN THE WATER COLUMN DURING DRILLING OF THE RISERED SECTIONS AT DISCHARGE POINT 1 FOR ALL THE SEASONS

Source: Livas 2022a

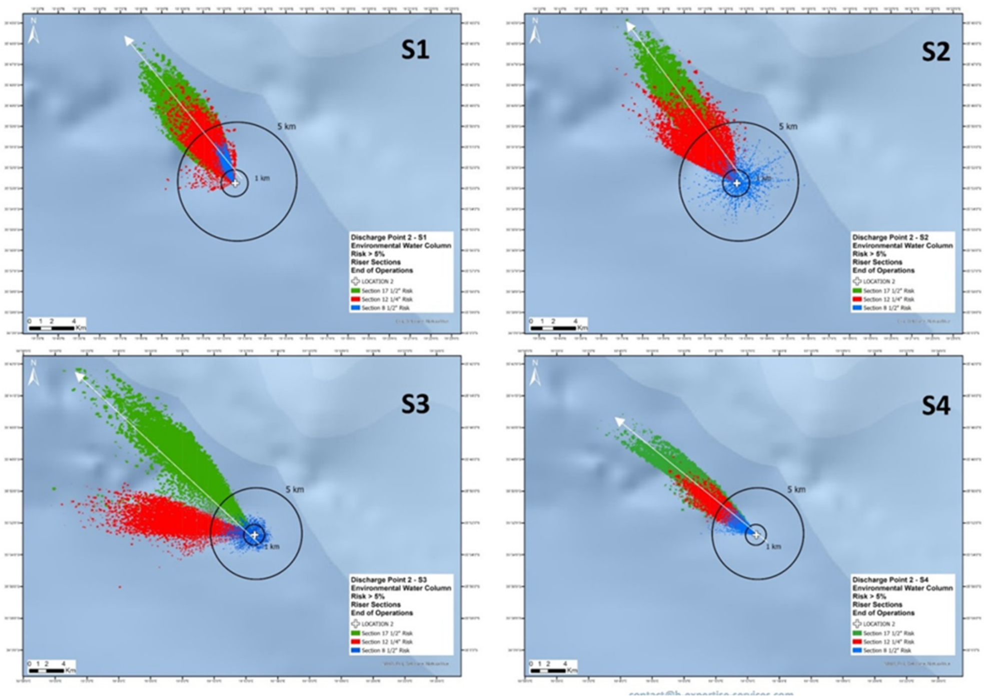


FIGURE 9-12: CUMULATIVE SIGNIFICANT ENVIRONMENTAL RISK IN THE WATER COLUMN DURING DRILLING OF THE RISERED SECTIONS AT DISCHARGE POINT 2 FOR ALL THE SEASONS

Source: Livas 2022a

Conclusions on drilling fluid toxicity

The overall conclusion drawn from toxicity tests around the world 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 noted above barite, most abundant ingredient in WBMs and NADFs, is insoluble and non-biodegradable. Other additives in WBMs are only mildly toxic to marine life, but are present in such low concentrations that evidence of long-lasting ecological impacts is lacking. Thus, the toxicity effects of WBM are negligible. NADFs, however, constitute a higher risk of chemical toxicity due to components such as fatty acids. The most toxic additives include diesel fuel (in some NADFs), corrosion inhibitors, detergents, defoamers, and emulsion breakers, but are usually not present in concentrations high enough to contribute significantly to whole mud toxicity. 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 oil (Group III NADFs, as proposed by TEEPSA) are the least toxic.

Many field monitoring studies have been performed since the 1970s to determine short- and long-term impacts of drilling discharges on the marine environment. Many monitoring studies 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 & Gray 1995; Bakke *et al.* 2013), and persisting over the long term (>15 years) (OSPAR 2008; Daan *et al*. 2006; Bakke *et al.* 2013; Henry *et al*. 2017), although recovery of benthos can start within just a few years post-drilling (Tait *et a*l. 2016). This compares well with the modelling results undertaken for the current project, which predicted that the environmental risk of contaminants in the sediments from the risered sections extends to a maximum 5 km from the well site and persists beyond 10 years after operations.

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) and the effects of these muds are restricted primarily to the seabed in the immediate vicinity of the drilling unit and for a short distance down current from the discharge (OSPAR 2008). 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.

In assessing this impact, it is important to note that the sediment plume in the water column and depositional footprint on the seabed are directed away from the 'critically endangered' Brown's Bank Rocky Shelf Edge by the prevailing currents, but potentially overlap with the 'Vulnerable' Cape Canyon habitat. Similarly, the sediment plume and depositional footprint may overlap with the CBAs in the area of interest depending on the location of the well(s). The depositional footprint is also highly localised, and concentrations of total discharge in the superficial layers of seabed sediments do not overlap with these sensitive ecosystem types. Benthic and demersal species that spawn, lay eggs or have juvenile life stages dependent on the seafloor habitat (e.g., hake and kingklip) may be negatively affected by smothering effects. However, the major fish spawning areas occur further inshore on the shelf to the east of the area of interest and beyond the chemical footprint (see Figure 7-23). Although the cuttings plume is directed in a NW direction and away from inshore spawning grounds of key commercial species (e.g., hake, anchovy and sardine), there is some overlap with egg and larval distribution of these species in the inshore portion of the area of interest only.

The potential toxic effects of drilling muds on benthic communities and associated food chain, or the potential for bioaccumulation of mud constituents, is considered of **low intensity** for unconsolidated sediments and **high intensity** for sensitive and potentially vulnerable habitats in the CBAs or the EBSA to the north of the area of interest could be impacted, although most of the chemical constituents are biodegradable or rapidly dilute in the receiving water. The intensity of the impact on the water column is considered to be of **medium intensity**, as it overlaps with the egg and larval distribution of hake (see Figure 7-24), anchovy and sardine (see Figure 7-25). The maximum cumulative risk throughout the entire water column would, however, remain **localised** (*i.e*. riserless: confined to a maximum distance of 52 km from the well site in the direction of the prevailing current (NW) to a maximum of 20 m above and 10 m below the modelled discharge point, following the seabed slope; risered: confined to a maximum distance of 25.6 km in a NW direction). Releases of chemical constituents are pulsed, with those above the Predicted No Effect Environmental Concentration (PNEC) persisting for only a few hours during the risered drilling stages and, therefore, not influencing benthic communities. Chemicals released during the risered drilling stages and adsorbed onto the cuttings contribute minimally to the environmental risk to the water column as most of the NADF is recycled. For example, the high toxicity INVERMUL NT and EZ MUL NT contribute only 3-8% to the total environmental risk (depending on the season) due to the low quantities used in the NADFs. Rapid dilution of these constituents ensures that impacts would persist only over the **short-term** in the water column (i.e. rapidly diluted and dispersed (few hours) and are not extending beyond the 28 days required for the drilling of the base case). However, the impact persists in the sediments for up to 10 years to a distance of 1.5 - 2.1 km (depending on discharge point and season) in a NW direction. Thus, the duration for sediment toxicity is **long-term**.

Thus, for both drilling stages, the **magnitude** (or consequence) of the potential toxicological impacts of drilling fluids on sediments is considered **high** for up to five wells regardless of season, but **very low** for the water column.

Impact Significance

In unconsolidated sediments, based on the **low sensitivity** of receptors and the **low magnitude**, the potential impact on the marine benthic biota is considered to be of **very low significance**.

On hardgrounds, based on the **high sensitivity** of receptors and the **high magnitude**, the potential impact on the marine benthic biota is considered to be of **high significance**.

In the water column, based on the **low sensitivity** of receptors and the **very low magnitude**, the potential impact on the marine benthic biota is considered to be of **negligible significance**.

Identification of Mitigation Measures

In addition to the measures recommended to avoid of vulnerable hardground habitats (see Section 9.2.2.1.1), the following measures will be implemented to reduce the toxicity and bioaccumulation effects on marine fauna:

No.	Mitigation measure	Classification
1	Ensure only low-toxicity, low bioaccumulation potential and partially biodegradable additives are used in drilling fluid and cement.	Avoid/reduce at source
2	Maintain a full register of Material Safety Data Sheets (MSDSs) for all chemical used, as well as a precise log file of their use and discharge.	Reduce at source/Abate on site

No.	Mitigation measure	Classification
3	If NADFs are used for drilling the risered sections, ensure regular maintenance of the onboard solids control package and avoid inappropriate discharge of NADF cuttings.	Reduce at source/Abate on site
4	Monitoring requirements: • Test drilling fluids for toxicity, barite contamination and zero oil content (for WBM) and less than 6% (for NADF) to ensure the specified discharge standards are maintained. • Monitor (using ROV) cement returns and if significant discharges are observed on the seafloor terminate cement pumping. • Monitor (using ROV) hole wash out to reduce discharge of fluids as far as possible.	Reduce at source/Abate on site

Residual Impact Assessment

This potential impact cannot be eliminated due to the nature of the drilling approach and the necessity for the use of WBM and NADFs in the drilling process. With the implementation of the mitigation measures, the residual impact on marine fauna will have a lower intensity, and the significance will reduce to **NEGLIGIBLE significance** (unconsolidated sediments) and **MEDIUM significance** (hardgrounds), but remains of **NEGLIGIBLE significance** for the water column.

Additional Assessment Criteria

The impact is **fully reversible** (water column and unconsolidated sediments) **to partially reversible** (hardground substrates) after drilling operations cease. The loss of resource is **low** with mitigation and the cumulative potential is **possible** due to the long-term duration of the impacts. As pre-drilling ROV surveys would reveal the presence of hardgrounds, which would be actively avoided during siting of wells, the likelihood of an impact is reduced to **unlikely**.

TABLE 9-14: BIOCHEMICAL IMPACT OF DRILLING FLUID AND CEMENT ON UNCONSOLIDATED SEDIMENT BIOTA

Project Phase:	Operation	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	LOW	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	LOW	VERY LOW
Intensity	LOW	VERY LOW
Extent	LOCAL	LOCAL
Duration	LONG TERM	LONG TERM
Significance	VERY LOW	NEGLIGIBLE
Probability	HIGHLY LIKELY	HIGHLY LIKELY
Confidence	HIGH	HIGH
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	LOW
Cumulative potential	POSSIBLE	POSSIBLE

TABLE 9-15: BIOCHEMICAL IMPACT OF DRILLING FLUID ON HARDGROUND SUBSTRATE BIOTA

Project Phase:	**Operation**	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**HIGH**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**HIGH**	**MEDIUM**
Intensity	HIGH	MEDIUM
Extent	LOCAL	LOCAL
Duration	LONG TERM	LONG TERM
Significance	**HIGH**	**MEDIUM**
Probability	**UNLIKELY**	**UNLIKELY**
Confidence	**HIGH**	**HIGH**
Reversibility	**PARTIALLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**MEDIUM**
Cumulative potential	**POSSIBLE**	**POSSIBLE**

TABLE 9-16: BIOCHEMICAL IMPACT OF DRILLING FLUID AND CEMENT ON MARINE ORGANISMS IN THE WATER COLUMN

Project Phase:	**Operation**	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**LOW**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	MEDIUM	LOW
Extent	LOCAL	LOCAL
Duration	SHORT TERM	SHORT TERM
Significance	**NEGLIGIBLE**	**NEGLIGIBLE**
Probability	**POSSIBLE**	**POSSIBLE**
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**LOW**
Cumulative potential	**UNLIKELY**	**UNLIKELY**

9.2.2.1.3 Increased water turbidity and reduced light penetration on marine ecology

Impact Magnitude (or Consequence)

The discharge of cuttings will result in changes in water turbidity in the vicinity of the discharge point, which could reduce light penetration through the water column with potential adverse effects on the photosynthetic capability of phytoplankton and the foraging efficiency of visual predators.

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 Section 9.2.2.1.1). 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. Indirect impacts to the water column arising from the dispersed and settling cuttings include changes in water turbidity in the vicinity of the discharge point. Increased turbidity may limit light penetration thereby negatively affecting primary productivity of phytoplankton communities.

The model results identified that the maximum cumulative risk throughout the entire water column would be as follows for the two drilling phases:

- Riserless: risk is confined to a maximum distance of 52 km from the well site in the direction of the prevailing current (NW) to a maximum of 20 m above and 10 m below the discharge point, following the seabed slope.
- Risered: risk confined to a maximum distance of 25.6 km in a NW direction.

The risk in the water column is pulsed, corresponding to the various drilling stages and ceases once operations have been completed. The variation in current direction between the scenarios modelled, however, result in different directional spreads of the turbidity plume, although the NW and WNW directions are the most dominant.

Although turbid water is a natural occurrence along the southern African coast (resulting from aeolian and riverine inputs, re-suspension of seabed sediments in the wave-influenced nearshore areas and seasonal phytoplankton production in the upwelling zones), further offshore, in the area of interest, surface waters tend to be clearer and less productive as they are beyond the influence of coastal upwelling. Consequently, the major spawning areas are all located on the continental shelf, these being inshore of the area of interest (see Figure 7-23). However, seasonally high abundances of ichthyoplankton (hake, sardine and anchovy eggs and larvae), particularly in late winter and early spring may occur in the inshore portions of the area of interest (see Figure 7-24 and Figure 7-25). By avoiding the major spawning areas and the rapid dilution and widespread dispersion of settling particles, any adverse effects in the water column would be ephemeral and localised and short-term. Thus, any potential effects on phytoplankton and ichthyoplankton production, fish migration routes and spawning areas, or on benthic and demersal species in the area would be negligible.

Increased turbidity of near-bottom waters through disposal of cuttings at the wellbore and below sea surface 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. However, in most cases sub-lethal or lethal responses occur only at concentrations well in excess of those anticipated at the wellbore.

The impact of increased turbidity in the water column and elevated suspended sediment concentrations will thus be comparatively **localised** (within a distance of 25.6 km (surface) and 52 km (seafloor) of the well site), of **low**

intensity (as concentrations are expected to be sublethal and would be easily tolerated by marine fauna), over the very **short term** (days). The biochemical impact of reduced water quality through increased turbidity is thus considered of **very low magnitude** (or consequence).

Impact Significance

Due to the low sensitivity of the receptors expected in the offshore pelagic and soft-sediment benthic environment and the very low magnitude, the impact is deemed to be of **negligible significance**. In the case of benthic communities from deep-water hardgrounds, the sensitivity to increased turbidity is also considered to be low, despite their high sensitivity to physical disturbance. The impact of increased turbidity on deep-water reef communities is therefore also deemed to be of **negligible significance**.

Identification of Mitigation Measures

No mitigation measures for potential indirect impacts on the water column are proposed or deemed necessary, in additional to the project controls.

Residual Impact Assessment

This potential impact cannot be eliminated due to the necessity of disposal of drill cuttings and thus remains of **NEGLIGIBLE significance**.

Additional Assessment Criteria

The impact is **fully reversible** after drilling operations cease. The loss of resource is **low** with mitigation and the cumulative potential is **unlikely**.

TABLE 9-17: IMPACTS OF DRILL CUTTINGS DISCHARGE ON WATER COLUMN AND BOTTOM-WATER BIOCHEMISTRY (TURBIDITY AND LIGHT)

Project Phase:	**Operation**	
Type of Impact	**Indirect**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**LOW**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	LOW	LOW
Extent	LOCAL	LOCAL
Duration	SHORT TERM	SHORT TERM
Significance	**NEGLIGIBLE**	**NEGLIGIBLE**
Probability	**UNLIKELY**	**UNLIKELY**
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	-	-
Cumulative potential	**UNLIKELY**	**UNLIKELY**

9.2.2.1.4 *Reduced physiological functioning of marine organisms due to indirect biochemical effects in the sediments*

Impact Magnitude (or Consequence)

A further indirect impact (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.

Generally speaking, biodegradable organic matter in cuttings piles can have a greater effect on the structure and function of benthic communities than sediment texture, deposition rate or, in some cases, chemical toxicity (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 & 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 & Rosenberg 1978; Gray *et al.* 2002; Tait *et al.* 2016). 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 benthic communities.

WBM and NADF cuttings 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. Similarly, the NADF typically degrade rapidly and only cause localised hypoxia in underlying sediments (EPA 2000; OGP 2003).

Marine organisms respond to hypoxia in various different ways which can result in reduced growth and feeding, and may eventually affect individual fitness. More mobile species will be able to actively avoid hypoxia, although this may render them more vulnerable to predation. However, hypoxia may eliminate relatively immobile or sedentary benthic species, thereby changing the species composition of the community.

Development of anoxic conditions beneath deposited cuttings discharged on the seafloor is highly unlikely due to the low deposition thicknesses (less than 0.5mm) predicted in the cuttings fallout footprint for distances beyond approximately 650 m (Discharge 1) and 205 m (Discharge 2) from the well location and because no oxygen-scavenging chemicals will be discharged (Livas 2022a). Thus, any potential deep-water hardground habitats occurring beyond 650 m from a well site are unlikely to be impacted.

Should anoxic conditions develop, these are likely to be limited to the area of maximum deposit thickness of the cuttings pile around the wellbore (**site specific**), where they would have an impact of **low intensity** on the benthic macrofauna (as deep-water soft-sediment communities typically show a degree of tolerance to hypoxic sediment conditions), with recovery expected over the **short term** (within a few months) due to bioturbation. The impact is thus considered to be of **very low magnitude** (or consequence).

Impact Significance

Due to the low sensitivity of the receptors expected and the very low magnitude, the impact is deemed to be of **negligible significance**.

Identification of Mitigation Measures

Refer to measures recommended to avoid of vulnerable hardground habitats (see Section 9.2.2.1.1). No additional mitigation is considered necessary.

Residual Impact Assessment

This potential impact cannot be eliminated due to the necessity of disposal of drill cuttings. Although the intensity reduces to very low, the impact remains of **NEGLIGIBLE significance**.

Additional Assessment Criteria

The impact is **fully reversible** after drilling operations cease. The loss of resource is **low** with mitigation and the cumulative potential is **unlikely**.

TABLE 9-18: IMPACT ON BENTHIC COMMUNITIES DUE TO BIOCHEMICAL EFFECTS RELATED TO THE DEVELOPMENT OF ANOXIC SEDIMENTS

Project Phase:	**Operation**	
Type of Impact	**Indirect**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**LOW**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	LOW	VERY LOW
Extent	SITE	SITE
Duration	SHORT TERM	SHORT TERM
Significance	**NEGLIGIBLE**	**NEGLIGIBLE**
Probability	**POSSIBLE**	**POSSIBLE**
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**LOW**
Cumulative potential	**UNLIKELY**	**UNLIKELY**

9.2.2.1.5 Summary of the Risks to Sensitive Habitats from Drilling Discharges

The greatest risk of drill cuttings discharge on marine communities is that of smothering. Cuttings discharged at the seabed during the spudding of a well form a highly localised spoil mound around the wellbore, thinning outwards. In contrast, the cuttings discharged at the surface from the drilling unit form two plumes. The larger particles and flocculated solids, which constitute approximately 90% of the discharge, settle to the seabed nearest the wellbore while the fine-grained unflocculated solids and soluble components of the mud 10% of the discharge) are rapidly diluted in the receiving waters and are dispersed in the water column at increasing distances from the drill unit.

In the high energy environment of Block 5/6/7, strong surface currents will rapidly dispersed and redistributed drilling solids discharged at the surface. The accumulation of drilling discharges on the seabed from surface discharges will, therefore, be minimal and any adverse smothering effects on benthic community composition will be difficult to detect above the natural variability. Nonetheless, the benthos of deep-water hard substrata such as those occurring on the Southeast Atlantic Slope Seamount, Brown's Bank Rocky Shelf Edge habitat and potentially in the CBAs and submarine canyon systems off the shelf edge within the area of interest for drilling, are considered highly sensitivity and potential smothering effects on these biota need to be considered when planning well locations.

The first point to consider is that the area if interest does not overlap directly with any offshore MPAs or EBSAs. Furthermore, drilling discharge modelling study considered the worst-case scenario with regard to sensitive area. Modelling results indicate that the maximum sediment thickness observed at the wellbore is 141 cm (Discharge Point 1: Season 2), with the maximum distance with a significant environmental risk to the sediments (thickness deposits and grain size variation) above 5% extending as far as 5 km from the Discharge Point 1 (Season 1) in a NW direction and therefore away from sensitive habitats and across a highly localised area of Southeast Atlantic Upper Slope ecosystem type characterised by Southeast Atlantic Unclassified Slope unconsolidated substratum, which has been assigned a threat status of 'Least Concern'. The environmental risk from the discharged drilling solids is primarily due to changes to the natural grain size distribution of the receiving sediments, with risks persisting beyond 10 years after the end of drilling operations. This, however, is a conservative estimate as it did not take into account any reworking of the impacted sediments through bioturbation, or resuspension or background sediment transport due to the Benguela Current. Physical recovery of the sediments is thus likely to occur much faster thereby facilitating rapid recolonisation and recovery of the benthic community structure to functional similarly with those originally present.

Significant environmental risk with the water column, due to the release of barite used in the drilling of the riserless sections, was observed up to maximum distance of 52 km to the NW from Discharge Point 1 (Season 3) and 8.5 km to the NW from Discharge Point 2 (Season 2). The risk is confined to <20 m above and <10 m below the discharge point following the seabed slope. Depending on the location of the well, the environmental risk to the near-bottom water column could thus extend into the Southeast Atlantic Unclassified Slope unconsolidated substratum protected by the CBA. However, this habitat type has been assigned a threat status of 'Least Concern'. Seasonal effects in the length, height and spread of the contaminant plume during riserless drilling are evident, but the contaminant risk does not extend as far as sensitive areas. The Cape Canyon and Associated Islands EBSA and its associated CBAs, which lie approximately 80 km north of the area of interest, lie at the outer limits of the risk. In contrast, chemicals released at the surface through discharge of drilling wastes during the risered stages are rapidly diluted and dispersed (few hours) and are not detectable beyond the cessation of drilling operations. For both modelled discharge locations, the chemical footprints are directed in a NW direction away from the sensitive habitats and lie well offshore and at a considerable distance from sensitive spawning areas.

