
Aqaba Amman Water Desalination and Conveyance Project (AAWDGP) Interim ESIA Addendum

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Abbreviations

AAWDCP	Aqaba Amman Water Desalination and Conveyance Project
ASEZA	Aqaba Special Economic Zone Authority
BACI	Before-After Control-Impact
BAP	Biodiversity Action Plan
CEGCO	Central Electricity Generating Company
CFD	Computational Fluid Dynamics
CIP	Cleaning in place
CSS	Coral Scientific Supervisor
DDV	Drop-down video
E&S	Environmental and social
ECE	Environmental critical equipment
EPC	Engineering, Procurement and Construction
ESIA	Environmental and Social Impact Assessment
ESMS	Environmental and Social Management System
FAT	Factory acceptance testing
FSRU	Floating Storage and Regasification Unit
GPS	Global Positioning System
HAZID	Hazard identification study
HAZOP	Hazard and operability study
HDPE	High-density polyethylene
HSE	Health, safety and environment
IFC	International Finance Corporation
IPS	Intake Pumping Station
ISO	International Organisation for Standardisation

Abbreviations

MBES	Multibeam echosounder
MSL	Mean sea level
MSS	Marine Science Station
MWI	Ministry of Water and Irrigation
NCPC	National Carrier Project Company
O&M	Operations and maintenance
P&ID	Piping and instrumentation diagram
RO	Reverse osmosis
ROV	Remotely operated vehicle
RYC	Royal Yacht Club
SCUBA	Self-contained underwater breathing apparatus
SEPCO	Samra Electric Power Company
TBM	Tunnel Boring Machine
TRI	Terrain Ruggedness Index
TSS	Total suspended solids

Executive Summary

This Interim ESIA Addendum has been prepared to assess the environmental implications of changes to the seawater intake system and marine outfall design that have occurred following disclosure of the 2025 AAWDCP ESIA. The assessment reflects the continued development of the Project design and incorporates additional engineering studies, environmental surveys, modelling, stakeholder engagement and constructability assessments completed during 2026.

Reasons for the Design Changes

The change to the seawater intake system was driven by confirmation that the existing CEGCO/SEPCO intake lagoon and intake pumping station could be utilised by the Project. Asset condition surveys, engagement with SEPCO and consultation with the Jordanian authorities demonstrated that the existing facilities provide a viable alternative to construction of a new intake lagoon and pumping station. As a result, the marine habitat disturbance associated with constructing a new intake system can be avoided while retaining the mitigation measures previously proposed in the 2025 ESIA.

The change to the marine outfall resulted from detailed bathymetric surveys, engineering design development and constructability reviews completed after ESIA disclosure. These studies identified that the outfall design assessed in the 2025 ESIA would require substantially greater dredging and trenching than originally anticipated, would increase seabed disturbance, would be difficult to construct using effective sediment containment measures, and would require specialist deep-water installation techniques beyond the Project's diving limits. Alternative solutions, including micro-tunnelling, were assessed but were found to present significant technical, programme and construction challenges.

After evaluating the alternatives, the canyon outfall was selected as the only technically viable solution. The alignment uses a naturally occurring canyon characterised by a higher proportion of soft sediment and lower coral abundance than surrounding reef habitats. The canyon also provides a natural pathway for transport of the dense brine discharge towards deeper water, reducing interaction with coral-rich reef areas.

Benefits of Additional Data and Studies

The assessment benefits from a significantly improved evidence base compared with that available during preparation of the 2025 ESIA. Since disclosure, the Project has completed additional bathymetric, hydrographic, geophysical, and diver surveys; further stakeholder engagement; updated engineering studies; detailed alternatives analysis; additional marine biodiversity surveys; a desk-based review of coral and seagrass salinity tolerance; and updated CFD and Delft3D modelling of the revised outfall design.

These additional studies have improved understanding of seabed conditions, habitat distribution, coral cover, construction requirements, plume behaviour and ecological sensitivity. The updated surveys have allowed habitat-specific coral and seagrass cover values to be incorporated into impact quantification, replacing a number of assumptions used in the 2025 ESIA. The revised modelling has also benefited from higher-resolution bathymetric data and a more developed engineering design, providing greater confidence in predictions of plume behaviour and environmental exposure.

Outfall Construction and Brine Plume Residual Impact Summary

Although the revised outfall design results in a larger construction footprint and a larger modelled brine plume than the design assessed in the Disclosed 2025 ESIA, the residual ecological impacts are lower. The canyon alignment places all construction activities within diver-accessible depths, allowing coral

translocation of coral to be applied across the entire construction footprint. As a result, the residual construction impact decreases from 207 m² to 176 m² despite the increase in the unmitigated construction area from 2,646 m² to 6,441 m².