9.2.2.2 Impact of Cuttings, Drilling Fluid and Cement Discharge on Fisheries

Potential Impact Description

The discharge of drill cuttings, drilling fluids and residual cement will result in the physico-chemical disturbance of the seabed sediments and accumulation on the seabed, as well as result in an increase of sediment in the water column with potential toxic effects (see Section 9.2.2.1 for the assessment of faunal impacts). The effects of sediment deposition at the seabed extend to potential smothering of and toxic effects on benthic communities and associated trophic level cascade effects which could affect normal feeding patterns of certain fish species. This could have an impact on commercial fisheries that operate in the area through the reduction in catch rates and/or an increase in fishing effort (**indirect negative** impact). The impact assessment is summarised in Table 9-19.

In order to assess these impacts the expected fall and spatial extent of the deposition of discharged cuttings was investigated in the Drilling Discharges Modelling Study (see Appendix 6 and Appendix 9 in Volume 2) and discussed in Section 9.2.2.1.

Project Controls

Refer to Section 9.2.2.1.

Sensitivity of Receptors

The drilling activities would be undertaken in the offshore marine environment more than 60 m offshore. The fishing sectors that could be affected by the discharge of drill cuttings are those that operate within or adjacent to the area of interest, namely demersal trawl, demersal longline, large pelagic long-line and tuna pole. The sensitivity of these sectors to cuttings discharge is considered to be **low**, as fishing gear would not be impacted and activity could continue in adjacent areas.

The sediment plume (NW direction) is unlikely to overlap with the fishing grounds of the midwater trawl, small pelagic purse-seine, West Coast rock lobster, South Coast rock lobster, traditional linefish, squid jig and small-scale fisheries. Thus, there is unlikely to be an impact on these sectors due to cuttings discharge.

The majority of the area of interest for drilling is situated in an ecosystem type rated by SANBI as of “Least Concern”. Identified Critical Biodiversity Areas (CBAs) do, however, occur within the area of interest for drilling, covering 5.4% (558 km^2) of the area of interest outside of the ammunition dump. The biodiversity features specifically protected by these CBAs include spawning areas for certain fish and areas of high anchovy egg density. Seasonally high abundances of ichthyoplankton (hake eggs and larvae), particularly in late winter and early spring, may occur in the inshore portions of the area of interest. The overall sensitivity of fisheries recruitment receptors is considered **low**.

Impact Magnitude (or Consequence)

The results of the Drilling Discharges Modelling Study are summarised in Section 9.2.2.1 and are not repeated here.

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 (e.g., hake, kingklip, squid; all of which spawn inshore of the area of interest for drilling) may be negatively affected by the smothering effects of drill cuttings. However, the major fish spawning occurs further inshore on the shelf (see Figure 7-23). Although the depositional footprints are unlikely to coincide with the spawning areas for hake, seasonally high abundances of ichthyoplankton (hake eggs and larvae), particularly in late winter and early spring, may occur in the inshore portions of the area of interest. Although there is this small possibly of overlap, 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 are considered to be negligible.

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. Although the impact intensity on benthic biota communities is considered to range from medium (unconsolidated sediments) to high (see Section 9.2.2.1), the impact on fishing in and adjacent to the area of interest is of **low intensity**. The maximum cumulative risk on the seabed and throughout the entire water column would remain **localised** (i.e. 5 km from the drilling unit per well for smothering risk to 52 km for potential toxic effects in the direction of the prevailing current, north-westerly). Rapid dilution (few hours) of these constituents ensures that impacts would persist only over the **short term** (i.e. not extending beyond the 28 days required for required for the drilling of the base case).

The **magnitude** (or consequence) of the impacts of drilling fluids on fishing is thus considered **very low** for up to five wells regardless of season.

Impact Significance

Due to the low sensitivity of the receptors expected in the new drill area and the very low magnitude, the impact is deemed to be of **negligible significance** (see Table 9-19).

Identification of Mitigation Measures

Refer to measures recommended to avoid of vulnerable hardground habitats and reduce the toxicity and bioaccumulation effects on marine fauna (see Section 9.2.2.1.1 and 9.2.2.1.2, respectively). No additional mitigation is considered necessary.

Residual Impact Assessment

This potential impact cannot be eliminated due to the necessity of disposal of drill cuttings. The residual impact remains of **NEGLIGIBLE significance** (see Table 9-19).

Additional Assessment Criteria

The impact is **fully reversible** after drilling operations cease. The loss of resource is **low** with mitigation and the cumulative potential is **unlikely** due to the rapid dilution of constituents.

TABLE 9-19: IMPACT ON THE FISHING INDUSTRY DUE TO THE DISCHARGE OF WELL DRILL CUTTINGS

Project Phase:	**Operation**	
Type of Impact	**Indirect**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**LOW**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	LOW	LOW
Extent	LOCAL	LOCAL
Duration	SHORT TERM	SHORT TERM
Significance	**NEGLIGIBLE**	**NEGLIGIBLE**
Probability	**POSSIBLE**	**POSSIBLE**
Confidence	**MEDIUM**	**MEDIUM**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**VERY LOW**
Cumulative potential	**UNLIKELY**	**UNLIKELY**

9.2.3 Generation of Underwater Noise

Source of Impact

The project activities that will result in an increase in underwater ambient noise levels are:

Exploration Phase	Project phase	Activity
Drilling	Mobilisation	Transit of drilling unit and support vessels to drill site
	Operation	Operation of drilling unit and support vessels at the drill site
		Transit of support /supply vessels between the drilling unit and port
		Vertical seismic profiling (VSP) of the well
	Demobilisation	Transit of drilling unit and support vessels from drill site

These activities are described further below:

- The presence and operation of the drilling unit and support vessels will introduce a range of underwater noises from their engines into the drilling site surrounding water column that may potentially contribute to and/or exceed ambient noise levels in the area. For non-impulsive noise, overall noise level from combined noise emissions from the drilling unit and two support vessels (worst-case) is approximately 198.1 dB re 1 µPa @ 1m (or dB re 1 µPa2·S @ 1m) (SLR 2022).
- Vertical seismic profiling (VSP) is a standard method that may be used during well logging and can generate noise that could exceed ambient noise levels. VSP source generates a peak sound pressure level (Pk SPL) of 242.2 dB re 1µPa at 1 m, a peak to peak sound pressure level (Pk-Pk SPL) of 248.0 dB re 1 µPa @ 1m, a root-mean-square sound pressure level (RMS SPL) of 238.3 dB re 1 µPa @ 1m, and a sound exposure level (SEL) 223.8 dB re µPa2·s @ 1m. 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 up to nine hours per well to complete to complete approximately 250 shots, depending on the well's depth and number of stations being profiled.

9.2.3.1 Impact on Marine Fauna

Potential Impact Description

Project activities will increase the ambient noise levels in the vicinity of the drilling site and project vessels in transit to and from the site. Elevated noise levels could impact marine fauna by:

- Causing direct physical injury to hearing or other organs (**direct negative** impact), including permanent (PTS)[54] or temporary threshold shifts (TTS)[55];
- Causing disturbance to the receptor resulting in behavioural changes or displacement from important feeding or breeding / spawning areas (**direct negative** impact).
- Masking or interfering with other biologically important sounds (e.g., communication, echolocation, signals and sounds produced by predators or prey) (**indirect negative** impact).

In order to assess these impacts an Underwater Noise Modelling study was undertaken (see Appendix 8 in Volume 2). A summary of these results is presented and discussed below. The impact assessment is summarised in Table 9-21 and Table 9-23.

9.2.3.1.1 Impact of Vessel and Drilling Noise on Marine Fauna

Project Controls

TEEPSA and the drilling contractor will ensure that the proposed exploration activities are undertaken in a manner consistent with good international industry practice and BAT.

All whales and dolphins are given protection under South African Law. The Marine Living Resources Act, 1998 (No. 18 of 1998) states that no whales or dolphins may be harassed, killed or fished. No vessel may approach closer than 300 m to any whale and a vessel should move to a minimum distance of 300 m from any whales if a whale surfaces closer than 300 m from a vessel.

Sensitivity of Receptors

Vessel noise would primarily take place in the area of interest and along the route taken by the support vessels between the drilling unit and port. The area of interest is located approximately 60 km offshore at its closest point and far removed coastal MPAs and any sensitive coastal receptors. The licence area (not drill area) does, however, overlap with the Southeast Atlantic Seamounts and Brown's Bank offshore MPAs and Brown's Bank, Protea Seamount Cluster and Cape Canyon and associated Islands, Bays and Lagoon EBSAs. Although higher productivity and localised shelf-edge upwelling occurs within Block 5/6/7, it occurs inshore and to the north of the area of interest for drilling. Thus, surface waters tend to be clearer and less productive as they are beyond the influence of coastal and shelf-edge upwelling. Furthermore, being dependent on nutrient supply, plankton

[54] A permanent threshold shift is a permanent shift in the auditory threshold, which results in permanent hearing loss.
[55] A temporary threshold shift is a temporary shift in the auditory threshold, which results in temporary hearing loss.

abundance is typically spatially and temporally highly variable and is thus considered to have a **low** sensitivity. The major spawning areas are also all located on the continental shelf, inshore of the area of interest (see Figure 7-23). Seasonally high abundances of ichthyoplankton (hake, sardine and anchovy eggs and larvae), particularly in late winter and early spring may, however, occur in the inshore portions of the area of interest (see Figure 7-24 and Figure 7-25).

Migratory pelagic species transiting through the drill area may be directly affected. The taxa most vulnerable to disturbance by underwater noise are turtles, and large migratory pelagic fish and marine mammals. Some of the species potentially occurring in the drill area, are considered regionally or globally 'Critically Endangered' (e.g., southern bluefin tuna, leatherback turtles and blue whales), 'Endangered' (e.g., Black-Browed and Yellow-Nosed Albatross, whale shark, shortfin mako shark, fin and sei whales), 'Vulnerable' (e.g., bigeye tuna, blue marlin, loggerhead turtles, oceanic whitetip shark, dusky shark, great white shark, longfin mako and sperm whale, Bryde's and humpback whales) or 'near threatened' (e.g., striped marlin, blue shark, longfin tuna/albacore and yellowfin tuna). Although species listed as 'Critically Endangered' or 'Endangered' may potentially occur in the drill area, the drill area is located in a main marine traffic route and thus is in an area already experiencing increased marine traffic and vessel noise. Thus, the sensitivity of receptors to vessel and drilling noise is considered to be **medium**.

Impact Magnitude (or Consequence)

The ocean is a naturally noisy place and marine animals are continually subjected to sounds from physical 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 (McCauley 1994; Duarte *et al.* 2021). 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 be expected to interfere directly or indirectly with such activities affecting the physiology and behaviour of marine organisms (NRC 2003). Of all human-generated sound sources, the most prevalent in the ocean is the noise of shipping. A comparison of the various noise sources in the ocean is shown in Figure 9-13.

As Block 5/6/7 is located within the main offshore shipping routes that pass around southern Africa (see Figure 7-93), the shipping noise component of the ambient noise environment is expected to be significant within and around the area of interest (OceanMind Limited 2020). Given the significant local shipping traffic and relatively strong metocean conditions specific to the area, ambient noise levels are expected to be 90–130 dB re 1 μPa for the frequency range 10 Hz – 10 kHz (SLR 2022).

The overall noise level generated by **drilling operations on site** (drill rig and support vessels) is approximately 198 dB re 1 μPa @ 1m, and thus falls within the hearing range of most fish and marine mammals. Thus, the underwater noise from well drilling operations may induce localised behavioural changes or masking of biologically relevant sounds in some marine fauna. 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.

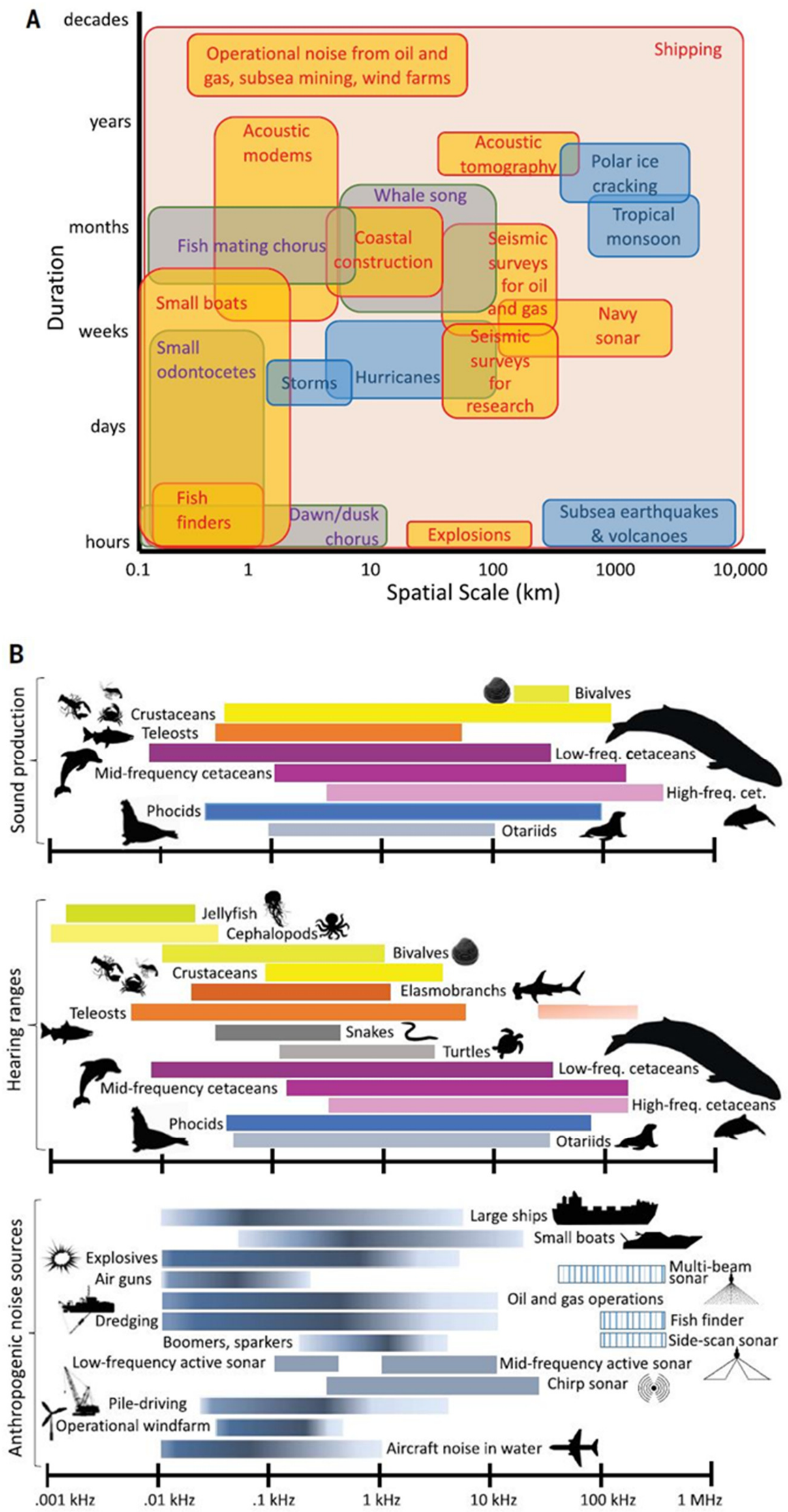


FIGURE 9-13: SOURCES AND ANIMAL RECEIVERS OF SOUND IN THE OCEAN. A) SPATIAL EXTENT AND DURATION OF SELECTED SOUND PRODUCING EVENTS, AND B) APPROXIMATE SOUND PRODUCTION AND HEARING RANGES OF MARINE TAXA AND FREQUENCY RANGES OF SELECTED ANTHROPOGENIC SOUND SOURCES

Source: Duarte et al. 2021

Physical injury

Based on the noise exposure criteria provided by Southall *et al.* (2019), the Underwater Noise Modelling study (SLR 2022; Appendix 8 in Volume 2) estimates the zones of **cumulative impact for 24 hours exposure duration leading to potential TTS and PTS do not extend beyond 4.25 km and 230 m from the drill site, respectively** (see Table 9-20), with low frequency cetaceans (i.e. mysticetes: southern right, humpback, sei, fin, blue, Bryde's, minke) showing the highest sensitivity. However, as most pelagic species likely to be encountered within the licence area are highly mobile, they would be expected to move away from the sound source before trauma could occur. **With a decreased exposure of 0.5 hours, the zones of impact would be significantly reduced, with TTS- and PTS-onset zones within 330 m and 30 m, respectively**. 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 PTS-onset thresholds.

Based on the noise exposure criteria provided by Popper *et al.* (2014), the Underwater Noise Modelling study predicts that TTS may occur at close range for **sea turtles** and **fish species** with swim bladders involved in hearing, at a **maximum threshold distance of 170 m from the source for 12h** (see Table 9-20). The threshold limit is not reached for fish species lacking swim bladders or where the swim bladders are not involved in hearing. The non-impulsive stationary drilling operation noise, therefore, has very low physiological impacts (both mortality and recovery injury) on fish and sea turtle species.

The area of interest lies on the western extent of the gannet and penguin foraging areas (see Figure 7-32), and overlaps with the distributions of a number of pelagic seabirds. As the area of interest lies offshore of the distribution of small pelagic fish species that constitute the main prey of these seabirds, numbers are expected to be low.

Due to their extensive distributions, the numbers of pelagic species (large pelagic fish, 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 intensity of potential physiological injury as a result of drilling and vessel noise would be rated as **low**.

Behavioural Avoidance

The underwater noise from well drilling operations 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). Research has found that the responses of cetaceans to noise sources are often 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 & 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).

The Underwater Noise Modelling study predicts that non-impulsive noise from drilling activities could result in **behavioural disturbance in cetaceans to distances of between 59.7 km and 66.2 km**[56]. This implies that whales such as Humpback and Southern Right whales migrating and/or breeding along the South- West Coast may be affected by the vessel and drilling noise as this is likely to extend to the shore. This potential behavioural disturbance must, however, be seen in context with the high ambient noise expected in the area of interest due to its location within the main shipping routes around southern Africa. The intensity of the impact of potential behavioural disturbance as a result of drilling and vessel noise on cetaceans is considered to be **low**.

Continuous noise of any level that is detectable by fishes or sea turtles can mask signal detection, and thus may have a pervasive effect on their behaviour. According to Popper *et al*. (2014), for non-impulsive noise sources in general, relatively high to moderate behavioural risks are expected for fish species at near to intermediate distances (tens to hundreds of meters) from the source location. Relatively low behavioural risks are expected for fish species at far field distances (thousands of meters) from the source location. The major spawning areas, as well as egg and larval drift pathways of commercially important species, such as hake, pilchards, horse mackerel and anchovy lie inshore of the area of interest for drilling, and are unlikely to be impact by the behavioural disturbance zone. Thus, the intensity of the impact on fish and turtles is considered to be **low**.

As noted above, the area of interest for drilling lies on the western extent of the gannet and penguin foraging areas and numbers are expected to be low. The area does, however, overlap with the distributions of a number of pelagic seabirds.

TABLE 9-20: SUMMARY OF THE MAXIMUM ZONES OF IMPACT FOR VESSEL AND DRILLING NOISE

<table>
<tr><th rowspan="2">Animal Type</th><th rowspan="2" colspan="2">Drilling activities</th><th colspan="4">Maximum threshold distances, m</th></tr>
<tr><th>PTS onset</th><th>TTS onset</th><th colspan="2">Behavioural disturbance</th></tr>
<tr><td rowspan="3">Marine mammals</td><td colspan="2">Drilling – immediate behavioural impact</td><td>-</td><td>-</td><td colspan="2">66 200 m</td></tr>
<tr><td>Drilling – cumulative</td><td>24 hr</td><td>230 m</td><td>4 250 m</td><td colspan="2" rowspan="2">-</td></tr>
<tr><td>Drilling – cumulative</td><td>0.5 hr</td><td>30 m</td><td>330 m</td></tr>
<tr><td rowspan="2">Fishes and sea turtles</td><th colspan="2">Drilling activities</th><th>Mortality and potential mortal injury</th><th>Recovery injury</th><th>TTS</th><th>Behavioural disturbance - sea turtles only</th></tr>
<tr><td colspan="2">Drilling – cumulative</td><td>-</td><td>40 m for 48h</td><td>170 m for 12h</td><td>-</td></tr>
<tr><td colspan="7">Note: A dash indicates the threshold is not applicable.</td></tr>
</table>

[56] The zones of impact for drilling and vessels are larger than that for VSP (see Section 9.2.3.1.2). Firstly, it is important to understand that these are two different types of noise, VSP is impulsive and drilling is non-impulsive. Secondly, the noise criteria (thresholds) to measure the impact on animals are different for each type of noise. Finally, in the case of VSP, the cumulative sound exposure is based on 250 spaced pulses, while in the drilling scenario, the cumulative exposure is based on 24 hours of continuous noise.

Magnitude

Due to their extensive distributions, the numbers of pelagic species (large pelagic fish, turtles and cetaceans) encountered during the proposed 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 **intensity** of potential injury or behavioural disturbance as a result of drilling and vessel noise is rated **low**. Furthermore, the area of interest is located in a main marine traffic route and thus is in an area already experiencing increased marine traffic and vessel noise. The duration of the impact would be limited to the **short-term** (3-4 months per well) and extend **locally** (behavioural disturbances would be expected up to 66 km from the drill site). The potential physiological injury or behavioural disturbance as a result of drilling and vessel noise would thus be of **very low magnitude** (or consequence) for up to five wells and all onshore logistic base alternatives.

Impact Significance

Based on the **medium sensitivity** of receptors and the **very low magnitude**, the potential impact on the marine fauna is considered to be **very low significance** without mitigation.

Identification of Mitigation Measures

The following measures will be implemented to reduce noise at the source:

No.	Mitigation measure	Classification
1	Implement a maintenance plan to ensure all diesel motors and generators receive adequate maintenance to minimise noise emissions.	Avoid/reduce at source
2	Ensure vessel transit speed between the drill site and port is a maximum of 12 knots (22 km/hr), except within 25 km of the coast where it is reduced further to 10 knots (18 km/hr).	Avoid/reduce at source

Residual Impact Assessment

The generation of noise from drilling and project vessels cannot be eliminated. Despite mitigation, the intensity, extent or duration of the impact remains unchanged. Thus, the potential impact remains of **VERY LOW significance** with very minor effects on receptors.

Additional Assessment Criteria

The impact is **fully reversible** after the vessel operations cease. The loss of resource is **low** and the cumulative potential is **likely** as the area of impact is located in a main traffic route.

TABLE 9-21: IMPACT ON MARINE FAUNA FROM DRILLING AND VESSEL NOISE

Project Phase:	Mobilisation, Operation and Decommissioning	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	MEDIUM	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	LOW	LOW
Extent	LOCAL	LOCAL
Duration	SHORT TERM	SHORT TERM
Significance	**VERY LOW**	**VERY LOW**
Probability	**POSSIBLE**	**POSSIBLE**
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**VERY LOW**
Cumulative potential	**LIKELY**	**LIKELY**

9.2.3.1.2 Impact of Underwater Noise from VSP on Marine Fauna

Project Controls

TEEPSA and the drilling contractor will ensure that VSP activities are undertaken in a manner consistent with good international industry practice and BAT.

Sensitivity of Receptors

The area of interest is located 60 km offshore at its nearest point and far removed coastal MPAs and any sensitive coastal receptors. Migratory pelagic species, some of which are listed as globally Endangered or Critically Endangered, transiting through the area of interest may be directly affected. Refer to Section 9.2.3.1.1. Receptor sensitivity to noise from VSP is considered to be **high**.

Impact Magnitude (or Consequence)

Physical Injury

The volumes and the energy released into the marine environment are significantly smaller than what is required or generated during conventional seismic surveys[57]. The peak pressure levels from a single VSP pulse are likely to cause both PTS and TTS on-set in marine mammals and potential mortal injury in fish and turtles. The Underwater Noise Modelling study (SLR 2022; Appendix 8 in Volume 2) predicts that animals would, however, need to be directly adjacent to or below the VSP source (**marine mammals: <10 m; fish and turtles: <30 m**) to

[57] A typical seismic volume of energy is 3 000 cubic inches, while a VSP is around 1 000 cubic inches. In addition, the energy dissipated by a VSP is concentrated in one place, while a seismic survey covers a larger area.

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 80 m from the VSP source** (see Table 9-22).

TABLE 9-22: SUMMARY OF THE MAXIMUM ZONES OF IMPACT FOR VERTICAL SEISMIC PROFILING

Animal Type	Drilling activities		Maximum threshold distances, m			
			PTS onset	TTS onset	Behavioural disturbance	
Marine mammals	VSP – immediate impact		45 m	80 m	2 160 m	
	VSP – cumulative	250 VSP pulses	90 m	630 m	-	
	VSP – cumulative	50 VSP pulses	50 m	220 m		
Fishes and sea turtles	Drilling activities		Mortality and potential mortal injury	Recovery injury	TTS	Behavioural disturbance - sea turtles only
	VSP – immediate impact		30 m	30 m	-	1 520 m
	VSP – cumulative	250 VSP pulses	50 m	80 m	630 m	-
	VSP – cumulative	50 VSP pulses	30 m	40 m	220 m	-
Note: A dash indicates the threshold is not applicable.						

As most pelagic species likely to be encountered within the licence area are highly mobile, they would be expected to flee and move away from the sound source before trauma could occur. However, assuming an animal does not move away from the noise source, the cumulative maximum threshold distances would apply (see Table 9-22). Considering the cumulative impact (250 discharges within 9 hours) on marine mammals, the maximum threshold distances will be in the order of up to **470 m and 630 m for TTS onset and up to 90 m for PTS onset for low frequency cetaceans**, with the threshold distances for the remaining hearing groups being considerably lower. **For fish and turtles, the cumulative impact will result in maximum distances in the order of 80 m for recovery injury and 630 m for TTS-onset**. Since the key Southern Right calving and nursing areas off the South-West Coast and major fish spawning areas fall outside of the maximum threshold distances for TTS, PTS and behaviour, cumulative effects would not be expected and it is considered likely that most animals would avoid sound sources at distances well beyond those at which injury is likely to occur. This is, however, not the case for ichthyoplankton which drifts in the current and cannot move out of the way.

The zone of 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 impact, and the cumulative zones of impact would apply (potential mortal injury for fish eggs and larvae is modelled to be within 40 m). Potential impacts on ichthyoplankton and pelagic invertebrates would thus be of high intensity at close range, but highly localised and transient due to the localised and short-term nature of the VSP operations. The volumes and the energy released into the marine environment are significantly smaller than what is required or generated during conventional seismic surveys[58]. Impacts are, therefore, not comparable to the significant declines in zooplankton abundance within a maximum range of 1.2 km of an airguns' passage as reported by McCauley et al. (2017). Although the major spawning areas of commercially important species, such as hake, pilchards, horse

[58] A typical seismic volume of energy is 3 000 cubic inches, while a VSP is around 1 000 cubic inches. In addition, the energy dissipated by a VSP is concentrated in one place, while a seismic survey covers a larger area.

mackerel and anchovy, all lie inshore of the area of interest, and should in no way be affected by the highly localised VSP operations, there is some overlap with egg and larval distribution of these species in the inshore portion of the area of interest only. Declines in zooplankton abundance as a result of VSP operations are therefore likely to be negligible.

It is evident from Table 9-22 that animals would need to be in relatively close proximity to the operating sound source (VSP) to suffer physiological injury, and in reality, marine fauna in the offshore habitat of Block 5/6/7 would not stay in the same location for the entire period and therefore cumulative effects would not be expected. It is thus considered likely that most animals would avoid sound sources at distances well beyond those at which injury is likely to occur.

In the case of noise generated during VSP, the effects on marine fauna (ichthyoplankton, fish, diving seabirds, turtles, marine mammals) are considered to be of **medium intensity**, with the worst case being possible TTS onset in cetaceans within 630 m of the sound source. Effects would, however, remain **local** and for the duration of the VSP activities (**short-term**; up to 9 hours per well). The impact of underwater noise generated during VSP is thus considered of **very low magnitude** (or consequence) for up to five wells.

Behavioural Avoidance and Masking of Sounds

Potential behavioural disturbance from the VSP pulses is predicted to occur for **marine mammals of all hearing groups up to 2.16 km from the source**. In the case of **turtles, potential behavioural disturbance is predicted to occur up to 1.52 km from the source**.

According to Popper *et al*. (2014), for non-impulsive noise sources in general, relatively high to moderate behavioural risks are expected for fish species at near to intermediate distances (tens to hundreds of meters) from the source location. Relatively low behavioural risks are expected for fish species at far field distances (thousands of meters) from the source location. Behavioural responses of fish, such as avoidance of seismic survey areas and changes in feeding behaviours in response to seismic sounds, have been documented to occur at received levels of between 130 and 180 dB re 1 µPa, with disturbance ceasing at noise levels below this level (Slabbekoorn *et al.* 2019).

Only in cases where animals remain in specific coastal areas for the purposes of calving or spawning, or are associated with specific oceanic focal features such as seamounts, may cumulative effects on behaviour be realised. This said, the key Southern Right calving and nursing areas off the South-West Coast and major fish spawning areas fall outside of the maximum threshold distances for TTS, PTS and behaviour avoidance. Therefore, the zones of impact represent the worst-case consideration and will reduce logarithmically with decreased exposure time period.

In the case of noise generated during possible VSP operations, the behavioural effects on marine fauna are considered to be of **low intensity** and would remain **local** as behavioural disturbances would be expected within less than 2.8 km of the drilling location and for the duration of the VSP activities (**short term**; 9 hours per well). The impact of underwater noise generated during VSP is thus considered of **very low magnitude** (or consequence) for up to five wells.

Impact Significance

Based on the **high sensitivity** of receptors and the **very low magnitude**, the potential impact on the marine fauna is considered to be **low significance** without mitigation.

Identification of Mitigation Measures

The following measures will be implemented for VSP activities within the new drilling area (adapted from JNCC guidelines for geophysical surveys):

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	Ensure 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 is no cetaceans, turtles, penguins and shoaling large pelagic fish activity close to the source.	Abate on site
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 observations and possibly acoustic detections within the 500 m mitigation zone continuously during VSP operation to identify if there are any cetaceans present.	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 a cetacean is 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.	Abate on site

No.	Mitigation measure	Classification
4.2	Breaks 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	Ensure 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-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

Residual Impact Assessment

The generation of noise from VSP cannot be eliminated when required as part of the well logging. With the implementation of the mitigation measures, which would reduce the intensity of the impact from medium to low, the residual impact remains of **LOW significance** due to the high sensitivity of the receptors (see Table 9-23).

Additional Assessment Criteria

The impact is **fully reversible** after VSP operations cease. The loss of resource is **low**, the mitigation potential is **medium,** and the cumulative potential is **likely**.

TABLE 9-23: IMPACT ON MARINE FAUNA FROM VERTICAL SEISMIC PROFILING

Project Phase:	**Mobilisation, Operation and Decommissioning**	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**HIGH**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	MEDIUM	LOW
Extent	LOCAL	LOCAL
Duration	SHORT TERM	SHORT TERM
Significance	**LOW**	**LOW**
Probability	**LIKELY**	**LIKELY**
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**MEDIUM**
Cumulative potential	**LIKELY**	**LIKELY**

9.2.3.2 Impact on Fishing

Potential Impact Description

Elevated noise levels could impact fish by:

- causing direct physical injury to hearing or other organs;
- masking or interfering with other biologically important sounds (e.g., communication, echolocation, signals and sounds produced by predators or prey); and
- causing disturbance to the receptor resulting in behavioural changes or displacement from important feeding or breeding areas.

These could have a secondary impact on the fishing industry, namely reduced catch and/or increased fishing effort (**indirect negative** impact). The impact assessment is summarised in Table 9-25 and Table 9-28.

Project Controls

TEEPSA will require the drilling contractor to ensure that the proposed project is undertaken in a manner consistent with good international industry practice and BAT.

Sensitivity of Receptors

A description of each commercial sector operating in the licence area is presented in Section 7.8. The affected fisheries sectors (receptors) have been identified based on the extent of overlap of fishing grounds with the estimated zone of impact for disturbance. The demersal trawl, demersal long-line, large pelagic long-line and tuna pole sectors have historically operated within portions of the area of interest for drilling and zone of impact. A summary of proportional catch and effort by those fishing sectors within the area of interest, well drilling safety zone and behavioural zone of impact is presented in Table 9-24. All the other fishing sectors, including the small-scale fishery, fall outside the area of interest and zones of impact.

Sensitivity herein considers the extent of fishing ground, ability of the fishing industry to operate as expected considering a project-induced change to their normal fishing operations (linked in part to fishing gear type and vessel manageability), as well as the vulnerability of the targeted fish species.

The greatest risk of physiological injury from seismic 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, however, the swim-bladders are either underdeveloped or absent, and the risk of physiological injury through damage of this organ is therefore lower (Pisces 2022). 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 in South African fisheries, *Thunnus albacares* (yellowfin) and *T. obesus* (bigeye), do have swim bladders (Collette & Nauen, 1983) and so may be physically vulnerable.

Consequently, the sensitivity of the tuna pole sector is considered to be **high**, whereas the sensitivity of the demersal trawl, demersal longline and large pelagic longline sectors is considered to be **medium**. The other fisheries sectors fall outside the estimated noise disturbance zone for fish of up to 5 km from the drilling unit.

TABLE 9-24: SUMMARY OF PROPORTIONAL CATCH AND EFFORT (%) BY FISHING SECTOR WITHIN THE AREA OF INTEREST AND ZONES OF IMPACT

Sector	% of National Catch			% of National Effort		
	Within area of interest	Within 500 m safety zone (0.79 km^2)	Within 5 km noise disturbance zone (78.5 km^2)**	Within area of interest	Within 500 m safety zone (0.79 km^2)	Within 5 km noise disturbance zone (78.5 km^2)**
Demersal Trawl	**0.27**	**0.02**	**0.17**	**0.16**	**0.03**	**0.12**
Demersal Hake Longline	**0.12**	**0.02**	**0.20**	**0.10**	**0.02**	**0.15**
Large Pelagic Longline	**5.79**	**3.9 ***	**0.18**	**7.25**	**3.9 ***	**0.18**
Tuna Pole	**13.74**	**0.10**	**1.24**	**12.54**	**0.10**	**0.70**

NOTES:
***** The 500 m safety zone around the drilling unit would result in an exclusion area of 0.79 km^2. However, since surface longlines are unattended and drift in surface currents before they are retrieved, the potential area of exclusion to fishing operations would be greater than the 500 m around the drilling unit. Vessel operators would be obliged to take a precautionary approach in order to avoid gear entanglement with the stationary drilling unit by avoiding a much wider area. Based on an assumed average line length of 60 km, operators could be expected to avoid setting lines within a distance of 30 km of the drilling unit in order to avoid potential gear entanglement. Thus, for the large pelagic longline sector, an exclusion of 30 km from the drilling unit is considered.
** Based on the noise exposure criteria provided by Popper et al. (2014), for non-impulsive noise sources in general, relatively high to moderate behavioural risks are expected at near to intermediate distances (tens to hundreds of meters) and relatively low behavioural risks are expected for fish species at far field distances (thousands of meters) from the source location. For the purposes of this study, considering that relatively low behavioural risks to a distance of a few kilometres around the drilling unit, a conservative distance of 5 km was used to calculate the catch and effort within the zone of noise disturbance.

9.2.3.2.1 Impact of Vessel and Drilling Noise on Fishing

Impact Magnitude (or Consequence)

As Block 5/6/7 is located within the main offshore shipping routes that pass around southern Africa, the shipping noise component of the ambient noise environment is expected to be significant within and around the area of interest for drilling (OceanMind Limited 2020). Given the significant local shipping traffic and relatively strong metocean conditions specific to the area, ambient noise levels are expected to be 90–130 dB re 1 µPa for the frequency range 10 Hz – 10 kHz (SLR 2022). The sound level generated by drilling operations (drill rig and support vessels) is approximately 198 dB re 1 µPa @ 1m. The noise generated by the drill unit vessel and support vessels, thus falls within the hearing range of most fish and would be audible for considerable ranges before attenuating to below threshold levels.

Based on the noise exposure criteria provided by Popper et al. (2014), the Underwater Acoustics Modelling Study (Appendix 8 in Volume 2) predicts that non-impulsive noise from drilling activities could result in potential TTS to a distance of 170 m from the drill site and injury (recoverable) within 40 m from the drill site (see Table 9-20). Besides physiological effects, the underwater noise from well drilling operations 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). Behavioural responses of fish, such as avoidance of seismic noise and changes in feeding behaviours in response to seismic sounds, have been documented to occur at received levels of between 130 and 180 dB re 1 µPa, with disturbance ceasing at noise levels below this level (Slabbekoorn *et al.* 2019). Based on the noise exposure criteria provided by Popper et al. (2014), for non-impulsive noise sources in general, relatively high to moderate behavioural risks are expected at near to intermediate distances (tens to hundreds of meters) from the source location. Relatively low behavioural risks are expected for fish species at far field distances (thousands of meters) from the source location. The noise modelling results show that the RMS SPL levels reduce to below 180 dB re 1 µPa within

10 m and below 160 dB re 1 µPa within 110 m (Dana Lewis *pers comm*). For the purposes of this study, considering that relatively low behavioural risks to a distance of a few kilometres around the drilling unit, a conservative distance of 5 km has been used to calculate the catch and effort within the zone of noise disturbance.

The fisheries affected by this impact include those sensitive fisheries indicted above, namely demersal trawl, demersal longline, large pelagic longline and tuna pole. Based on the overlap of fishing grounds with the affected area (to a distance of a few kilometres around the drilling unit or vessel), the impact has been rated as being **local** in extent.

The impact of drilling and vessel noise is considered to be of **medium intensity**, based on the catch and effort within the estimated 78.5 km^2 behavioural disturbance zone (based on a conservative radius of 5 km from the drilling location) and considering that the proposed new drilling rea is located in a main marine traffic route and thus is in an area already experiencing increased marine traffic and vessel noise.

- Demersal trawl sector: The maximum catch and effort may be affected amounted to 0.17% (212 tons) and 0.12% (46 drags) of the overall national catch and effort figures.
- Demersal longline (hake) sector: The maximum catch and effort that may be affected amounted to 0.20% (8.95 tons) and 0.15% (9 lines) of the overall national catch and effort figures.
- Large pelagic longline sector: The maximum catch and effort that may be affected amounted to 0.18% (4.9 tons) and 0.18% (4 line) of the overall national catch and effort figures.
- Tuna pole sector: The maximum catch and effort that may be affected amounted to 1.24% (35.3 tons) and 0.70% (18 fishing events) of the overall national catch and effort figures.

For all sectors the impact is considered to be **short-term** (3-4 months for drilling) with the duration of behavioural effects are generally short-term, with duration of the effect being less than or equal to the duration of exposure, although these vary between species.

The overall **magnitude** of the impact of sound on catch rates during these activities is assessed to be **very low** for all four sectors.

Impact Significance

Based on the **sensitivity** of the receptors possibly present in the area of interest and the **very low to low magnitude** predicted above, the potential impact **significance** on the various fishing sectors is presented below and summarised in Table 9-25. The project will thus have negligible economic impact on the four commercial sectors identified and small-scale fisheries will not be impacted under normal operation.

Fishing Sector	Sensitivity	Magnitude	Significance
Demersal trawl	Medium	Very Low	**Very Low**
Demersal longline	Medium	Very Low	**Very Low**
Large pelagic longline	Medium	Very Low	**Very Low**
Tuna Pole	High	Very Low	**Low**

Identification of Mitigation Measures

Refer to Section 9.2.6.1 on the impact of temporary safety zone around drilling unit for mitigation. This mitigation relates to ensuring good communication and coordination with the various fishing sectors.

Residual Impact Assessment

With the implementation of the mitigation measures, which will ensure good communication and coordination with affected sectors, allowing them to focus fishing in other areas, the intensity of the impact will reduce to low. The residual impact **significance** will remain the same for all four sectors:

- Demersal trawl, demersal longline and large pelagic longline: **VERY LOW**
- Tuna Pole: **LOW**

Additional Assessment Criteria

The impact is **fully reversible** after the drilling and vessel operations cease. The impact is **possible**, loss of resource is **low** and the cumulative potential is **unlikely**.

TABLE 9-25: OVERALL IMPACT ON FISHING FROM VESSEL AND DRILLING NOISE

Project Phase:	**Mobilisation, Operations and Decommissioning**	
Type of Impact	**Indirect**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**HIGH** (tuna pole) to **MEDIUM** (demersal trawl sector, demersal longline and large pelagic longline)	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	MEDIUM	LOW
Extent	LOCAL	LOCAL
Duration	SHORT TERM	SHORT TERM
Significance	**LOW** (tuna pole)	**LOW** (tuna pole)
	VERY LOW (demersal trawl, demersal longline and large pelagic longline)	**VERY LOW** (demersal trawl, demersal longline and large pelagic longline)
Probability	**POSSIBLE**	**POSSIBLE**
Confidence	**MEDIUM**	**MEDIUM**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**LOW**
Cumulative potential	**UNLIKELY**	**UNLIKELY**

9.2.3.2.2 Impact of VSP on Fishing

Impact Magnitude (or Consequence)

Sensitivity and hearing range are highly variable amongst fish species. Data indicates that fish possessing a swim bladder are more sensitive to impulsive sounds, such as those generated by VSP, than fish without swim bladders (Popper et al., 2014). Most tuna, key species targeted by the large pelagic longline and tuna pole sectors, do not have a swim bladder.

Studies have shown that physical damage to fish caused from VSP sources occurs only in the immediate vicinity of the airguns, in distances of less than a few meters. Based on the noise exposure criteria provided by Popper et al. (2014), the Underwater Acoustics Modelling Study (Appendix 8 in Volume 2) predicts that the peak pressure levels from a single VSP pulse are likely to cause both PTS and TTS on-set in fish. It is predicted that animals would, however, need to be directly adjacent to or below (<30 m) the VSP source to be affected (see Table 9-22). Considering the cumulative impact (250 discharges within 9 hours) on fish, the maximum threshold distances will be in the order of up to 50 m for mortality, 80 m for recoverable injury and 630 m for TTS onset in the worst case scenario. As most pelagic species likely to be encountered within the new drill area are highly mobile, they would be expected to flee and move away from the sound source before trauma could occur.

Behavioural responses to impulsive sounds are varied and any changes in spawning, migration and feeding behaviour of fishes in response to VSP could affect fisheries through reduced catches resulting from changes in feeding behaviour, abundance and vertical distribution. Such behavioural changes could lead to decreased commercial catch rates if fish move out of important fishing grounds. Behavioural responses of fish, such as avoidance of seismic noise and changes in feeding behaviours in response to seismic sounds, have been documented to occur at received levels of between 130 and 180 dB re 1 µPa, with disturbance ceasing at noise levels below this level (Slabbekoorn *et al.* 2019). As noted in the section above, relatively high to moderate behavioural risks are expected for fish species at near to intermediate distances (tens to hundreds of meters) from the source location and relatively low behavioural risks are expected for fish species at far field distances (thousands of meters) from the source location (Popper *et al*. 2014). The catch and effort within the estimated 78.5 km^2 behavioural disturbance zone (based on a radius of 5 km from the drilling location) are summarised below.

- Demersal trawl sector: The maximum catch and effort may be affected amounted to 0.17% (212 tons) and 0.12% (46 drags) of the overall national catch and effort figures.
- Demersal longline (hake) sector: The maximum catch and effort that may be affected amounted to 0.20% (8.95 tons) and 0.15% (9 lines) of the overall national catch and effort figures.
- Large pelagic longline sector: The maximum catch and effort that may be affected amounted to 0.18% (4.9 tons) and 0.18% (4 line) of the overall national catch and effort figures.
- Tuna pole sector: The maximum catch and effort that may be affected amounted to 1.24% (35.2 tons) and 0.70% (18 fishing events) of the overall national catch and effort figures.

Although the effects would largely be limited to the 500 m safety exclusion zone where fishing cannot take place in any event, due to the variability in research on changes in catch rates caused by VSP, the intensity of the impact has been rated **medium** in accordance with a precautionary approach. Based on the overlap of fishing grounds with the affected area (to a distance of a few kilometres around the drilling unit), the impact is rated as being **local** in extent. The fishing grounds of the demersal trawl, demersal longline, large pelagic longline and tuna pole thus fall within the threshold of sound levels that may lead to a behavioural response from fish.