The revised plume assessment demonstrates that the increase in plume extent does not translate into a proportional increase in ecological impact. Additional habitat mapping and coral cover surveys show that the majority of the expanded plume footprint occurs within deep sand and sediment-dominated habitats that support very little coral. Approximately 75% of the modelled 2% salinity plume occurs over deep sand habitat where average coral cover is only 0.05%.

Consequently, although the 2% salinity plume footprint increases from 9,076 m² to 69,027 m², the residual plume impact decreases from 1,362 m² to 396 m². Application of the 5% salinity threshold, which is considered more representative of ecological sensitivity and monitoring requirements, further reduces the residual plume impact to 66 m². Overall, the revised outfall design benefits from the use of a natural canyon feature that reduces interaction with coral-rich habitats, enables effective coral translocation during construction, and directs the brine plume predominantly into deeper habitats characterised by very low coral abundance. Further survey work of the plume area is planned to improve the spatial resolution of the habitat mapping.

Assessment of the desalination brine indicates that iron concentrations are expected to dilute below the conservative screening threshold of 0.05 mg/L within approximately 15–25 m of the diffuser, such that iron-related toxicity and nutrient enrichment impacts are considered negligible. Modelling also indicates no significant transboundary impacts, with salinity increases at international boundaries remaining within natural background variability and iron concentrations predicted to be below ambient levels at the Jordan–Saudi Arabia border. Consequently, neither salinity nor iron are expected to result in measurable transboundary environmental effects.

Intake System Summary of Residual Impact

The revised seawater intake arrangement substantially reduces residual impacts compared with those assessed in the Disclosed 2025 ESIA by avoiding construction of a new intake lagoon and intake pumping station and making use of the existing facilities. As a result, direct disturbance to marine habitats associated with intake construction is avoided while the mitigation measures previously committed to in the 2025 ESIA, including the floating oil boom, bubble curtain and fish return system, are retained.

The residual impact associated with operation of the intake system is estimated at 500 m² (including coral and seagrass habitat), compared with 21,447 m² in the Disclosed 2025 ESIA. This reduction reflects both the change in intake location and the use of updated habitat mapping, coral cover and seagrass cover data collected during 2026. The revised assessment demonstrates that the majority of the quantified impact area occurs within sand and patch reef and shallow seagrass habitats, with only a very small residual impact to existing coral communities.

The assessment indicates that operation of the intake is not expected to result in direct material impacts to established coral colonies. The principal potential effect relates to the modification of water movement and the possible deflection of larvae and other planktonic life stages from their natural transport pathways. Consequently, existing coral colonies will remain in situ and no coral translocation is required. Coral settlement studies, benthic habitat monitoring and adaptive management measures will be implemented to verify the assessment predictions and confirm that recruitment, coral cover and habitat condition are maintained during operation.

Summary of change to residual impact

Compared with the Disclosed 2025 ESIA, the revised intake and outfall design reduces the total residual impact from 23,016 m² to 1,072 m² (including coral and seagrass habitat) when assessed using the 2% salinity plume, representing an approximate 95% reduction. This improvement reflects avoidance of new intake construction, application of coral translocation, improved habitat mapping, and routing of the plume predominantly through low-coral, sediment-dominated habitats. If the 5% salinity threshold is applied, the total residual impact reduces further to 742 m². A direct comparison with the Disclosed 2025 ESIA is not possible for the 5% plume because that assessment only quantified impacts using the 2% threshold.

Residual Impact in the Context of Jordan's Total Reef Extent

The residual impacts of the AAWDCP were assessed in the context of Jordan's national coral reef resource using both the Allen Coral Atlas reef extent dataset and the Aqaba Marine Reserve nomination records. Using the Allen Coral Atlas estimate of approximately 2.63 million m² of reef habitat, the Project's residual coral impact represents approximately 0.02% of Jordan's reef extent under the 2% plume scenario (603 m²) and approximately 0.01% under the 5% plume scenario (273 m²). The Aqaba Marine Reserve nomination records, which estimate approximately 4 million m² of coral reef habitat within Jordanian waters of the Gulf of Aqaba, indicate similarly low proportions of approximately 0.015% and 0.007%, respectively. Although localised coral habitat loss will occur, the affected area represents a very small proportion of the national reef resource. Consequently, the residual impact is not expected to result in a measurable reduction in reef extent, ecological connectivity, larval dispersal, nursery habitat availability, or ecosystem functioning at either the Jordanian coastline scale or the wider Gulf of Aqaba scale.