Reports on observed declines in catch rates differ considerably between studies, however, behavioural effects are generally **short-term**, with duration of the effect being less than or equal to the duration of exposure, although these vary between species and individuals, and are dependent on the properties of the received sound. There could, however, possibly be a **medium-term** indirect impact on demersal trawl and demersal longline sectors due to the potential overlap with hake spawning areas / period and impact on recruitment, assuming the VSP occurs within the inshore potions of the area of interest and coincides with the key hake spawning period between late winter and early spring.

The overall **magnitude** of the impact of sound on catch rates during these activities is assessed to be **low** for the demersal trawl and demersal long-line sectors and **very low** for the large pelagic longline and tuna pole sector.

Impact Significance

Based on the **sensitivity** of the receptors possibly present in the area of interest and the **very low to low magnitude** predicted above, the potential impact **significance** on the various fishing sectors is presented below and the worst case summarised in Table 9-26. The project will thus have negligible economic impact on the four commercial sectors identified and small-scale fisheries will not be impacted under normal operation.

Fishing Sector	Sensitivity	Magnitude	Significance
Demersal trawl	Medium	Low	**Low**
Demersal longline	Medium	Low	**Low**
Large pelagic longline	Medium	Very Low	**Very Low**
Tuna Pole	High	Very Low	**Low**

Identification of Mitigation Measures

Refer to Section 9.2.6.1 on the impact of temporary safety zone around drilling unit for mitigation. This mitigation relates to ensuring good communication and coordination with the various fishing sectors.

Residual Impact Assessment

The generation of noise from VSP cannot be eliminated when part of the wells logging. With the implementation of the mitigation measures, which will ensure good communication and coordination with the various fishing sectors allowing them to focus fishing in other areas, the intensity of the impact will reduce by one level for all sectors. The residual impact **significance** for the following sectors is as follows:

- Demersal trawl: **VERY LOW**
- Demersal longline: **VERY LOW**
- Large pelagic longline: **VERY LOW**
- Tuna Pole: **LOW**

Additional Assessment Criteria

The impact is **fully reversible** after the vessel operations cease. The impact is **possible**, loss of resource is **low** and the cumulative potential is **unlikely**.

TABLE 9-26: OVERALL IMPACT ON FISHING FROM VSP NOISE

Project Phase:	**Operation**	
Type of Impact	**Indirect**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**HIGH** (tuna pole) to **MEDIUM** (demersal trawl sector, demersal longline and large pelagic longline)	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**LOW** (demersal trawl and demersal long-line) **to VERY LOW** (large pelagic longline and tuna pole)	**VERY LOW** (demersal trawl and demersal long-line and large pelagic longline tuna pole)
Intensity	MEDIUM	LOW
Extent	LOCAL	LOCAL
Duration	SHORT TERM (large pelagic longline and tuna pole) to MEDIUM TERM (demersal trawl and demersal longline)	SHORT TERM to MEDIUM TERM
Significance	**LOW** (demersal trawl, demersal longline and tuna pole)	**LOW** (tuna pole)
	VERY LOW (large pelagic longline)	**VERY LOW** (demersal trawl, demersal longline and large pelagic longline)
Probability	**HIGHLY LIKELY**	**POSSIBLE**
Confidence	**MEDIUM**	**MEDIUM**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	-	**LOW**
Cumulative potential	**UNLIKELY**	**UNLIKELY**

9.2.4 Presence of Subsea Infrastructure

Source of Impact

The project activities that will result in an increase in hard substrata on the seabed are:

Project phase	Activity
Mobilisation	N/A
Operation	Placement of wellhead on the seabed
	Discharge of residual cement during riserless casing and plugging stages
Demobilisation	Abandonment of wellhead on seabed (with over-trawlable abandonment cap)

These activities are described further below:

- During initial cementing of the well, excess cement (100 m^3 per well in the worst case for all cementing / plugging operations) emerges out of the top of the well onto the cuttings pile or is discarded on the seabed. 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 approximately 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 individual well decommissioning.

- After the exploration wells have been sealed, tested for integrity and abandoned, the wellheads (with a height of approximately 3 m and a diameter of 1 m) in waters deeper than 750 m will be left (abandoned) on the seafloor, where it is deemed safe to do so, thereby providing hard substrate in an area of otherwise unconsolidated sediments. If deemed unsafe and a risk to demersal fishing, the wellheads will be removed. Abandoned wellheads will be fitted with over-trawlable abandonment caps, which are estimated to measure approximately 5.2 m x 5.2 m, with a height of 4.4 m.

9.2.4.1 Impact on Marine Fauna

Potential Impact Description

Placement of wellheads on the seabed and subsequent abandonment create islands of hard substrata in an otherwise uniform area of unconsolidated sediments. 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 (**direct neutral** impact). The impact assessment is summarised in Table 9-27.

Project Controls

TEEPSA will ensure that the contractors undertake the drilling operation 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.

Sensitivity of Receptors

The sensitivity of the benthic communities of unconsolidated sediments is considered low. While the sensitivity of deep-water reef communities is considered high, the area of interest for drilling avoids such known sensitive habitats and the well(s) will specifically be sited to avoid sensitive hardgrounds (ROV survey). Thus, the overall sensitivity of receptors to the presence of well drilling infrastructure, considering the small percentage of the habitats potentially affected, despite the presence of a CBAs, is considered to be **low**. Refer to Section 9.2.1.1 for further detail.

Impact Magnitude (or Consequence)

The presence of the subsea infrastructure (e.g., excess cement, wellheads and abandonment cap) will increase the amount of hard substrate that is available for the colonisation of benthic organisms. This may increase biodiversity and biomass in the vicinity of physical structures on the seabed.

Solidified excess cement discarded during cementing of the casings could also potentially provide hard substratum for benthic organisms to colonise in an environment otherwise dominated by unconsolidated sediments, if it does not gradually dissolve into the surrounding seawater. In addition, it will be covered with some drill cuttings from the risered drilling stages, which form a highly localised spoil mound around the wellbore.

The BOP, which will only temporarily increase the amount of hard substrate on the seafloor for the duration of the drilling operation (3-4 months), will not contribute to this impact. Similarly, if the wellheads were removed upon abandonment, they would not contribute this impact. However, the abandonment of the wellheads (with over-trawlable abandonment cap with a height of 4.4 m) on the seabed can alter the community structure in an area, and effectively increase the availability of hard substrate for colonisation by sessile benthic organisms, thereby locally altering and increasing biodiversity and biomass.

Studies have shown that oil and gas infrastructure associated with permanent production platforms provides a sheltering habitat for fish usually associated with complex reef habitats, and infrastructure may positively affect larval production, which could subsequently result in increased recruitment success. The alterations to community structure due to the abandoned wellheads will, however, 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 and jacopever), which show a preference for structural seabed features, and benthic invertebrates (deep-water hard substrata can support sensitive species some of which may be longer-lived VME species), it may enhance colonisation by non-indigenous species thereby posing a threat to natural biodiversity. However, due to the water depths in the new drill area (700 m to 3 200 m), colonisation by invasive species is unlikely to pose a significant threat to natural biodiversity in the deep-sea habitats.

The increase or modification of a site's biodiversity due to the presence of subsea structures is considered a secondary impact of **low intensity**. The impact will be **site specific** for each well. The impact will be **permanent** for abandoned wellheads resulting in the **magnitude** (or consequence) of the impact being **low**. However, if the wellheads were removed upon abandonment, the duration would be reduced to **short-term** and the **magnitude** (or consequence) to **very low**.

Impact Significance

Due to the **low sensitivity** of benthic communities of unconsolidated sediments and the **very low** (wellhead removal) to **low** (well abandonment) **magnitude** of the impact, the presence of sub-sea structures on seabed biodiversity is deemed to be **negligible** (wellhead removal) or **very low** (well abandonment) **significance**.

Identification of Mitigation Measures

In addition to the measures recommended to avoid of vulnerable hardground and sensitive habitats (see Section 9.2.2.1.1), the following measures will be implemented:

No.	Mitigation measure	Classification
1	Monitor (by ROV) cement returns and if significant discharges are observed on the seafloor terminate cement pumping.	Reduce at source/Abate on site
2	Undertake a post drilling ROV survey to scan seafloor for any dropped equipment around the well site. Retrieve these objects, where practicable, after assessing the safety and metocean conditions.	Repair / restore
3	Ensure any excess cement onboard the drilling unit is shipped to shore for storage or disposal.	Reduce at source

Residual Impact Assessment

This potential impact cannot be eliminated if the wellheads are abandoned on the seafloor. With the proposed mitigation, the intensity and residual impact of unconsolidated sediments remains **NEGLIGIBLE** (wellhead removal) or **VERY LOW** (well abandonment) **significance**.

Additional Assessment Criteria

The impact is **fully reversible** (wellhead removal) or **irreversible** (well abandonment) after the operations cease. The loss of resource is **low**, the mitigation potential is **very low,** and the cumulative potential is **unlikely**.

TABLE 9-27: IMPACTS OF SUBSEA INFRASTRUCTURE ON MARINE BIODIVERSITY

Project Phase:	**Operation and Decommissioning**	
Type of Impact	**Direct**	
Nature of Impact	**Neutral**	
Sensitivity of Receptor	**LOW**	
	Alternative 1: Wellhead removal	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	LOW	LOW
Extent	SITE	SITE
Duration	SHORT TERM	SHORT TERM
Significance	**NEGLIGIBLE**	**NEGLIGIBLE**
Probability	**UNLIKELY**	**UNLIKELY**
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**VERY LOW**
Cumulative potential	**UNLIKELY**	**UNLIKELY**
	Alternative 2: Wellhead abandonment	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**LOW**	**LOW**
Intensity	LOW	LOW
Extent	SITE	SITE
Duration	PERMANENT	PERMANENT
Significance	**VERY LOW**	**VERY LOW**
Probability	**HIGHLY LIKELY**	**HIGHLY LIKELY**
Confidence	**HIGH**	**HIGH**
Reversibility	**IRREVERSIBLE**	**IRREVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**VERY LOW**
Cumulative potential	**POSSIBLE**	**POSSIBLE**

9.2.4.2 Impact on Commercial Fishing

Potential Impact Description

The abandonment of the wellhead on the seafloor will also pose an obstruction to any fishing activity directed towards the seabed (specifically the demersal trawl sector). Thus, reducing fishing grounds for the demersal trawl sector, potentially resulting in a potential loss of catch and damage to fishing gear (**direct negative** impact). The impact assessment is summarised in Table 9-28.

The demersal long-line sector, which also sets its gear on the seafloor, will not be impacted after well abandonment as this sector will be permitted to set lines over an abandoned wellhead. This sector is not considered further here.

Project Controls

Abandoned wellheads would be fitted with an over-trawlable abandonment cap to minimise the risk of damage to demersal trawl gear.

Sensitivity of Receptors

Sensitivity here considers the extent of the demersal trawl grounds and the ability of the demersal trawl sector to operate as expected considering a project-induced change to their normal fishing operations. Considering wellhead abandonment, even though wellheads will be fitted with over-trawlable abandonment caps, the demersal trawl sector may still choose to left nets to avoid the abandoned wellheads and avoid damage to their trawl gear, which will result in reduced access to available fishing ground (whilst the net is lifted from the seabed, they are unable to harvest the targeted fish stock). Thus, the sensitivity of the demersal trawl sector to wellhead abandonment is considered to be **medium**.

Impact Magnitude (or Consequence)

Demersal trawling effort in relation to Block 5/6/7 and area of interest for proposed exploration drilling area is shown in Figure 7-57 and Figure 9-14. The area of interest for proposed exploration drilling is situated offshore of the main trawl grounds in the area; however there the area does coincide with the outer depth range of fishing effort (up to 800 m water depth). The area of interest for proposed exploration drilling covers 364 km^2 of trawling ground, which amounts to 0.64% of the total extent of the offshore demersal trawling footprint within the South African EEZ. Over the period 2017 to 2019, an average of 60 trawls per year were reported within the area of interest yielding 317 tonnes of hake. This is equivalent to 0.16% and 0.27% of the overall effort and catch, respectively, reported nationally by the sector.

The abandonment of a wellhead within the demersal trawl "ring fenced" fishing area[59] (Figure 9-14 for the extent of the "ring-fenced" fishing area) would exclude fishing from an area of 0.79 km^2 around each wellhead (500 m radius), which is equivalent to 0.001% of the designated offshore trawl grounds. Placed across the area of highest fishing activity within the area of interest for proposed drilling, an average of 9 drags per year could be expected across the affected area (equivalent to 0.03% of the overall national effort figures reported by the sector).

The impact on the demersal trawl sector will be limited to the immediate area of the wellheads (**site**) and is of **medium intensity**, based on the low catch and effort recorded in the area of interest (up to 800 m water depth). Since the abandoned wellheads will present a permanent obstruction to the demersal trawl sector, the impact will persist beyond the temporary drilling operation (**permanent**). Thus, the **magnitude** (or consequence) is considered to be **medium**.

[59] The "ring fenced" area is a voluntary measure adopted by the hake trawl industry in 2008 to prevent the spatial expansion of trawling operations beyond areas that had already been impacted to prevent further impact on the benthic habitat (https://en.wikipedia.org/). It represents approximately 4.4% of South Africa’s territorial waters where demersal trawling can take place. Trawling outside the "ring fenced" zone requires the completion of an ESIA (https://www.sadstia.co.za/sustainability/ring-fence-initiative/).

Impact Significance

Due to the **medium sensitivity** of the receptors and the **medium magnitude** of the impact, the presence of abandoned wellheads is deemed to be of **medium significance** (see Table 9-28). The alternative of removing the wellhead (although not the preferred option) would allow normal fishing operations to resume in the drill area after decommissioning (**no impact**).

Identification of Mitigation Measures

The following measures will be implemented:

No.	Mitigation measure	Classification
1	Avoid drilling within the boundaries of the current demersal trawl "ring fenced" area or remove wellhead structures located within this area.	Avoid / restore
2	Ensure abandoned wellheads are surveyed and accurately charted with the SAN Hydrographer.	Avoid

Residual Impact Assessment

This potential impact can be eliminated (**NO IMPACT**) if drilling avoids the current demersal trawl "ring fenced" area or if the wellheads are removed from the "ring fenced" area.

Additional Assessment Criteria

The impact is **fully reversible** (wellhead removal) after the operations cease. The loss of resource is **low**, the mitigation potential is **high,** and the cumulative potential is **possible** with future exploration in the area.

TABLE 9-28: IMPACT IMPACT OF WELLHEAD ABANDONMENT ON FISHING (DEMERSAL TRAWL)

Project Phase:	**Operation and Decommissioning**	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**MEDIUM**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**MEDIUM**	**-**
Intensity	MEDIUM	-
Extent	SITE	-
Duration	PERMANENT	-
Significance	**MEDIUM**	**NO IMPACT**
Probability	**PROBABLE**	**-**
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**-**
Mitigation Potential	**-**	**HIGH**
Cumulative potential	**POSSIBLE**	**POSSIBLE**

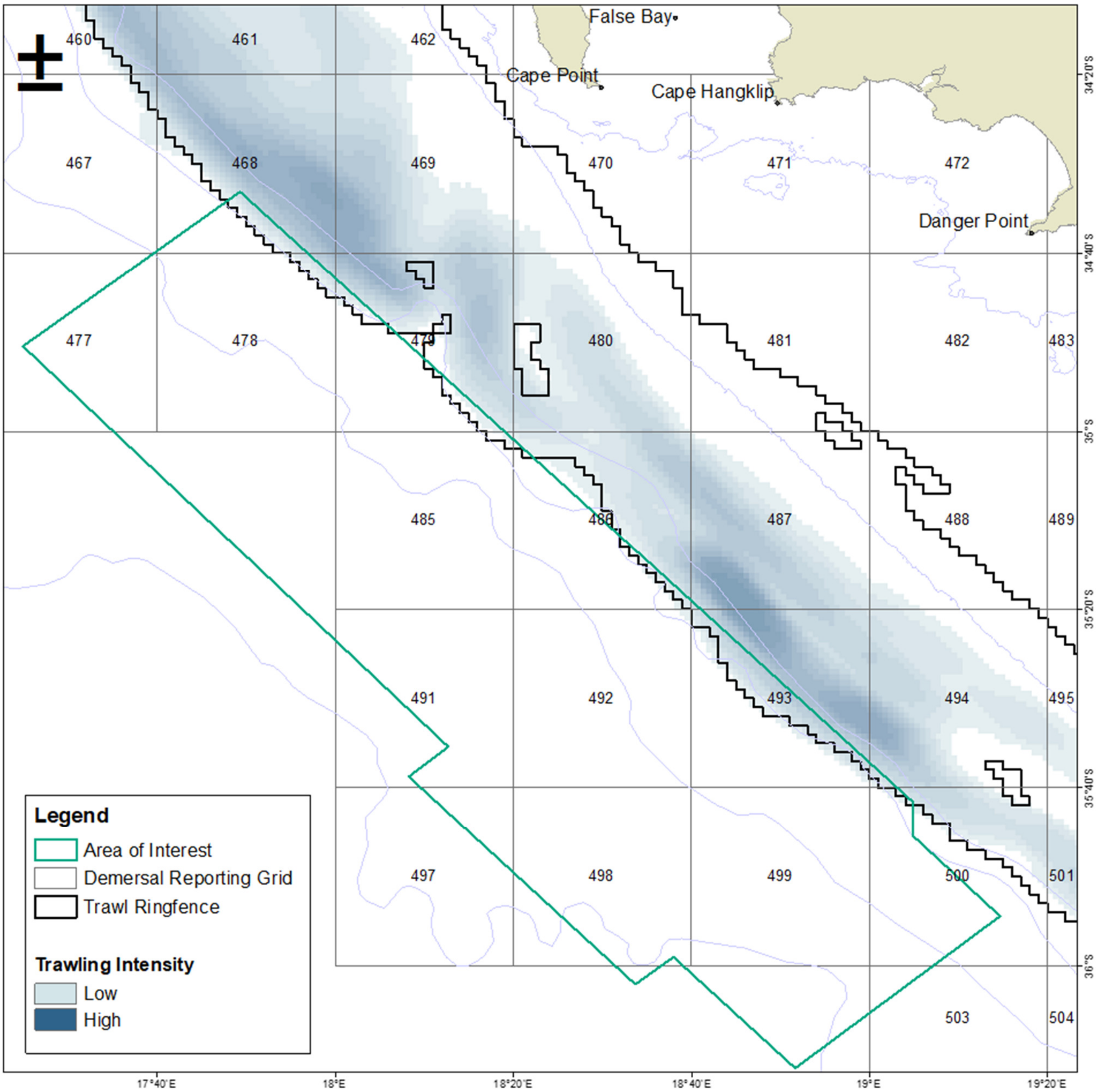


FIGURE 9-14: AREA OF INTEREST IN RELATION TO THE DEMERSAL TRAWL "RING FENCED" AREA, DEMERSAL TRAWLING INTENSITY AND COMMERCIAL GRID BLOCKS

Source: CapMarine, 2022

9.2.5 Well Testing

Source of Impact

The project activities related to well (flow) testing include:

Project phase	Activity
Mobilisation	N/A
Operation	Flaring of hydrocarbons
	Possible discharge of treated produced water
Demobilisation	N/A

Well or flow testing may be undertaken to determine the economic potential of a discovery before the well is either abandoned or suspended. Activities will include:

- During well testing it may be necessary to flare off some of the hydrocarbons 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 volume of hydrocarbons produced would depend on the quality of the reservoir but is kept to a minimum. However, an estimated 10 000 bbl oil could be flared per test (i.e. up to 20 000 bbl over the two tests associated with an appraisal well).
- If produced water arises during well flow testing (note: 14.5 m^3 was produced during the recent Luiperd well drilling campaign in 2020), these would be separated from the oily components and treated onboard to reduce the remaining hydrocarbons and discharged overboard or be shipped to shore for disposal. Reinjection of the produced water in the well may be considered if volumes are large and cannot be managed onboard the drilling unit.

9.2.5.1 Impacts on Air Quality and GHG Emissions from Flaring

Emissions related to well testing and flaring are considered and assessed cumulatively with normal operations in this Section 9.1.1.

9.2.5.2 Impacts on Marine Fauna from Lighting from Flare

Potential Impact Description

The intense light from flaring at night will increase ambient lighting in offshore areas. Increased ambient lighting may disturb and disorientate pelagic seabirds feeding in the area (**direct negative** impact). This increase lighting may also result in physiological and behavioural effects on fish and cephalopods (**indirect negative** impact), as these maybe drawn to the lights at night where they maybe more easily preyed upon by other fish and seabirds. The impact assessment is summarised in Table 9-29.

Project Controls

TEEPSA will ensure that the contractors undertake the drilling operation in a manner consistent with good international industry practice and BAT.

Sensitivity of Receptors

Refer to Section 9.1.2.1 for a description of receptor sensitivity. The overall sensitivity of receptors to increased lighting is considered to be **medium**.

Impact Magnitude (or Consequence)

Drilling activities would be undertaken in the offshore marine environment, 60 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 coastal species (Cape Gannets up to 140 km offshore) and migratory pelagic species (pelagic seabirds, marine mammals and fish) transiting through the area of interest. 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 intense lighting flaring at night may disturb and disorientate pelagic seabirds feeding in the area.

Flaring lighting may also result in physiological and behavioural effects of fish and cephalopods, as these may be drawn to the increased lighting at night where they may be more easily preyed upon by other fish, marine mammals and seabirds. As seals are known to forage up to 220 km offshore, the proposed new drill area, therefore, falls within the foraging range of seals from the seal colony at Duikerklip near Hout Bay, at Seal Island in False Bay and at Geyser Rock at Dyer Island, which lie about 70 km, 100 km and 98 km inshore of the area of interest, respectively. Odontocetes, however, are also highly mobile, supporting the notion that various species are likely to occur in the licence area and thus potentially be attracted to the area.

The light from flaring would be in addition to the other operational lights on the drilling unit and thus not as intense if it were the sole light source. Also due to the proximity of drill area to a main traffic route, the **intensity** of impact is expected to be **low**. The extent of impact is **site specific**, while the duration will be **short-term** (4 days of flaring over a period over a 14-day period assuming two tests). Thus, the **magnitude** (or consequence) is considered to be **very low**.

Impact Significance

Based on the **medium sensitivity** of receptors and the **very low magnitude**, the potential impact on the marine fauna is considered to be **very low significance** without mitigation.

Identification of Mitigation Measures

The following measures will be implemented to mitigate lighting impact:

No.	Mitigation measure	Classification
1	Optimise well test programme to reduce flaring as much as possible during the test.	Reduce at source/ Abate on site
2	Keep disorientated, but otherwise unharmed, seabirds in dark containers (e.g., cardboard box) for subsequent release during daylight hours.	Repair or restore

Residual Impact Assessment

Should flow testing be required, the need for flaring cannot be eliminated. Despite the implementation of the few minor mitigation measures, the residual impact remains of low intensity, very low magnitude and of **VERY LOW significance**.

Additional Assessment Criteria

The impact is **fully reversible** after the well test operations cease. The loss of resource is **low** and the cumulative potential is **unlikely**.

TABLE 9-29: IMPACT ON MARINE FAUNA FROM FLARE LIGHTING

Project Phase:	**Operation**	
Type of Impact	**Indirect / Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**MEDIUM**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	LOW	LOW
Extent	SITE	SITE
Duration	SHORT TERM	SHORT TERM
Significance	**VERY LOW**	**VERY LOW**
Probability	**POSSIBLE**	**POSSIBLE**
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**VERY LOW**
Cumulative potential	**UNLIKELY**	**UNLIKELY**

9.2.5.3 Impacts on Marine Fauna from Hydrocarbon 'Drop-Out' during Flaring

Potential Impact Description

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. This could have toxic effects on marine fauna (**indirect negative** impact). The impact assessment is summarised in Table 9-30.

Project Controls

TEEPSA will ensure that the contractors undertake the drilling operation in a manner consistent with good international industry practice and BAT.

Sensitivity of Receptors

Refer to Section 9.1.2.1 for a description of receptor sensitivity. The overall sensitivity of receptors to increased lighting is considered to be **medium**.

Impact Magnitude (or Consequence)

The area of interest is located approximately 60 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 ensure that any discharges move mainly in a north-westerly direction away from coast (refer to drilling discharge modelling results in Section 9.2.2.1). Given the offshore location of the area of interest, 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** and limited to the drilling location (**site specific**) over the **short-term** (4 days of flaring over a period of up to 14 days). The impact of well testing is therefore considered of **very low magnitude** (or consequence).

Impact Significance

Based on the **medium sensitivity** of receptors and the **very low magnitude**, the potential impact on the marine fauna is considered to be **very low significance** without mitigation.

Identification of Mitigation Measures

The following measures will be implemented to mitigate impact:

No.	Mitigation measure	Classification
1	Optimise well test programme to reduce flaring as much as possible during the test.	Reduce at source/ Abate on site
2	Commence with well testing during daylight hours, as far as possible.	Reduce at source/ Abate on site
3	Use a high-efficiency burner for flaring to maximise combustion of the hydrocarbons in order to minimise emissions and hydrocarbon 'drop-out' during well testing.	Avoid / Reduce at source
4	Monitor flare (continuous) for any malfunctioning, etc. (including any drop-out).	Avoid/reduce at source

Residual Impact Assessment

Despite the implementation of the few minor mitigation measures, the residual impact remains of low intensity, very low magnitude and of **VERY LOW significance**.

Additional Assessment Criteria

The impact is **fully reversible** after the well test operations cease. The loss of resource is **low** and the cumulative potential is **unlikely**.

TABLE 9-30: IMPACT ON MARINE FAUNA FROM HYDROCARBON 'DROP-OUT'

Project Phase:	**Operation**	
Type of Impact	**Indirect**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**MEDIUM**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	LOW	LOW
Extent	SITE	SITE
Duration	SHORT TERM	SHORT TERM
Significance	**VERY LOW**	**VERY LOW**
Probability	**POSSIBLE**	**POSSIBLE**
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**VERY LOW**
Cumulative potential	**UNLIKELY**	**UNLIKELY**

9.2.5.4 Impact on Marine Fauna from Discharge of Produced Water

Potential Impact Description

Produced water would contain hydrocarbons at varying concentrations and when discharged in the marine environment could, without treatment, 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) (**indirect negative** impact). The impact assessment is summarised in Table 9-31.

Project Controls

TEEPSA will ensure that the contractors undertake the drilling operation in a manner consistent with good international industry practice and BAT.

The hydrocarbon component will be burned off via the flare booms, while the water is temporarily collected in a slop tank. The 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.

Reinjection of the produced water into the drilled well may be considered if volumes are large and cannot be managed onboard the drilling unit.

Sensitivity of Receptors

Refer to Section 9.1.2.1 for a description of receptor sensitivity. The overall sensitivity of receptors to produced water is considered to be **medium**.

Impact Magnitude (or Consequence)

If water from the reservoir does flow with the hydrocarbons to the surface (maximum of 10 - 15 m^3, as produced during the 2020 Luiperd well drilling campaign) during the well test, the hydrocarbon component will be separated and flared, while the produced water will be treated and possibly discharged. Assuming treatment to 30 mg/l, the discharge of 10 - 15 m^3 would result in 300 - 450 g (0.03 g x 10 000 or 15 000 litres) of diluted reservoir hydrocarbons being discharge to sea per well.

The area of interest is located approximately 60 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 ensure that any discharges move mainly in a north-westerly away from coast (refer to drilling discharge modelling results in Section 9.2.2.1). Given the offshore location of the area of interest, operational discharges are expected to disperse rapidly and are unlikely to have an impact on sensitive coastal receptors.

Based on the relatively small discharge volumes and treatment to <30 mg/l of hydrocarbon, offshore location, high energy sea conditions and dominant wind / current direction, the potential impact of possible produced water discharges will be of **very low intensity, short-term duration** (4 days of flaring over a period of up to 14 days) and **site specific**. Thus, the **magnitude** (or consequence) is, therefore, considered to be **very low**.

Impact Significance

Based on the **medium sensitivity** of receptors and the **very low magnitude**, the potential impact on the marine fauna is considered to be **very low significance** without mitigation.

Identification of Mitigation Measures

No additional mitigation, other than the project control (namely treatment to < 30 mg/l) is recommended.

Residual Impact Assessment

Should flow testing be undertaken, produced water would either be discharged to sea or shipped to shore. Since no additional mitigation is proposed, the residual impact remains of very low magnitude and of **VERY LOW significance**. In shipped to shore there would be **NO IMPACT**.

Additional Assessment Criteria

The impact is **fully reversible** after the well test operations cease. The loss of resource is **low** and the cumulative potential is **unlikely**.

TABLE 9-31: IMPACT ON MARINE FAUNA FROM THE DISCHARGE OF TREATED PRODUCED WATER

Project Phase:	**Operation**	
Type of Impact	**Indirect**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**MEDIUM**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	VERY LOW	VERY LOW
Extent	SITE	SITE
Duration	SHORT TERM	SHORT TERM
Significance	**VERY LOW**	**VERY LOW**
Probability	**POSSIBLE**	**POSSIBLE**
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**VERY LOW**
Cumulative potential	**UNLIKELY**	**UNLIKELY**

9.2.6 Temporary Safety Zones Around Drilling Unit

Source of Impact

The project activities that are likely to affect the fishing industry and other marine users due to exclusion are provided below:

Project phase	Activity
Mobilisation	N/A
Operation	Operation of drilling unit and support vessels at the drill site
Demobilisation	N/A

A drilling unit is considered to be an "offshore installation" and is protected by a 500 m safety zone. All unauthorised vessels would be excluded from entering this safety zone. The safety zone will result in an exclusion area of approximately 0.79 km^2 around the drilling unit.

9.2.6.1 Impact on Fishing

Potential Impact Description

The implementation of the 500 m safety zone around the drilling unit will effectively exclude fishing around the drilling unit. The temporary exclusion of fisheries from the safety zone will effectively reduce fishing grounds, which in turn could potentially result in a loss of catch and/or increased fishing effort (**direct negative** impact). The impact assessment is summarised in Table 9-32.

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).

Sensitivity of Receptors

A description of each fisheries sector operating in the licence area is presented in Section 7.8. The affected fisheries sectors (receptors) have been identified based on the extent of overlap of fishing grounds with the licence block. The **demersal trawl, demersal long-line, large pelagic long-line and tuna pole sectors** have historically operated within portions of the area of interest for drilling. The other fisheries sectors fall outside the 500 m safety zone. A summary of proportional catch and effort by fishing sector within Block 5/6/7, area of interest for drilling and well drilling safety zone is presented in Table 9-24.

Sensitivity here considers the extent of the fishing ground and the ability of the fishing industry to operate as expected considering a project-induced change to their normal fishing operations. The sensitivity of a particular fishing sector to the impact of the safety zone would differ according to the degree of disruption to that fishing operation. The current assessment considers this to be related to the type of gear used by the particular fishery and the probability that the fishing operation can be relocated away from the affected area (safety zone) into alternative fishing areas. For instance, pelagic longline vessels set a drifting mainline, which are up to 100 km in length. Once deployed, the line will be left to drift in surface water currents for several hours before retrieval. Gear may cover a large area during this time and may provide a threat of entanglement around the drilling unit. For this reason and the catch and effort in the area of interest, large pelagic long-line has been categorised as **high sensitivity**, whereas the demersal trawl and demersal longline sectors, which are potentially more adaptable to exclusion than the large pelagic longline sector, are considered to be **low sensitivity**. The tuna pole sector, which is highly more mobile, is also rated as **low sensitivity**.

Impact Magnitude (or Consequence)

For all sectors the impact is considered to be **short-term** (3-4 months for drilling) with the extent being limited to the 500 m radius around the drilling unit (**site**). The **intensity** of the impact on the four affected sectors based on the catch and effort within the safety zone (summarised below and in Table 9-24), is **low**.

- Demersal trawl sector: The maximum catch and effort within the 500 m drilling unit safety zone that may be affected amounts to 0.02% (40 tons) and 0.03% (9 drags) of the overall catch and effort figures.
- Demersal longline sector: The maximum catch and effort within the 500 m drilling unit safety zone that may be affected amounted to 0.02% (<1 ton and 1 line) of both the overall catch and effort figures.
- Large pelagic longline sector: The maximum catch and effort within 30 km[60] of the drilling unit that may be affected amounts to 3.9% (105 ton, 70 lines) of both the overall catch and effort figures.
- Tuna pole sector: The maximum catch and effort within the 500 m drilling unit safety zone that may be affected amounts to 0.1% (1.2 tons, 2 fishing events) of both the overall catch and effort figures.

Thus, the **magnitude** (or consequence) for these four sectors is considered to be **very low**.

The proposed area of interest for drilling does not overlap with the fishing grounds of the midwater trawl, demersal longline, small pelagic purse-seine, large pelagic purse-seine, tuna pole-line, line fish, West Coast rock lobster, South Coast rock lobster, squid jig or small-scale fisheries. Thus, there will be **no impact** on these sectors due to the presence of the drilling unit.

Impact Significance

Based on the sensitivity of the receptors and the magnitude predicted above, the potential impact on the various fishing sectors is presented below and the worst-case (large pelagic longline) is summarised in Table 9-32.

Fishing Sector	Sensitivity	Magnitude (Consequence)	Significance
Demersal trawl	Low	Very Low	**Negligible**
Large pelagic longline	high	Very Low	**Low**
Demersal longline	Low	Very Low	**Negligible**
Tuna pole sector	Low	Very Low	**Negligible**

[60] The 500 m safety zone around the drilling unit would result in an exclusion area of 0.79 km^2. However, since surface longlines are left unattended and drift in surface currents before they are retrieved, these lines can become entangled around the stationary drilling unit. Thus, the potential area of exclusion to fishing operations would be greater than the 500 m safety zone around the drilling unit. Vessel operators would be obliged to take a precautionary approach to reduce the risk of gear entanglement by avoiding a much wider area. Based on an assumed average line length of 60 km, operators could be expected to avoid setting lines within a distance of 30 km of the drilling unit in order to avoid potential gear entanglement.

Identification of Mitigation Measures

No.	Mitigation measure	Classification
1	At least three weeks prior to the commencement of the drilling operations, notify via email or other means the following key stakeholders of the proposed activity (including navigational co-ordinates of well location, timing and duration of proposed activities) and the likely implications thereof (specifically the safety clearance requirements around the drilling unit): • Fishing industry / associations: FishSA, SA Tuna Association; SA Tuna Longline Association, Fresh Tuna Exporters Association, South African Deepsea Trawling Industry Association (SADSTIA) and South African Hake Longline Association (SAHLLA). • Other key stakeholders: SAN Hydrographer, South African Maritime Safety Association and the DFFE Vessel Monitoring, Control and Surveillance Unit in Cape Town. These stakeholders should again be notified when the drilling unit is off location.	Avoid
2	Request, in writing, the HydroSAN to broadcast a navigational warning via Navigational Telex (Navtext) and Cape Town radio (Channel 16 VHF; Call sign: ZSC) for the duration of the drilling campaign.	Avoid
3	Manage the lighting on the drilling unit to ensure that it is sufficiently illuminated to be visible to fishing vessels and compatible with safe operations.	Abate on site
4	Notify any fishing vessels at a radar range of 24 nm from the drilling unit via radio regarding the safety requirements around the drilling unit.	Abate on site
5	Establish a functional 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

Residual Impact Assessment

The potential impacts cannot be eliminated due to the nature of the activity and associated safe operational zone. With the implementation of the mitigation measures, which will ensure good communication and coordination with the various fishing sectors allowing them to focus fishing in other areas, the intensity of the impact will reduce by one level for all sectors. The residual impact **significance** will remain the same for all four sectors:

- Demersal trawl: **NEGLIGIBLE**
- Large pelagic longline: **NEGLIGIBLE**
- Demersal longline: **LOW**
- Tuna pole: **NEGLIGIBLE**

Additional Assessment Criteria

The impact is **fully reversible** after the drilling unit leaves site. The impact probability ranges from **probable** (pelagic longline) to **possible** (for the remaining sectors). The loss of resource is **low** and the cumulative potential is **possible**.

TABLE 9-32: IMPACT ON MOST SENSITIVE FISHING DUE TO SAFETY ZONE AROUND DRILLING UNIT

Project Phase:	**Operation**	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**HIGH** (large pelagic longline)	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	LOW	VERY LOW
Extent	SITE	SITE
Duration	SHORT TERM	SHORT TERM
Significance	**LOW** (large pelagic longline)	**LOW** (large pelagic longline)
Probability	**PROBABLE** (large pelagic longline)	**PROBABLE** (large pelagic longline)
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**LOW**
Cumulative potential	**POSSIBLE**	**POSSIBLE**

9.2.6.2 Impact on Local Tourism, Recreation and Recreational Fishing, and Commercial Shipping

Potential Impact Description

The implementation of the 500 m safety zone will effectively exclude other vessels from around the drilling unit. Thus, their presence presents a potential risk of interference with recreational fishing boats and other marine recreational activities. The exclusion of other vessels from the safety zone may require these vessels to adjust their course slightly (detour) to avoid the drilling unit (**direct negative** impact). The impact assessment for commercial shipping (worst case) is summarised in Table 9-33.

Project Controls

Refer to Section 9.2.6.1.

Sensitivity of Receptors

Receptors in this context is limited to offshore recreational and pleasure vessels that are likely to operate in proximity to the ports of Cape Town and Saldanha Bay, as this is where the risk of interaction with the support vessels is the highest.

Both the ports of Cape Town and Saldanha Bay support extensive commercial vessel traffic, and recreational and pleasure vessels should already have ample experience of operating around commercial vessels. The sensitivity of recreational and pleasure vessels at Cape Town and Saldanha Bay is therefore considered to be **very low**.

A large number of vessels navigate offshore of the South-West Coast on their way around the southern African subcontinent (see Figure 7-93). Although the majority of vessel traffic, including commercial and fishing vessels, remains relatively close inshore a significant amounts of ship traffic can be anticipated in the vicinities of Block 5/6/7 and is, therefore, expected to pass through the block. Thus, the sensitivity of commercial shipping is considered to be **medium**.

Impact Magnitude (or Consequence)

The entire South-West Coast supports extensive domestic and international tourism-based accommodation, facilities, and activities. Much of the coastline supports popular tourism and recreational beaches, while the nearshore and offshore marine environment supports extensive recreational use (including swimming, surfing, snorkelling, and diving, onshore and nearshore recreational fishing, spearfishing, boat charters, whale watching, shark-cage diving, etc.). Given the isolated nature of exploration activities (greater than 60 km from the coast at its closest point) the drilling unit's day-to-day operations will likely have negligible interactions with any nearshore tourism, recreational or recreational fishing activities. However, since the licence area is located within a main shipping route, interaction with commercial shipping is more likely.

Offshore small recreational or pleasure vessels are limited by their certification – which varies from Category E (limited to a distance of 1 nm from shore and 15 nm from an approved launch site) to Category C (15 nm offshore), Category B (limited to day or night passages but within 40 nm of the coastline) to Category A (allowing for extended or ocean passage). Most recreational craft are Category C certified with some commercial recreational charter craft Category B. In all instances (barring Category A) the potential for interaction between the drilling unit and recreational vessels in the area of intertest is negligible.

There is the potential for interactions between the exploration vessels and both nearshore and offshore vessels, but only as the exploration vessels transit between the exploration block and the logistics base (in either Cape Town or Saldanha Bay).

The support vessels will result in a negligible increase in the number of commercial vessels entering either the port of Cape Town or Saldanha Bay. In addition, certified recreational and pleasure crafts continue to operate around existing commercial vessels and port operations.

Assuming that the project vessels (and other vessels) follow normal laws of the sea and standard harbour and safety controls, the impact on local tourism, recreation and recreational fishing, is considered to be of **regional** extent, **short-term** duration and **low intensity**. The potential impact on commercial shipping is, however, considered to be of **medium intensity**. Thus, the **magnitude** (consequence) is considered to be **very low** for Cape Town and Saldanha Bay, and **low** for commercial shipping.

Impact Significance

Based on the **very low to medium sensitivity** of receptors and the **very low to low magnitude**, the potential impact is of **negligible significance** (Cape Town and Saldanha Bay) and **low significance** (commercial shipping).

Identification of Mitigation Measures

Recommendations to mitigate the potential impact on local tourism, recreation and recreational fishing, commercial shipping are similar to that recommended for the fishing industry (see Section 9.2.6.1).

Residual Impact Assessment

Based on the **very low sensitivity** of receptors and the **very low magnitude**, the residual impact remains **negligible significance** for Cape Town and Port Elizabeth, but with **medium sensitivity** and reduction of the **intensity to low**, the residual significance is **very low** for commercial shipping.

Additional Assessment Criteria

The impact is considered to be fully **reversible**. The mitigation potential is **high** in terms of notification and avoidance, the loss of resource is **low**, and the cumulative potential is **likely**. It should be noted that cumulative impact of multiple operations undertaking similar drilling exercise would increase the overall traffic and as a result hazard risks and concomitant safety concerns. However, given the magnitude of current traffic and small numbers of vessels, and limited trip occurrence, even under an increased number of operations the magnitude and significance is likely to remain low.

TABLE 9-33: IMPACT ON COMMERCIAL SHIPPING DUE TO SAFETY ZONE AROUND DRILLING UNIT

Project Phase:	Mobilisation, Operation and Decommissioning	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**MEDIUM**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**LOW**	**VERY LOW**
Intensity	MEDIUM	LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	**LOW**	**VERY LOW**
Probability	**POSSIBLE**	**POSSIBLE**
Confidence	**MEDIUM**	**MEDIUM**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**HIGH**
Cumulative potential	**LIKELY**	**LIKELY**

9.3 EMPLOYMENT AND PROCUREMENT OF GOODS AND SERVICES

Source of Impact

The project activities that are likely to result in economic benefits / impacts for local service providers or suppliers and other sectors are:

Project phase	Activity
Mobilisation	Rental of quay space for use as laydown area, warehouse, and mud plant (for preparation of drilling fluids)
	Appointment of specialised international and local service providers and staff
	Procurement of long lead items, importation and transportation of drilling equipment and bulk materials
	Accommodation rental and local spend (e.g., catering and supplies)
Operation	Provision of services from local service providers (e.g., berthing, accommodation, catering, waste management and refuelling)
	Operation of drilling unit and supply vessels
	Operation of helicopters
	Rental of quay space
	Berthing during crew changes
Demobilisation	Demobilisation of logistics base, services, and work force

The exploration activities will result in limited economic benefits due to the short-term nature of the activity with respect to the use of local service providers or suppliers. The demand for such local services will be largely limited to logistics, supply base, helicopters, refuelling, catering, goods, accommodation, waste management and other well drilling activities (e.g., logging, cementing and testing) provided at the onshore logistics base in Cape Town or Saldanha Bay. The specialised nature of the drilling unit is such that skills are not available locally and are sourced from international contractors. The technical nature of the operations means that the drilling unit is crewed by highly skilled personnel, who are part and parcel of the contract.

Although the project activities may benefit local and provide opportunities, it may impact other sectors and put added pressure on local facilities and limit the ability of local authorities to respond to the Oil and Gas sector operation.

9.3.1 Jobs and Business Opportunities

9.3.1.1 Impact on Local Content / Local Economic Development

Potential Impact Description

The proposed project will result in a temporary spending injection that will benefit the local economy. All expenditures will lead to increased economic activity that will result in **direct and indirect positive** impacts on employment and income. The impact assessment is summarised in Table 9-34.

Project Controls

TEEPSA local content policy includes a local content clause in its contracts whereby every major service provider must submit a local content plan focusing on local spend, skills development and local employment opportunities.

Sensitivity of Receptors

The receptors in the context of the exploration activities are considered as Cape Town (preferred alternative) and Saldanha Bay as the potential logistics bases for the rig and support vessels. Cape Town is a major metropolitan area that support large and diversified economic sectors and a very large employment base. Saldanha also has a well-developed port facility. The sensitivity of both Cape Town and Saldanha Bay is, therefore, considered to be **very low**.

Impact Magnitude (or Consequence)

There are limiting factors in terms of promoting local economic development. The Project is of a relatively short-term duration (approximately six months per well) limiting any potential for long-term development benefits. In addition, TEEPSA will likely contract local contractors where the skills and expertise are available, and this will be the larger and more established businesses and bulk suppliers. There are only likely to be restricted benefits to local SMME's outside of incidental expenditure.

The majority of the workforce will comprise highly specialised skilled staff that will come in with the drilling unit (180 - 200 people working on rotation). In addition, up to 177 local people will be appointed on the proposed project per well drilling campaign, who will be based both onshore and offshore. The maximum number of people on board the drilling unit at any one time would be up to 140 people, with the remainder being based permanently onshore or short periods during crew changes. The use of local labour will be prioritised where possible in line with TEEPSA's local content policy requirements.

The proposed exploration activities are expected to inject USD 90 million into the regional South African economy (based on TEEPSA's 2020 drilling campaign off the South Coast), which will largely be directed to bulk suppliers and logistics support. It is not possible to determine the total exploration spend that will be directed into the local Cape Town Metropolitan and / or Saldanha areas. The proposed exploration activities will have minimal demand for local content and local employment, outside of the use of local services providers for logistics, supply base, helicopters, refuelling, catering, goods, accommodation, waste management, etc. The benefits of this low demand for **local** services and employment in both Cape Town and Port Elizabeth is considered to be of **very low intensity**, and only of **short-term** duration. The positive impact is, however, considered to be of **very low magnitude** (or consequence).

Impact Significance

Based on the **very low sensitivity** of receptors and the **very low magnitude**, the potential impact (or benefit) to the local economy is of **negligible positive significance**.

Identification of Mitigation Measures

The following mitigation measures are recommended to maximise business benefits and manage potential over expectation:

No.	Mitigation measure	Classification
1	Apply fair, transparent, and reasonable preferential contracting of local companies with the suitable expertise and proven transformation track record to maximise benefits. The need for transparency includes the disclose of tender awards.	Enhancement
2	Engage coastal community(ies) that are oriented towards small-scale fishing within the direct area of influence for beneficiation from local economic development and corporate responsibility programmes, or similar.	Enhancement
3	Include as a condition of contracting that any non-local service providers will apply reasonable preferential sub-contracting of companies (depending on which location is selected as the logistics base). Ensure contractors demonstrate their commitment to maximisation of local employment, service awards and sub-contracting.	Enhancement
4	Ensure that all service providers / contractors actively manage community expectations related to local procurement, local content, and local employment opportunities. This should include a co-ordinated and approved public message / statement prepared jointly with TEEPSA and communicated as and when necessary.	Avoid
5	Implement a public information and disclosure programme covering all TEEPSA exploration activities to ensure that the public are informed of the exploration activities (specifically onshore and nearshore activities). As part of the public information and disclosure programme, disclose project information via local media and communication channels – e.g., newspaper articles, public notices, newsletters, websites and meetings as required. Focus should be placed on the Saldanha Bay in particular (if selected as the location for onshore logistics base.	Avoid
6	Engage with local community forums, business chambers, tourism offices and other collective organisations on a regular basis in order to disclose information to key stakeholders and draw out any ongoing issues and concerns. Focus should be placed on the Saldanha Bay in particular (if selected as the location for onshore logistics base).	Avoid

No.	Mitigation measure	Classification
7	Establish a functional 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.	Avoid

Residual Impact Assessment

The implementation of the enhancement and mitigation measures will not change the intensity, extent or duration of the impact. Thus, the residual impacts will remain of **NEGLIGIBLE significance**.

Additional Assessment Criteria

The cumulative potential is **likely**. Caution will be needed in terms of managing over-expectation of economic benefits and employment opportunities around Saldanha Bay. This is particularly important when considering cumulative benefits should additional exploration activities commence (by either TEEPSA or other exploration right holders) in a relatively short period.

TABLE 9-34: ECONOMIC BENEFITS FOR LOCAL SERVICE PROVIDERS AND SUPPLIERS DUE TO EMPLOYMENT AND BUSINESS OPPORTUNITIES

Project Phase:	**Mobilisation, Operation and Decommissioning**	
Type of Impact	**Direct / Indirect**	
Nature of Impact	**Positive**	
Sensitivity of Receptor	**VERY LOW**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	VERY LOW	VERY LOW
Extent	LOCAL	LOCAL
Duration	SHORT TERM	SHORT TERM
Significance	**NEGLIGIBLE**	**NEGLIGIBLE**
Probability	**DEFINITE**	**DEFINITE**
Confidence	**HIGH**	**HIGH**
Reversibility	**N/A**	**N/A**
Loss of Resources	**N/A**	**N/A**
Mitigation Potential	**-**	**N/A**
Cumulative potential	**LIKELY**	**LIKELY**

9.3.1.2 Impact on Local Economic Sectors

Potential Impact Description

There will be moderate expectations amongst some stakeholders that TEEPSA's operations will support local businesses and provide opportunities. In addition, there will be substantial interest in terms of how the exploration activities (as well as long term Oil and Gas sector development) will alter current development trends toward tourism, residential development and service sectors, as well as suitability of the local property market and tourism appeal (**indirect neutral** impact). The impact assessment is summarised in Table 9-35. Note: Impact on commercial fishing is assessed in Section 9.2.2.2, 9.2.3.2 and 9.2.6.1.

Project Controls

TEEPSA's local content policy includes a local content clause in its contracts whereby every major service provider must submit a local content plan focusing on local spend, skills development and local employment opportunities.

Sensitivity of Receptors

The receptors in the context of the exploration activities are considered as Cape Town (preferred alternative) and Saldanha Bay as the potential logistics bases for the rig and support vessels. Cape Town is a major metropolitan area that supports large and diversified economic sectors that can support, and potentially benefit from the exploration activities. Saldanha also has a well-developed commercial port facility. The sensitivity of both Cape Town and Saldanha Bay is considered to be **very low**.

Impact Magnitude (or Consequence)

Cape Town and Saldanha Bay support a diversified economy typical of major metropolitan areas, specifically the tertiary sector (finances and insurances, real estate, and business services as well as wholesale, retail, catering, and accommodation) in the case of Cape Town and the commercial services sector in Saldanha Bay. The exploration activities will be able to benefit from locally established economic sectors without placing any pressure on such sectors.

The Cape South-West Coast has seen rapid coastal residential and tourism development being extensively marketed as both a local and international tourism area), which can be seen as being incompatible with the future development of the Oil and Gas sector. There will likely be substantive interest in terms of the short-term and long-term Oil and Gas sector development and how this will promote or hinder future residential and tourism development.

No direct impact is likely, however, in a worst-case scenario where misinformation and negative connotations associated with the exploration activities are spread via social media, there is a risk that this will impact on the existing perceptions in terms of the suitability of the local property market and tourism appeal, as well as perceived economic benefits. Much of the impacts will be driven by over-expectation in terms of benefits as well as risks related to local community opposition where residential housing and tourism is perceived to be at risk.

The proposed exploration activities will have a minimal **local** footprint and are of **short-term** duration. While Cape Town / Saldanha Bay and environs remain well geared to support and receive very low benefits from the exploration activities (very low intensity), there is a possible chance for conflict with existing residential and tourism sectors in the area of influence (low intensity). Overall, the **intensity** of the impact in this area is considered to be **low**.

The impact is, however, considered to be of **very low magnitude** (or consequence) for all onshore logistic alternatives.

Impact Significance

Based on the **low sensitivity** of receptors and the **very low magnitude**, all potential impacts on local economic sectors are of **negligible significance**.

Identification of Mitigation Measures

The mitigation listed in Section 9.3.1.1 aims to promote economic development while managing expectations, with specific emphasis on Saldanha Bay. In addition, a focussed media campaign is recommended to manage risks related to perceived impacts on local residential and tourism development.

Residual Impact Assessment

With the implementation of the mitigation measures, the residual impact will remain of **NEGLIGIBLE significance**.

Additional Assessment Criteria

The impact is considered to be **fully reversible** once exploration is complete. The mitigation potential is **low** and the loss of resource is **low**.

It is **possible** that there will be cumulative impacts should additional exploration activities commence (by either TEEPSA or other exploration right holders) in a relatively short period. While Cape Town and Saldanha Bay should readily absorb any parallel exploration activities, this may result in substantive interest from key economic sectors along the entire South-West Coast. Industries and businesses geared towards oil and gas will see substantive benefits, but there may be increased opposition from the residential and tourism sectors where they see such activities as degrading the appeal of the coastline.

TABLE 9-35: OVERALL IMPACT ON LOCAL ECONOMIC SECTORS

Project Phase:	Mobilisation, Operation and Decommissioning	
Type of Impact	Direct	
Nature of Impact	Neutral	
Sensitivity of Receptor	VERY LOW	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	VERY LOW	VERY LOW
Intensity	LOW	VERY LOW
Extent	LOCAL	LOCAL
Duration	SHORT TERM	SHORT TERM
Significance	NEGLIGIBLE	NEGLIGIBLE
Probability	LIKELY	POSSIBLE
Confidence	HIGH	HIGH
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	LOW
Cumulative potential	POSSIBLE	POSSIBLE

9.3.2 Use of Local Services and Facilities

9.3.2.1 Pressure on Local Services and Facilities

Potential Impact Description

The use of local service providers and suppliers, while considered an economic benefit, may also result in increased pressure on local providers or facilities if they do not have sufficient capacity to support the exploration or other activities (**direct negative** impact). This may include both public services (hospitals, clinics, and emergency responses.), as well as private services (accommodation, transport and others), but also consumption of products (i.e. food, consumables, etc.). The impact assessment is summarised in Table 9-36.

Note, the economic benefits with respect to the use of local service providers or suppliers in assessed in Section 9.3.1.

Project Controls

TEEPSA local content policy includes a local content clause in its contracts whereby every major service provider must submit a local content plan focusing on local spend, skills development and local employment opportunities.

Sensitivity of Receptors

The receptors in the context of the exploration activities are considered as Cape Town and Saldanha Bay as the potential logistics bases for the rig and support vessels.

The City of Cape Town provide a full range of social services and facilities, including: municipal administration; health and education facilities; and water, electricity and sanitation services. Cape Town and Saldanha Bay are broadly recognised are broadly recognised as better managed municipalities in South Africa by local municipal officials and local stakeholders. Saldanha Bay also has a well-developed port facility.

The exploration activities will support a workforce of approximately 180 - 200 international crew that would come in with the drilling unit, who will work on a rotational basis. In addition, there will be up to approximately 177 local people appointed on the proposed project per well drilling campaign, who will be based both onshore and offshore. The maximum number of people on board the drilling unit at any one time would be up to 140 people, with the remainder being based permanently onshore or short periods during crew changes. The onshore workforce may require the use of public facilities (including administrative, health, etc.) as part of day-to-day activities. The exploration workforce would make a negligible addition to the estimated 4.1 million population of the Cape Town municipal area and the 119 000 population of the Saldanha Bay municipal area. The drilling unit will require municipal potable water / drilling water.

The sensitivity of both Cape Town and Saldanha Bay is therefore considered to be **very low**.

Impact Magnitude (or Consequence)

The location of the onshore logistics base will ultimately be based on discussions with Transnet National Ports Authority and tenders from the Oil and Gas service provider industry. The logistics base will be located in a designated area zoned for industrial use and in accordance with spatial development plans. Therefore, no conflict with other land users is expected. Selection of the locality would be on the basis of there being sufficient space and capacity, and adequate facilities to accommodate the project without placing undue pressure or restriction on the continued provision of the same services to local communities. Both potential ports have existing facilities and operators which service the Oil and Gas industry. There would not be no requirement for the development of new facilities. The proposed operations would not constitute a significantly different or additional operation in the context of any of the potential ports. None of the required logistics / support operations are of such a nature, frequency or duration that they would place undue pressure on local infrastructure. Similarly, the selection of the base for air support (Cape Town) is on the basis of that there is adequate capacity to accommodate the project. The required air support operations are not of a nature, frequency or duration that would place undue pressure on local infrastructure.

General waste landfill sites are located at the two onshore base options, Cape Town and Saldanha Bay. Cape Town also has a hazardous landfill site. The services of an appropriately licenced waste contractor will be used to collect and transport all operational waste for recycling, treatment or disposal. The volumes of waste generated and requiring onshore management are relatively small. The disposal of waste onshore will be fully traceable to ensure it is disposed at appropriately licenced waste facilities.

The relatively small onshore workforce in the municipal area will result in a minimal local footprint or presence and will be of **short-term** duration and **very low intensity** for both onshore logistic base alternatives. The proposed exploration activities will have a minimal **local** footprint. Thus, the potential for impacts of pressure on local services or facilities is considered to be of **very low** magnitude (or consequence).

Impact Significance

Based on the **very low sensitivity** of receptors and the **very low magnitude**, the potential impact on local integrated panning is of **negligible significance** for all onshore logistic alternatives.

Identification of Mitigation Measures

As the impact on local services and facilities is deemed negligible, no specific mitigation measures or recommendations are deemed necessary. Refer to Section 9.3.1.1 for recommended measures to maximise business benefits and manage potential over-expectation.

Residual Impact Assessment

The implementation of the mitigation measures will not change the intensity, extent or duration of the impact. Thus, the residual impact will remain of very low magnitude and **NEGLIGIBLE significance.**

Additional Assessment Criteria

The impact is considered to be **fully reversible** once exploration activities are complete. The mitigation potential is **very low** and the loss of resource is **low**.

There is the **likely** chance of a cumulative impact should additional exploration activities commence (by either TEEPSA or other exploration right holders) in a relatively short period. Cape Town and Saldanha Bay should be able to absorb any parallel exploration activities.

TABLE 9-36: IMPACT OF PRESSURE ON LOCAL SERVICES AND FACILITIES

Project Phase:	**Mobilisation, Operation and Decommissioning**	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**VERY LOW**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	VERY LOW	VERY LOW
Extent	LOCAL	LOCAL
Duration	SHORT TERM	SHORT TERM
Significance	**NEGLIGIBLE**	**NEGLIGIBLE**
Probability	**UNLIKELY**	**UNLIKELY**
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**VERY LOW**
Cumulative potential	**LIKELY**	**LIKELY**

9.3.2.2 Pressure on Local Integrated Planning

Potential Impact Description

While there is national interest in the Oil and Gas sector, the project may not be aligned to local integrate planning directives, which may limit the ability of local authorities to respond to the Oil and Gas sector both in terms of day-to-day operations, as well as any unplanned events (**indirect negative** impact). The impact assessment is summarised in Table 9-37.

Project Controls

None.

Sensitivity of Receptors

The receptors in the context of the exploration activities are considered as Cape Town and Saldanha Bay as the potential logistics bases for the rig and support vessels (refer to Section 9.3.2.1). With respect to spatial developing planning, there is no specific provision made for or support of the Oil and Gas Sector, although Saldanha Bay Industrial Development Zone does support oil and gas activities. However, spatial planning priorities vary by ward, and the City of Cape Town is planning to support business development, urban renewal of the CBD, tourism and recreation, improvement in public services and integrated tourism projects. Saldanha has a well-developed port facility with a direct commercial purpose. The future economic development of the municipality is heavily invested in the establishment of the Saldanha Bay Industrial Development Zone, which is a Special Economic Zone focussed on the development of the energy and maritime industries. The quayside and logistics base of the Saldanha Bay Industrial Development Zone has attracted significant interest from operators for an "Offshore Supply Base", including the development of appropriate warehouses and workshops (SBIDZ 2020).

The sensitivity of Cape Town and Saldanha Bay are considered to be **very low**.

Impact Magnitude (or Consequence)

The proposed logistics facilities at either Cape Town or Saldanha Bay ports is consistent with the functions and activities undertaken at these harbours. The logistics base does not conflict with current activities in these harbours, nor will it impact on land-uses in the immediate surrounds. The use of the helicopter base / services is also considered have negligible impact with respect to local integrated planning. The exploration activities, therefore, does not conflict with the IDPs and SDFs, and any potential impact is considered to be **local** of **short-term** duration and of **very low intensity**. Thus, the magnitude (or consequence) is considered to be **very low** for both Cape town and Saldanha Bay.

Impact Significance

Based on the **very low sensitivity** of receptors and the **very low magnitude**, the potential impact on local integrated panning is of **negligible significance** for all onshore logistic alternatives.

Identification of Mitigation Measures

The Project is not seen to result in any inherent impacts that conflict with existing municipal IDP and SDFs, therefore no mitigation measures or recommendations are deemed necessary.

Residual Impact Assessment

No mitigation measures are considered necessary. The residual impact will remain of **NEGLIGIBLE significance**.

Additional Assessment Criteria

The impact is considered to be **fully reversible** once exploration activities are complete. The mitigation potential is **very low**, the loss of resource is **low**, and the cumulative potential is **likely** should additional and multiple exploration or production activities commence (by either TEEPSA or other exploration right holders) in a relatively short period.

TABLE 9-37: IMPACT OF PRESSURE ON LOCAL INTEGRATED PLANNING

Project Phase:	**Mobilisation, Operation and Decommissioning**	
Type of Impact	**Indirect**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**LOW**	
	Pre-Mitigation Impact	**Residual Impact**
Magnitude (Consequence)	**VERY LOW**	**VERY LOW**
Intensity	VERY LOW	VERY LOW
Extent	LOCAL	LOCAL
Duration	SHORT TERM	SHORT TERM
Significance	**NEGLIGIBLE**	**NEGLIGIBLE**
Probability	**UNLIKELY**	**UNLIKELY**
Confidence	**HIGH**	**HIGH**
Reversibility	**FULLY REVERSIBLE**	**FULLY REVERSIBLE**
Loss of Resources	**LOW**	**LOW**
Mitigation Potential	**-**	**VERY LOW**
Cumulative potential	**LIKELY**	**LIKELY**

9.4 CUMULATIVE IMPACTS

9.4.1 Introduction

Cumulative effects are commonly understood as the potential impacts which combine from different actions and which result in significant change, which is larger than the sum of all the impacts. The consideration of the 'cumulative impact' should include "past, present and reasonably foreseeable future developments or impacts". This requires a holistic view, interpretation and analysis of the biophysical, social and economic systems. Cumulative impact assessment is limited and constrained by the method used for identifying and analysing cumulative effects. It is not practical to analyse the cumulative effects of an action on every environmental receptor, the list of environmental effects should focus on those that are truly meaningful. For cumulative effects analysis to help the decision-maker and inform interested parties, it must be limited to effects that can be evaluated meaningfully (DEAT 2004).

While it is foreseeable that further exploration and future production activities (not considered as part of the current application for Environmental Authorisation) could arise if the current Environmental Authorisation application is granted, there is not currently sufficient information to make reasonable assertions as to nature of the resource (should one exist) and any future activities. This is due to the current lack of relevant geological information, which the proposed exploration process aims to address. The possible range of the future exploration or production activities that may or may not arise vary hugely in scope, location, extent, and duration depending on whether a petroleum resource(s) is discovered, its size, properties and location, etc. These cannot be reasonably defined until further exploration is undertaken (as proposed). It would not be reasonable to undertake an assessment of the environmental impacts of an undefined project. Potential impacts could not be reliably assessed, and the range of outcomes is so vast that the findings would be speculative at best and of no value in ascertaining the potential impacts. It is also possible that the proposed, or future, exploration determines that an economic petroleum resource does not exist, in which case there would be no production phase and no potential impacts associated with these activities.

Thus, the scope of this ESIA is limited to the assessment of activities proposed as part of this exploration project, i.e. drilling of up to five exploration wells, and does not aim to identify or assess the impacts or benefits of possible future exploration or production activities or outcomes. The outcome of the proposed exploration activities will determine the nature and extent of any potential resources within the licence block and potential future activities. Should the results of the currently proposed exploration be promising, a separate Environmental Authorisation application and ESIA process would need to be undertaken to assess the potential impacts associated with possible future production (i.e. extraction) activities. The Need and Desirability section (Section 5) deals, to some extent, with future production (extraction) as it documents national and international policy, which recognises the need for natural gas in the energy mix in the just transition to net-zero emissions by 2050. It also weighs up the risks of South Africa having to import natural gas for it needs, as at present, rather than being able to optimise the use of its own domestic oil and gas resources, should they exist, to assist in the transition to the 2050 carbon neutrality targets.

It should be noted that the assessment methodology used in the ESIA does by its nature already considers past and current activities and impacts. In particular, when rating the sensitivity of the receptors, the status of the receiving environment (benthic ecosystem threat status, protection level, protected areas, etc.) or threat status of individual species is taken into consideration, which is based to some degree on past and current actions and impacts (e.g., the IUCN conservation rating is determined based on criteria such as population size and rate of decline, area of geographic range / distribution, and degree of population and distribution fragmentation; and Brown's Bank Rocky Shelf Edge rated critically endangered due to very severe modification of habitat due to commercial demersal trawling - see Figure 9-15).

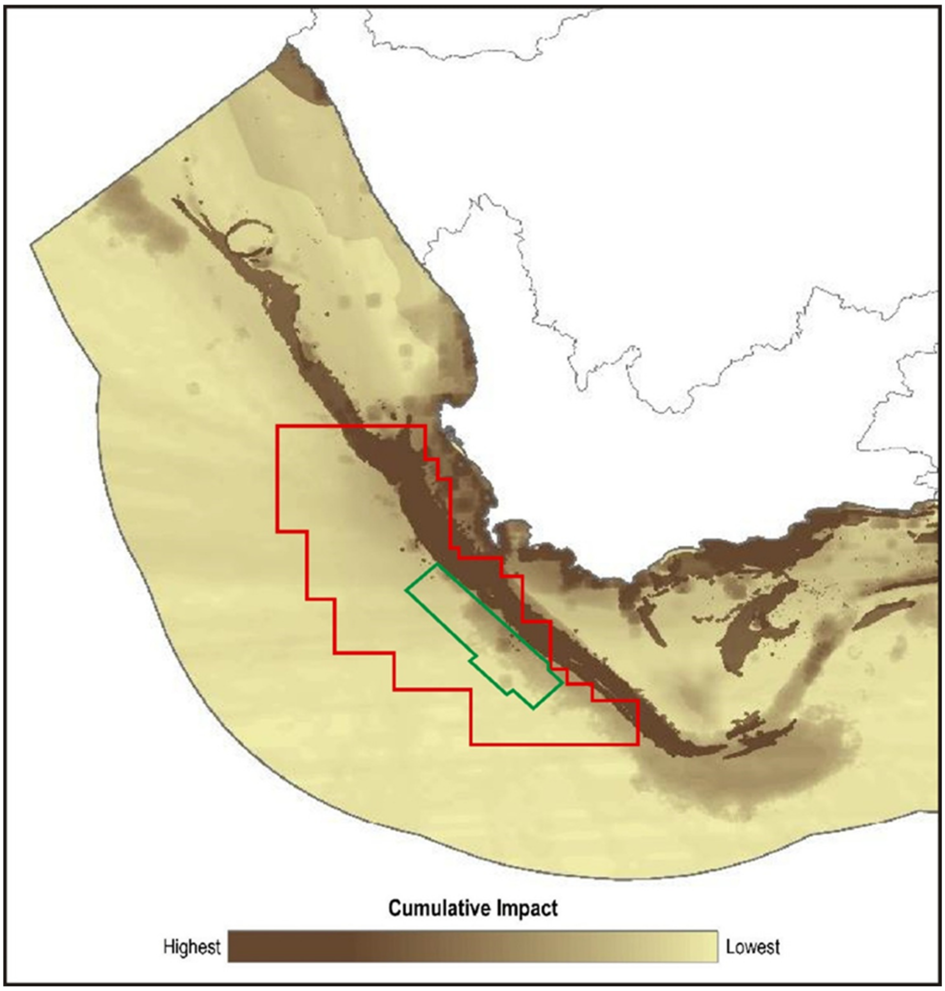


FIGURE 9-15: BLOCK 5/6/7 AND THE AREA OF INTEREST FOR DRILLING IN RELATION TO THE CUMULATIVE IMPACTS ON MARINE BIODIVERSITY

Note: Map is based the intensity of all cumulative pressures and the sensitivity of the ecosystem types to each these pressures Adapted from Harris et al. 2022

9.4.2 Oil, Gas and Mining in the South Africa offshore

Oil and gas exploration and production is currently undertaken in various licence blocks off the West, South and East coasts of South Africa (see Figure 7-94).

Between 2007/2008 and 2020/2021, 21 seismic surveys have been undertaken in South African waters (see Table 9-38; Figure 9-16). There are a number of current reconnaissance permit applications being undertaken for proposed seismic surveys off the West Coast (as of September 2022), although it is unlikely that all these will be undertaken as they are targeting similar areas in the Deep Water Orange Basin.

TABLE 9-38: SEISMIC SURVEYS UNDERTAKEN IN SOUTH AFRICA BETWEEN 2007/2008 AND 2021/2022

No.	Right Holder	Acquisition corporation	Ref	Year	Area	Survey type	Survey Areal Extent	Survey Vessel	Survey Duration	Offshore/Onshore
FINANCIAL YEAR 2021-2022										
1	Shell	Shearwater	ER 12/3/252	2021-2022	Transkei Basin	3D	TBC	MV Amazon Warrior	Dec 2021	Offshore
2	Seacher	Seacher	ER 12/1/038	2021	West Coast	2D	TBC	BGP Pioneer	Jan 2022	Offshore
FINANCIAL YEAR 2020-2021										
1	Shell	PGP Offshore	ER 12/3/274	2021	Orange Basin	2D	1 000 km	M/V BGP Pioneer vessel	Feb 2021 - Mar 2021	Offshore
FINANCIAL YEAR 2019-2020										
1	TEEPSA	PGS	ER 12/3/067	2019-2020	Block 11B/12B	2D	7 589 km	SW Cook	Dec 2019-Mar 2020	Offshore
2	TEEPSA	PGS	ER 12/3/067	2019-2020	Block 11B/12B	3D	2 305 km	Apollo	Dec 2019-Mar 2020	Offshore
3	Anadarko	PGS	ER 12/3/228	2019-2020	South-west coast	3D	TBC	Ramform Atlas	Dec 2019-Jan 2020	Offshore
4	TEEPSA	Polarcus	ER 12/3/067	2019	South Outeniqua	3D	570 km	Polarcus Asima	Mar 2019-Apr 2019	Offshore
FINANCIAL YEAR 2018-2019										
1	Equinor/OK Energy	PGS	ER 12/3/257	2018	Algoa East	2D	1 162 km	Sanco Atlantic	Apr 2018-May 2018	Offshore
2	Eni/Sasol	PGS	ER 12/3/236	2018	Durban/Zululand	3D	3 114 km	Ramform Sovereign	Mar 2018-May 2018	Offshore
3	ExxonMobil	PGS	ER 12/3/273, ER252	2018	Transkei frontier	2D	5 129 km	Sanco Atlantic	Jan 2018-May 2018	Offshore
FINANCIAL YEAR 2015-2016										
1	PGS Multiclient UK	PGS Geophysics	RP 12/1/015	2015-2016	Outeniqua and Bredasdorp Basin	2D	5 435.96 km	Atlantic Explorer	Dec 2015-Feb 2016	Offshore
2	Spectrum	Geoguide Consultants	RP 12/1/012 & 013	2015	south/east coast	2D	18 000 km	BGP Pioneer	Apr 2015-May 2015	Offshore
FINANCIAL YEAR 2014-2015										
1	PGS Exploration	PGS	multiclient	2013-2014	East Coast	2D	13 391 km	MV Sanco Spirit	Dec 2013-May 2014	Offshore
2	CGG /Sasol	CGG	ER 12/3/236	2014	East Coast	2D	6 100 km	CGG Princess	Mar 2013 - Apr2014	Offshore
FINANCIAL YEAR 2013-2014										
1	New Age	Polarcus	ER 12/3/201	2013-2014	Algoa Gamtoo	3D	658 km^2	Polarcus Nadia	Dec 2013-Jan 2014	Offshore
2	New Age	SeaBird exploration	ER 12/3/201	2013	Algoa Gamtoos	2D	1 787 km	Eagle Explorer	Feb 2013-Mar 2013	Offshore
3	Cairn India	Dolphin geophysics	ER 12/3/083	2014	West Coast	2D	2 200 km	Artemis Atlantis	Feb 2014 - Mar 2014	Offshore
FINANCIAL YEAR 2011-2012										
1	Impact Africa	PGS	ER 12/3/154	2012	East Coast	2D	3 100 km	SANCO Spirit	Jan 2012-Mar 2012	Offshore
2	Impact Africa	SeaBird exploration	ER 12/3/154	2011	East Coast	2D	1 900 km	Northern Explorer	May 2011-Jul 2011	Offshore
3	PetroSA	Western geco	ER 12/4/061	2011	Block 9	2D	730 km	WG Tasman	Apr 2011-May 2011	Offshore
4	PetroSA	Western geco	ER 12/4/062	2011-2012	Block 10	3D	3 470 km^2	WG Tasman	Nov 2011-Apr 2012	Offshore
FINANCIAL YEAR 2008-2009										
1	PASA	SeaBird exploration	TBC	2008	West Coast	2D	1 057 km	MV Munin explorer	Sep 2008-Sep 2008	Offshore

No.	Right Holder	Acquisition corporation	Ref	Year	Area	Survey type	Survey Areal Extent	Survey Vessel	Survey Duration	Offshore/Onshore
FINANCIAL YEAR 2007-2008										
1	PASA	Gems Survey LTD	TBC	2007	Orange Basin	2D	1 057 km	R/V Akademik Boris Petrov	November 2007 - December 2007	Offshore

Source: PASA (January 2022)

TABLE 9-39: OFFSHORE MINERAL PROSPECTING AND MINING OFF THE WEST COAST

YEAR	RIGHT HOLDER / OPERATOR	BLOCK	ACTIVITY	APPROVAL	CONDUCTED / COMPLETED
SOUTH AFRICAN SEA AREAS MINERALS PROSPECTING AND MINING					
2011	Aurumar	SASA 1C-9C SASA 12C, 14C-18C, 20C	Heavy minerals coring	Yes	Jan-Mar 2011: 2C-5C: Geophysical & coring; 7C-10C: Geophysical & coring; 12C, 14C-18C & 20C: Only desktop
2013-2014	Belton Park Trading	SASA 2C-5C	Geophysical surveys, coring, bulk sampling	Yes	Survey and sampling: ongoing in 2C and 3C Various prospecting operations undertaken over duration of prospecting right
2017	Belton Park Trading	SASA 2C (3C was incorporated into mining right area in 2019)	Mining	Yes	Ongoing prospecting and mining have taken place over various campaigns to date: 2C: 9 Aug – 7 Nov 2018; 13 Mar – 5 May 2019; 9 Jul – 25 Oct 2019; 2C & 3C: 27 Feb – 31 Aug 2020. Mining is currently ongoing
2018	De Beers Marine	SASA 6C	Geophysical surveys, sampling	Yes	Survey: May-Jul 2021 Sampling: Dec 2021 – Jan 2022
2020	Belton Park Trading	SASA 14B, 15B, 17B	Geophysical surveys, sampling	Yes, but appeal still under review	
2020	Belton Park Trading	SASA 13C, 15C, 16C, 17C, 18C	Geophysical surveys, sampling	Yes, but appeal still under review	
2021	De Beers Marine	SASA 4C & 5C	Geophysical surveys, sampling	Application in prep.	
2021	Samara Mining	SASA 4C & 5C	Geophysical surveys, sampling	Application contested and withdrawn	
2021-2022	Moonstone Diamond Marketing	SASA 11B, 13B	Geophysical surveys, sampling	Application delayed. Second EIA in prep.	
2022	Trans-Atlantic Diamonds	SASA 14A	Geophysical surveys, sampling	Yes	
2022	Trans-Atlantic Diamonds	SASA 11C	Geophysical surveys, sampling	FBAR on 2 March 2022	

Source: CapMarine 2022

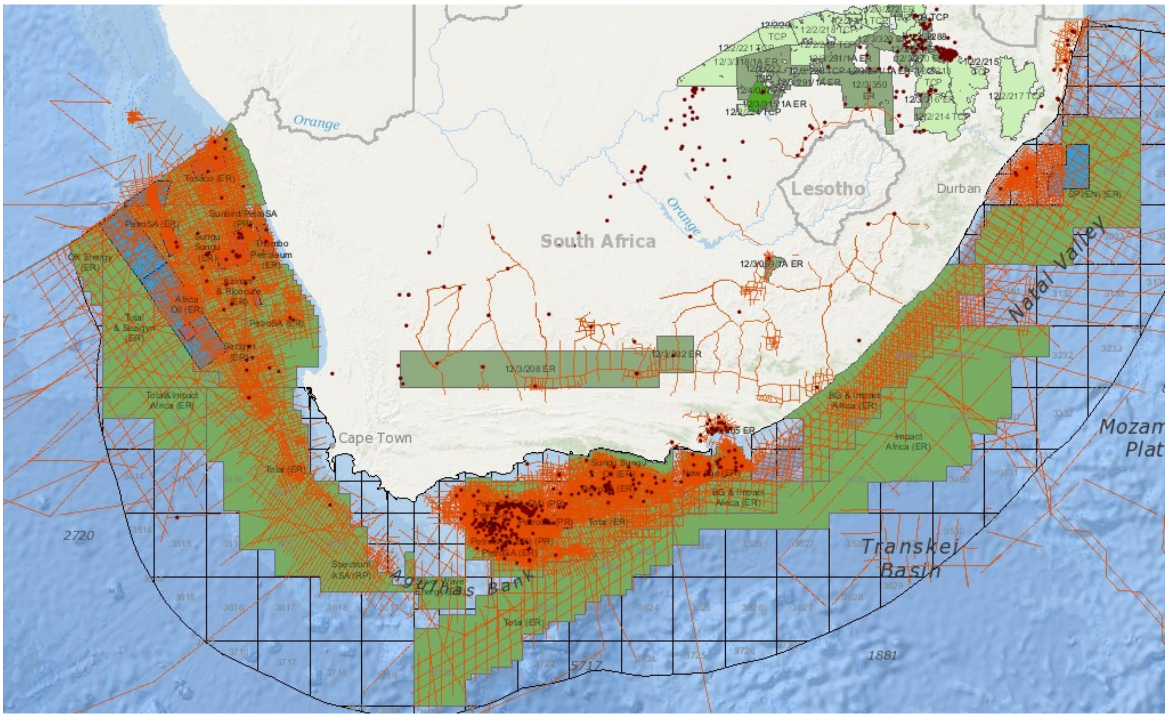


FIGURE 9-16: HISTORIC 2D (ORANGE LINES) AND 3D (BLUE POLYGONS) SEISMIC SURVEYS AND WELL DRILLING (DOTS) CONDUCTED OFF THE SOUTH AFRICA COAST

Source: https://geoportal.petroleumagencysa.com/Storefront/Viewer/index_map.html

In the order of 358 wells have been drilled in the South African offshore environment to date (based on information provided by PASA in 2021; see Figure 9-16), the majority of which have been drilled off the South Coast on the Agulhas Bank. Two wells were previously drilled by PetroSA (then Soekor) within Block 5/6/7 (see Figure 7-95); one of which was a "dry" well, while the other well showed signs of gas). Off the West Coast, Eco (Atlantic) Oil & Gas has commenced with drilling in Block 2B (as of 10 October 2022). Other possible future well drilling off the West Coast could also be undertaken in Block 1 (Exploration Right) and Block 2A (Production Right), for which existing rights and approvals exist. However, the timing of drilling in these blocks is unknown.

There is no current development or production from the South African West Coast offshore. The Ibhubesi Gas Field (Block 2A) (off West Coast, approximately 220 km north of Block 5/6/7) and Kudu Gas Field (off southern Namibia) have been identified for development. On the South Coast, PetroSA operates the F-A production platform, which was brought into production in 1992. The F-A platform is located 85 km south of Mossel Bay in a water depth of 100 m. Gas and associated condensate from the gas fields are processed through the platform. The produced gas and condensate are exported through two separate 93 km pipelines to the PetroSA GTL plant located just outside the town of Mossel Bay. It is widely reported that the gas supplying the Mossel Bay GTL plant from Block 9 was due to cease in late 2020 (Business Insider) and it seems likely to close unless a domestic gas supply is identified or a large bail out by the South Africa taxpayer is agreed to fund processing of higher cost feedstocks. In this respect, it should be noted that a production licence has been sought by TEEPSA for the offshore Block 11B/12B, which may offer hope to the Mossel Bay GTL plant, assuming the necessary approvals are obtained.

Table 9-38 and Table 9-39 list the applications for petroleum exploration and mineral prospecting / mining rights, respectively, in the Southern Benguela region (South African West Coast) since 2007, indicating which of these have been undertaken. Concurrent activities such as other planned speculative or proprietary seismic surveys in the southern Benguela region could add to the cumulative impact.

9.4.3 Biophysical

The primary impacts associated with the drilling of exploration wells (normal drilling operations) in the Southeast Atlantic Deep Ocean Ecoregion, relate to physical disturbance of the seabed, discharges of drilling solids to the benthic environment, underwater noise, infrastructure remaining on the seabed and the presence of associated vessels and drill unit. Other marine exploration and mining activities on the West Coast are all located well inshore and to the north of the area of interest. The major cumulative impacts on benthic ecosystems in Block 5/6/7 are the result of demersal trawling along the western edge of the Agulhas Bank (Harris et al. 2022). These are located inshore of the area of interest (see Figure 9-15).

Cuttings Discharge and Sediment Plume

The proposed exploration well drilling campaign (five wells) would generate a risk plume of cuttings and drilling muds in the water column. The maximum instantaneous risk would correspond to a footprint in the water column that would extend in a north-westerly direction impacting a maximum cumulative volume of 78.42 km^3 for a maximum duration of 17 days, which can be considered an insignificant percentage of the ecoregion as a whole. Oil and gas exploration and production activities in South Africa have focused on the Agulhas Bank with the development of the Oribi, Oryx and Sable oil fields and F-O gas fields, which lie to the east of Block 5/6/7. As noted above, in the order of 358 wells have been drilled in the South African offshore environment to date, the majority of which (200 wells) have been drilled off the South Coast on the Agulhas Bank, most of these in less than 250 m water depth (see Figure 7-95 and Figure 9-16). A further 46 were drilled on the West Coast, including the two wells within Block 5/6/7. Prior to 1983, technology was not available to remove wellheads from the seafloor, and most of the wells drilled off the South Coast remain with wellhead on the seabed. Despite the number of wells drilled in South African offshore, there is no evidence of long-term negative change (cumulative impacts) to faunal population sizes or irreparable harm as a direct result of these exploration drilling activities. In fact, Atkinson (2009) reported that abandoned wellheads in the vicinity demersal trawling grounds provide *some de facto* “protection” to marine infaunal, epifaunal and fish assemblages (Wilkinson & Japp 2005).

Assuming a conservative estimate of 2.64 km^2 of cumulative seabed affected per well (based on the footprint calculated for a single well), the total cumulative area impacted by the installation and cuttings fall-out of 358 wells in the South African EEZ (which has a total area of approximately 1 547 576 km^2) and 200 wells on the Agulhas Bank is estimated at 945 km^{2}and 528 km^2, respectively, with the cumulative impacted area for the West Coast amounting to 121 km^2. In reality the total cumulative impacted area at any one time is considerably less, due to the natural dispersion and recovery of benthic communities over the short to medium (shallow waters) and long term (deeper waters). Furthermore, as the area of interest for drilling and the associated depositional footprints will avoid MPAs and EBSAs, impacts will affect mostly communities in unconsolidated habitats, which are less sensitive to disturbance and recover more quickly than those inhabiting hardgrounds. In addition, TEEPSA will actively avoid and reduce potential impacts on sensitive and potentially vulnerable habitats by ensuring that wells are > 1 000 m from such habitats (using ROV survey prior to drilling). Thus, cumulative impacts are therefore less likely.

In terms of other well drilling off the West Coast, Eco (Atlantic) Oil & Gas has commenced with drilling in Block 2B (as of 10 October 2022). This block is located approximately 400 km to the north of Block 5/6/7 and there are unlikely to be any overlapping impacts from normal operations (e.g., discharges, underwater noise, etc.).

Underwater Noise

Noise associated with the proposed exploration programme would also have cumulative impact on marine fauna. Due to the licence area being located within the main vessel traffic routes that pass around southern Africa, ambient noise levels are naturally elevated. Sensitive receptors and faunal species (cetaceans, turtles and certain fish) are unlikely to be significantly additionally affected as faunal behaviour will not be affected beyond 66 km during drilling and beyond 2.2 km during VSP operations. Noise levels would return back to ambient after drilling is complete.

Data on behavioural reactions to noise and drill rig presence acquired over the short-term could, however, easily be misinterpreted as being less significant than the cumulative effects over the long-term and with multiple exposures, i.e. what is initially interpreted as an impact not having a detrimental effect and thus being of low significance, may turn out to result in a long-term decline in the population, particularly when combined with other acoustic and non-acoustic stressors (e.g., temperature, competition for food, climate change, shipping noise) (Przeslawski *et al.* 2015; Erbe *et al*. 2018, 2019; Booth *et al*. 2020; Derous *et al.* 2020). Physiological stress, for example, may not be easily detectable in marine fauna, but can affect reproduction, immune systems, growth, health, and other important life functions (Rolland *et al.* 2012; Lemos *et al.* 2021). Confounding effects are, however, difficult to separate from those due to exploration drilling.

Considering the noise effect of previous seismic surveys, despite the density of seismic survey coverage over the past years in the South African offshore and particularly off the West Coast, the number of Southern Right and Humpback whales around the southern African coast have increased, suggesting that, for these species at least, there is no evidence of long-term negative change to population size or irreparable harm as a direct result of seismic survey activities. Although surveys have revealed a steady population increase since the protection of the species from commercial whaling, more recent results, however, indicate changes in the prevalence of Southern Rights on the South African breeding ground, including a marked decline of unaccompanied adults since 2010 and extreme fluctuations in the number of cow-calf pairs since 2015. However, the change in demographics to likely spatial and/or temporal displacement of prey due to climate variability, and not seismic surveys (Vermeulen *et al.* 2020). To date no trophic cascades off the South African coast have been documented despite the completion of a number of seismic surveys having been completed.

There are a number of current reconnaissance permit applications being undertaken for proposed seismic surveys off the West Coast, although it is unlikely that all these will be undertaken as they are targeting similar areas in the Deep Water Orange Basin. These surveys are proposed northward of Block 5/6/7 and are unlikely to have any overlapping noise impacts.

Vessel lighting and Operational Discharges

There are numerous light sources and operational discharges from vessels operating within and transiting through the area, although each is isolated in space and most are mobile. Given the extent of the ocean and the point source nature of the lighting, the prevalence of sensitive receptors and faunal species interactions with the light sources is expected to be very low. Light levels would return back to ambient once operations are completed. Each of the vessels (fishing, shipping, exploration) operating within the area will make routine discharges to the ocean, each with potential to cause a local reduction in water quality, which could impact marine fauna. However, each point source is isolated in time and widely distributed within the very large extent of the open ocean. At levels compliant with MARPOL conventions, no detectable cumulative effects are anticipated.

Conclusion

Although possible future activities cannot be reasonably defined and it is unlikely that concurrent exploration activities will occur at the same time as the TEEPSA drilling campaign in Block 5/6/7, with the implementation of the proposed mitigation measures, **most of the potential residual impacts will be of short duration, typically ceasing once drilling is completed. Thus, impacts related normal operation are, therefore, considered unlikely to contribute to future cumulative impacts**, and thus no more significant than assessed in the preceding sections.

The one impact that is expected to continue into the long term is the impact relating to smothering of benthic biota due to cuttings discharge, which the drilling discharge modelling study predicted can last for up to 10 years. There is, however, currently no indication of further interest to undertake exploration drilling in the blocks adjacent to Block 5/6/7, which could result in depositional overlap within the area of interest. This is, however, unlikely as the area of interest is not located on the border of the Licence Block and any drilling in neighbouring blocks is unlikely to add to the environmental risk. Cumulative impacts would thus be no more significant than assessed in the preceding sections.

Although cumulative impacts from other hydrocarbon ventures in the area may increase in future, the cumulative impacts on the biophysical environment from the proposed drilling of exploration wells on the Western Agulhas Shelf edge can be considered of **LOW** significance.

9.4.4 Socio-Economic

General

A cumulative potential impact on social aspects is likely, should additional and multiple exploration or production activities commence (by either TEEPSA or other exploration right holders) in a relatively short period. Cape Town and Saldanha Bay should easily absorb any parallel exploration activities. Industries and businesses geared towards oil and gas could see substantive benefits, but there may be increased opposition from the residential and tourism sectors where they see such activities as impacting the sense of place and degrading the appeal of the coastline. The cumulative impact on social and economic receptors from the additional exploration is expected to be of **VERY LOW significance**. However, there will also be economic benefits and employment opportunities should additional exploration activities commence in a relatively short period. This is considered to be of **LOW positive significance**. The would been more significant benefits for South Africa if one considers extraction (production) - refer to discussion on the implication of the No-Go Alternative in Section 9.5.

Caution will be needed in terms of managing over-expectation of economic benefits and employment opportunities around Saldanha Bay in particular. This is particularly important when considering cumulative benefits should additional exploration activities commence (by either TEEPSA or other exploration right holders) in a relatively short period.

Fisheries

As noted in the section above, there are a number of reconnaissance permit applications being undertaken for proposed seismic surveys off the West Coast, although it is unlikely that all these will be undertaken as they are targeting similar areas in the Deep Water Orange Basin. These surveys are proposed northward of Block 5/6/7 and are unlikely to have any overlapping noise impacts. This said, it would result in a reduced fishing area for the large pelagic long-line sector in particular should these seismic and drilling activities occur at the same time, which is unlikely.

Impacts associated with Eco (Atlantic) Oil & Gas' current drilling in Block 2B off the West Coast (as of 10 October 2022) are unlikely to overlap with impacts from proposed drilling in Block 5/6/7 (e.g., underwater noise, discharges, etc.), as Block 2B is located approximately 400 km to the north of Block 5/6/7.

Noise, operational lighting and discharges associated with the proposed exploration programme would also have cumulative impact on marine fauna, and possible indirect impact on fishing in the area of interest. Due to the licence area being located within the main vessel traffic routes that pass around southern Africa, ambient noise levels are naturally elevated. Fishing receptors (namely demersal trawl, demersal longline, large pelagic longline and tuna pole-line) are unlikely to be additionally affected as fish behaviour will not be affected beyond an estimated 5 km from the drilling unit during drilling and VSP operations. Noise levels would return back to ambient after drilling is complete.

Although possible future activities cannot be reasonably defined and it is unlikely that concurrent exploration activities will occur at the same time as the TEEPSA drilling campaign in Block 5/6/7, with the implementation of the proposed mitigation measures, most of the potential impacts will be of short duration, typically ceasing once drilling is completed. Such impacts are, therefore, considered unlikely to contribute to future cumulative impacts, and thus no more significant than assessed in the preceding sections. As noted in the section above, the one impact that is expected to continue into the long-term is the impact relating to smothering of benthic biota and demersal fish habitat due to cuttings discharge. There is currently no indication of further interest to undertake exploration drilling in the blocks adjacent to Block 5/6/7, which could result in depositional overlap. In addition, demersal fishing does not occur off the continental shelf in the majority of Block 5/6/7; thus, cumulative impacts are not anticipated.

Although cumulative impacts from other hydrocarbon ventures in the area may increase in future, the cumulative impacts of the proposed drilling of exploration wells on fishing on the Western Agulhas Shelf edge can be considered of **LOW** significance.

In addition to the above, the following should also be considered to take account of catch variability and stock declines, which can be attributed to the following (Shomura et al 1995, Kuo-Wie Lan et al 2011, Lehodeya et al 2006 and Punt et al 1996):

- Increasing fishing effort exacerbated by improved fish finding technology (vessel monitoring systems, use of sonar, sea surface temperature spatial mapping using satellite technology);
- Environmental variability such as cold and warm water events e.g., Benguela El Niño events have been shown to result in a change in the vertical distribution of tuna stocks within the water column, resulting in reduced catch rates;
- Migration and feeding patterns that change abundance levels annually and are linked to the environment; and

- Inconsistent or irregular catch reporting.

Intangible Cultural Heritage

Various activities (not related to the proposed exploration activities) may affect intangible cultural heritages along the Northern Belt Coast (i.e. Alexander Bay to Saldanha Bay) and Western Cape Coast, including diamond mining, commercial fishing, port operations and recreational tourism impacts. These activities are already affecting the natural environment including the seawater and seabed. Commercial fishing, canning factories and other industry is also impacting on pollution and noise in coastal waters. The potential impacts related to the proposed project may exacerbate existing ocean health (i.e. increased turbidity, noise pollution, negative impact on marine biodiversity and, cultural heritage), thereby contributing to the overall cumulative impact.

Comparing the potential impacts of normal operations of the proposed exploration well drilling to existing activities, that by their very nature are difficult to mitigate and can cover large areas (e.g., seabed mining and commercial trawling), it can be argued that the proposed exploration drilling is likely to have less of an impact on the seabed and, therefore, on cultural heritage practices involving the sea than that of current commercial fishing and mining.

The cumulative impact on intangible cultural heritage is considered to be of **MEDIUM** significance.

9.5 IMPLICATIONS OF THE NO-GO ALTERNATIVE

The No-Go alternative represents the option not to proceed with the proposed exploration well drilling activities. This would leave the project area of influence in its current state (refer to the baseline description in Chapter 7), except for ongoing natural variations and changes caused by other human activities (e.g., fishing, commercial shipping, etc.). It thus represents the current status quo against which all potential project-related impacts will be assessed. Opting for the No-Go alternative means that none of the impacts anticipated from normal exploration drilling operations would occur. Additionally, the No-Go alternative would preclude the risks associated with accidental drilling-related events.

As noted in Section 5.6 above, the South African Government and international policy both promote the use of natural gas in the energy mix in the pathway to net-zero emissions by 2050, i.e. gas is needed in the just transition. At present, and in the proximate future (and therefore also in the ‘No Go’ option), this gas will have to be imported. Despite there potentially being local reserves that could be used instead of imports. The government has a continuing view that any existing oil or gas resources should be developed (see especially the MPRDA and the proposed Upstream Petroleum Resources Development Bill (B13-2021) (https://www. parliament.gov.za/bill/2298070). The presence and activity of TEEPSA, and other oil and gas exploration operators, in South African territory is as a result of this policy.

The No-Go alternative (which here assumes no future oil and gas exploration and production in South Africa) means that any domestic oil and gas resources that might occur in the area of interest cannot be identified and South Africa will not be able to optimise the use of its own domestic oil and gas resources, should they exist. Below is a summary of what the No-Go alternative could mean for South Africa.

- **In terms of electricity**, current end user consumption trends suggest that demand for power will remain broadly constant and, if current trends continue, then Eskom’s aging coal plants seems likely to remain unreliable and load shedding likely to continue.

- Eskom's heavy reliance on coal for electricity generation will keep South Africa's carbon emissions high (South Africa is the 12th largest CO_2 emitter in the world) and the meeting of 2050 targets will be challenging based on current transmission (distribution) capacity issues and battery storage technologies, which will slow the transition to renewable electricity generation in the short- to medium-term. In addition, both wind and solar provide intermittent power, as production is curtailed when the wind does not blow or the sun does not shine, respectively. To ensure reliable supply, it is necessary to supplement these sources with dispatchable power. This could be (i) pumped storage (but South Africa has limited opportunity for additional pumped storage capacity), (ii) batteries (but based on current technologies batteries can offer only limited capacity and discharge durations, and (iii) peaking thermal plants such as open (or preferably closed) cycle gas turbines (OCGT's).
- As solar and wind are not presently viable sources of base-load power, South Africa uses diesel to operate open cycle gas turbines to meet peak demand (https://www.eskom.co.za/wp-content/uploads/2021/09/GS-0003-Ankerlig-Gourikwa-Technical-Brochure-Rev-9-1.pdf), not gas which is cheaper and less polluting than diesel. As South Africa shifts from coal fired thermal power to renewable (solar and wind), the reliance on these peaking plants will increase.
- Eskom's increasing cost and high carbon emission power will continue to be a burden to the South African taxpayer.
- Unless other domestic oil and gas fields are developed, South Africa's demand for **gas and oil refined products** will continue to be met by imports. It is reasonable to believe that current supply / demand trends will continue (South African Petroleum Industries Association, International Energy Association) with the caveat that South Africa will not be immune from the current global energy disruptions. The impact of the Ukraine-Russia conflict could continue to be felt in global energy markets for some years. If so, international oil and prices will be higher for longer and countries in the West will pay greater attention to security of supply in their strategic energy policies. If South Africa wishes to import oil and gas, it will be competing with motivated European buyers on less favourable terms and at potentially higher prices.
- In terms of oil, the trend of South African oil refinery closures will continue. These closures include or will potentially include ENREF, SAPREF, CHEVREF and NATREF. In terms of gas, Mossel Bay Gas-to-Liquid (GTL) plant seems likely to close unless a domestic gas supply is identified or a large bail out by the South Africa taxpayer is agreed to fund processing of higher cost feedstocks (in this respect, it should be noted that a production licence application process has commenced for the offshore Block 11B/12B). Due to refinery closures, the demand for oil refined products is likely to be met by increased imports (probably from India and the Middle East). This will expose South Africa to large price risk due to the international energy market and high levels of energy supply risk; thus, exacerbating poverty and inequality.
- At present, Eskom controls much of its coal through production agreements and long-term pricing contracts. These mean that its major input's price is stable. In contrast, gas and oil will need to be purchased on the (volatile) open market. Future contracts for oil and gas are available, but for shorter periods and on less favourable terms than those in the local market for coal.
- Gas supplies currently piped to Gauteng from the Pande and Temane fields in central Mozambique are almost at an end and cannot be relied on going forward (https://www.offshore-technology.com/marketdata/pande-temane-complex-conventional-gas-field-mozambique, September 2022). The Northern Mozambican fields are presently facing political / military risks as a result of the Islamist insurgency in Cabo Delgado. Thus, unless a local supply is identified and developed, it seems certain that South Africa will need to develop and operate an LNG terminal (at significant additional cost) and import

gas via ship. There are financial and environmental threats associated with both options, i.e. relying on the Mozambican gas fields or building LNG terminals.

- As noted above, gas import initiatives will be contingent on international market developments. Strong desire to replace Russian gas supply will keep the Liquified Natural Gas (LNG) and Floating Storage and Regasification Unit (FSRU) markets tight (fully contracted) and, due to strong European demand, new FSRUs may not be available until 2028. Thus, it is estimated that import gas supply will only become available from about 2028, if South African terminals can offer a compelling destination for gas (compared to European alternatives) and for FSRUs (in the context of a motivated European market to secure gas and infrastructure to replace Russian gas supply). It is also important to note that despite Europe's emission target commitments at COP26, coal is re-emerging as a key source of energy for European countries racing to replace increasingly scarce natural gas as Russia shuts off key pipeline flows (www.markets.business insider.com; www.bloomberg.com; www.euronews.com, October 2022), which highlight the geopolitical risks on relying on oil and gas imports. The European energy crisis "*offers a glimpse of a future where a transition to a low-carbon economy that is not properly managed or stress-tested against scarcity and volatility might produce recurrent market crunches and hinder the decarbonisation trajectory*" (https://www.iss.europa.eu/content/europes-energy-crisis-conundrum, October 2022).

The No-Go alternative would prevent South Africa from identifying domestic gas that could offer an energy supply that could be competitively priced, produce relatively low carbon dispatchable power (lower carbon emissions than coal, oil or oil-fired generation) without the inherent weather risk of solar or wind generation (in the absence of utility scale batteries) and reduce South Africa’s exposure to the highly volatile international oil and gas markets (fluctuating price). Further to this, using a domestic resource would have a lower carbon footprint than importing from abroad and should not be seen to be in conflict with reaching carbon neutrality by 2050.

9.6 IMPACT ASSESSMENT AND MITIGATION SUMMARY

A summary of the assessment of potential environmental and social impacts and proposed mitigation associated with the proposed well drilling activities is provided in Table 9-40.

TABLE 9-40: SUMMARY OF THE SIGNIFICANCE OF THE IMPACTS ASSOCIATED WITH NORMAL OPERATIONS

Note:
(1) Neg = Negligible; VL = Very Low; L = Low; M = Medium; H = High; VH = Very High
(2) * indicates that no mitigation is possible / considered necessary or mitgtaion does not change assessment, thus significance rating remains.
(3) ** indicates that although the significance rating of the impact remains the same, the intensity, etxent or duraton of the impact decreases due to the proposed mitigation.

No.	Activities	Aspects	Impacts on Main Receptors	Pre-Mitigation Significance	Project Controls / Key Mitigation	Residual Significance
1	**OPERATION OF DRILL UNIT, VESSELS AND HELICOPTERS**					
1.1	**Emissions to Atmosphere**					
1.1.1	Emissions from the operation of the drilling unit, vessels and helicopters (including emissions from well testing)	Increase of air pollutants	Local reduction in air quality	**LOW**	• Compliance with MARPOL 73/78 Annex VI (fuel selection, maintenance) • Optimise rig positioning and movement, and support vessel logistics • Minimise flaring using a high-efficient burner	**VERY LOW**
1.1.2			Contribution to global GHG emissions and climate change	**LOW**		**VERY LOW**
1.2	**Routine Operational Discharges to Sea**					
1.2.1	Liquid and solid discharges to sea	Local reduction in water quality	Impact marine ecology/environment	**VERY LOW**	• Compliance with MARPOL 73/78 Annexes I, IV and V • Waste & Discharge and Maintenance management plans • No discharge within the Table Mountain National Park and Robben Island offshore MPAs and Cape Canyon and Seas of Good Hope EBSA	**VERY LOW**
1.2.1	Discharge of ballast water and vessel / equipment transfer	Potential introduction of alien invasive species	Impact of on marine biodiversity	**VERY LOW**	• Compliance with IMO 2004 Ballast Water Management Convention (discharge distance requirements) • Ballast tank and subsea equipment maintenance / cleaning	**NEGLIGIBLE**

No.	Activities	Aspects	Impacts on Main Receptors	Pre-Mitigation Significance	Project Controls / Key Mitigation	Residual Significance
1.3	**Noise from helicopters**					
1.3.1	Helicopter operations	Increased ambient airborne noise levels	Impact on coastal and marine fauna	**LOW**	• Avoid flying over sensitive areas (e.g., penguin and seal colonies) • Maintain specified altitudes	**LOW ****
1.4	**Lighting from drilling unit and vessels**					
1.4.1	Vessel and drill unit operation (at night)	Increased ambient lighting	Impact on marine fauna	**VERY LOW**	• Optimise lighting with safe operations	**VERY LOW ****
1.5	**Operation of Onshore facilities and offshore operations**					
1.5.1	Establishment of onshore logistic base and operation of vessel and helicopter	Alter visual, cultural, social and environmental qualities and characteristics	Impact on local (coastal) sense of place	**NEGLIGIBLE**	• Public information and disclosure programme • Community engagement • Grievance mechanism	**NEGLIGIBLE****
1.5.2	Vessel and drill unit operation (as well as the drilling and associated activities below)	Degradation and disturbance of the marine environment in terms of value with regard to spiritual, cultural and ritual importance	Impact on Intangible Cultural Heritage	**MEDIUM**	• Community engagement • Implement, based on the outcome of the consultation process, a ritual event(s) • Grievance mechanism	**MEDIUM** (remains medium for those who are categorically opposed to oil and gas exploration)
2	**DRILLING AND ASSOCIATED EXPLORATION ACTIVITIES**					
2.1	**Drilling and Placement of Infrastructure on the Seafloor**					
2.1.1	Disturbance of sediments during drilling	Physical seabed disturbance	Impact on benthic biota	**NEGLIGIBLE**	• Pre-drilling ROV survey • Well sites to avoid sensitive hardgrounds and vulnerable habitats	**NEGLIGIBLE ****

No.	Activities	Aspects	Impacts on Main Receptors		Pre-Mitigation Significance	Project Controls / Key Mitigation	Residual Significance
2.2	**Discharge of Cuttings, Drilling Fluid and Cement**						
2.2.1	Discharge of drill cuttings, WBM and cement	Physico-chemical disturbance of the seabed sediments and the water column	Smothering of benthic habitats	Unconsolidated sediments	**LOW**	• Pre-drilling ROV survey • Well sites to avoid sensitive hardgrounds and vulnerable habitats • Use low toxicity Group III NADF during risered drilling and treatment of cuttings • Monitor discharges	**LOW ***
2.2.2				Hardgrounds	**HIGH**		**MEDIUM**
2.2.3			Toxicity in water and sediments and bioaccumulation effects	Unconsolidated sediments	**VERY LOW**		**NEGLIGIBLE**
2.2.4				Hardgrounds	**HIGH**		**MEDIUM**
				Water column	**NEGLIGIBLE**		**NEGLIGIBLE ****
2.2.5			Increased water turbidity and reduced light penetration on marine ecology		**NEGLIGIBLE**		**NEGLIGIBLE ***
2.2.6			Reduced physiological functioning of marine organisms	Marine fauna	**NEGLIGIBLE**		**NEGLIGIBLE ****
2.2.7				Commercial fisheries	**NEGLIGIBLE**		**NEGLIGIBLE ***
2.3	**Generation of Underwater Noise**						
2.3.1	Drilling unit and support vessel operation on site and transit	Increased underwater noise levels	Impact on marine fauna		**VERY LOW**	• Maintenance Management Plan • Vessel speed regulation	**VERY LOW ***
			Impact on commercial fishing		**LOW**	• Stakeholder / vessel notification • Grievance mechanism	**LOW ****
			Impact on small-scale fishing		**NO IMPACT**		**NO IMPACT**
2.3.2	Vertical seismic profiling		Impact on marine fauna		**LOW**	• Marine Mammal Observer and Passive Acoustic Monitoring • Pre-shoot watch (visual and possible acoustic) • “Soft-start” procedures • Fauna monitoring during surveying • Shut-downs	**LOW ****

<table>
<tr><th>No.</th><th>Activities</th><th>Aspects</th><th colspan="2">Impacts on Main Receptors</th><th>Pre-Mitigation Significance</th><th>Project Controls / Key Mitigation</th><th>Residual Significance</th></tr>
<tr><td rowspan="2">2.3.3</td><td rowspan="2"></td><td rowspan="2"></td><td colspan="2">Impact on commercial fishing</td><td>LOW</td><td rowspan="2">• Stakeholder engagement and notification
• Navigational warning
• Grievance mechanism</td><td>LOW **</td></tr>
<tr><td colspan="2">Impact on small-scale fishing</td><td>NO IMPACT</td><td>NO IMPACT</td></tr>
<tr><td>2.4</td><td colspan="7">Presence of Subsea Infrastructure</td></tr>
<tr><td>2.4.1</td><td rowspan="4">Well abandonment and residual cement</td><td rowspan="4">Increased hard substrate on seafloor</td><td rowspan="2">Impact on marine biodiversity</td><td>Wellhead removal</td><td>NEGLIGIBLE</td><td rowspan="2">• Well sites to avoid sensitive hardgrounds and vulnerable habitats
• Monitoring of cement returns
• Post drilling ROV survey</td><td>NEGLIGIBLE *</td></tr>
<tr><td>2.4.2</td><td>Wellhead abandonment</td><td>VERY LOW</td><td>VERY LOW *</td></tr>
<tr><td>2.4.3</td><td rowspan="2">Impact on demersal trawling</td><td>Wellhead removal</td><td>NO IMPACT</td><td>• None</td><td>NO IMPACT</td></tr>
<tr><td>2.4.4</td><td>Wellhead abandonment</td><td>MEDIUM</td><td>• Over-trawlable abandonment cap
• Avoid drilling within the boundaries of the current demersal trawl “ring fenced” area or remove wellhead structures within this area
• Survey and accurately charted wellheads with the SAN Hydrographer</td><td>NO IMPACT</td></tr>
<tr><td>2.5</td><td colspan="7">Well testing</td></tr>
<tr><td>2.5.1</td><td rowspan="2">Flaring of hydrocarbons</td><td>Increased ambient lighting</td><td colspan="2" rowspan="2">Impact on marine fauna</td><td>VERY LOW</td><td rowspan="2">• Optimise test duration
• Commence with well testing during daylight hours, as far as possible, and operation monitoring
• High-efficiency burner for flaring</td><td>VERY LOW *</td></tr>
<tr><td>2.5.2</td><td>Hydrocarbon ‘Drop-Out’</td><td>VERY LOW</td><td>VERY LOW *</td></tr>
<tr><td>2.5.3</td><td>Discharge of produced water</td><td>Local reduction in water quality</td><td colspan="2">Impact marine ecology/environment</td><td>VERY LOW</td><td>• Onboard treatment of hydrocarbon component to <30 mg/l or ship to shore</td><td>VERY LOW *</td></tr>
</table>

No.	Activities	Aspects	Impacts on Main Receptors	Pre-Mitigation Significance	Project Controls / Key Mitigation	Residual Significance
2.6	**Temporary Safety Zone around Drilling Unit**					
2.6.1	Operation of drilling unit	Temporary safety zone around drilling unit	Impact on commercial fishing	**LOW**	• Stakeholder / vessel notification • Navigational warning • Vessel lighting and safety signals • Grievance mechanism	**LOW ****
			Impact on small-scale fishing	**NO IMPACT**		**NO IMPACT**
2.6.2			Disruption to tourism, recreation and recreational fishing, and commercial shipping	**LOW**		**VERY LOW**
3	**EMPLOYMENT AND PROCUREMENT OF GOODS AND SERVICES**					
3.1	**Jobs and Business Opportunities**					
3.1.1	Use of local services and facilities	Local employment and business opportunities	Economic benefits for local service providers and suppliers	**NEGLIGIBLE POSITIVE**	• TEEPSA local content policy • Manage community expectations • Stakeholder engagement • Grievance mechanism	**NEGLIGIBLE POSITIVE ***
3.1.2			Impact on local economic sectors	**NEGLIGIBLE**		**NEGLIGIBLE ***
3.2	**Use of Local Services and Facilities**					
3.2.1	Use of local services and facilities	Pressure on local services and facilities	Insufficient capacity to support the exploration or other activities	**NEGLIGIBLE**	• TEEPSA local content policy • Manage community expectations • Stakeholder engagement • Grievance mechanism	**NEGLIGIBLE ***
3.2.2		Pressure on local integrated planning	Limit the ability of local authorities to respond to the Oil and Gas sector operation	**NEGLIGIBLE**		**NEGLIGIBLE ***