Project ESMS and Adaptive Management

The AAWDCP Environmental and Social Management System (ESMS) and Adaptive Management Plan provide the framework through which marine environmental risks and impacts will be managed throughout the engineering, construction and operational phases of the Project. During detailed design and procurement, the ESMS will verify that environmental commitments, mitigation measures, and performance requirements are incorporated into engineering design, procurement specifications, and contractor management processes. This includes design reviews, HAZID and HAZOP studies, vendor package reviews, commissioning planning, and the development of a Design Verification Register to confirm that critical environmental controls and monitoring systems can achieve the required environmental outcomes.

During construction, the ESMS will guide implementation of mitigation measures associated with marine works, including coral translocation, sediment control, water quality protection, biodiversity management and contractor oversight. The system will establish responsibilities, monitoring requirements, reporting procedures and assurance processes to verify that environmental commitments are implemented effectively and that construction impacts remain consistent with those assessed in this report.

During operations, the Adaptive Management Plan will apply a Plan-Do-Check-Act approach supported by environmental and operational monitoring. The framework combines plume modelling, additional biodiversity surveys, coral exposure studies, coral settlement monitoring and a monitoring design to establish measurable thresholds for environmental performance. Monitoring results will be compared against predefined thresholds to determine whether Project impacts remain within predicted levels. Where monitoring identifies unexpected change or threshold exceedances, a structured response process will be implemented, ranging from operational adjustments and increased monitoring through to design modifications, additional offset measures or, if required, partial or full plant shutdown. This approach provides a mechanism to manage uncertainty, verify assessment predictions and ensure that marine biodiversity objectives are achieved throughout the operational life of the Project.

Translocation Overview

Coral translocation is a key mitigation measure to minimise residual impacts associated with outfall construction and shallow-water plume exposure. The approach involves the removal and relocation of corals and associated marine biota from areas affected by construction activities to suitable recipient sites. Based on the current assessment, between approximately 10,300 m² and 12,200 m² of shallow-water habitat may be suitable for translocation, depending on whether the 5% or 2% plume scenario is adopted. The assessment assumes an 80% translocation survival rate as the primary case, reflecting previous coral translocation experience in Aqaba and favourable local environmental conditions, and also evaluates a more conservative 60% survival scenario to account for uncertainty.

Initial Offset Quantification

The preliminary offset quantification shows that successful implementation of the proposed coral translocation programme could substantially reduce residual impacts and, consequently, the scale of biodiversity offset requirements. Using the primary assessment assumption of 80% translocation survival, the estimated residual coral impact is 603 m² under the 2% plume scenario and 273 m² under the 5% plume scenario. These residual impacts translate to indicative offset requirements of approximately 2,400 m² and 1,100 m², respectively, assuming restoration habitat supports an average coral cover of 25%.

To account for uncertainty in translocation performance, a more conservative 60% survival scenario was also assessed. Under this scenario, the residual coral impact increases to 884 m² for the 2% plume scenario and 509 m² for the 5% plume scenario, increasing the indicative offset requirement to approximately 3,500 m² and 2,000 m², respectively.

The comparison demonstrates that translocation success is a key factor influencing the final offset requirement. Higher translocation survival rates significantly reduce the residual impact requiring offset actions, while the 5% plume scenario consistently results in lower residual impacts and offset requirements than the 2% plume scenario. Although these calculations are preliminary and will be refined through the Biodiversity Action Plan, additional surveys and a quality-hectare-based accounting approach, they provide an initial indication of the potential range of offset requirements and support ongoing offset planning and site selection activities.

In addition to coral reef habitat, the assessment recognises that seagrass is an important ecological receptor and contributes to the Project's overall residual biodiversity impact. The current assessment identifies residual seagrass impacts associated with seawater abstraction, with the residual impact quantified through habitat-specific mapping and cover assessments. The Project will therefore develop dedicated seagrass restoration and offset initiatives alongside coral reef offset measures to address residual impacts that remain following application of the mitigation hierarchy. The final offset requirement will be refined as additional survey data become available and the Biodiversity Action Plan is developed, and may include restoration of degraded seagrass habitats, enhancement of existing meadows, and other conservation actions designed to deliver long-term ecological benefits.

Offset Planning

Planning for both coral translocation and biodiversity offsets has already commenced and forms an integral component of the Project's mitigation hierarchy and Biodiversity Action Plan. The Project has developed a clear framework that distinguishes between coral translocation, which will be used as a mitigation/minimisation measure to remove and safeguard corals affected by construction activities, and coral transplantation, which will be used as an offset measure to compensate for residual impacts that remain after avoidance, minimisation and restoration measures have been applied. The assessment has identified the areas where translocation and transplantation are appropriate and has established the

principles, methodologies, monitoring requirements and governance arrangements that will guide implementation.

As part of this planning process, potential recipient sites for both translocation and offset activities have been identified and assessed through field inspections undertaken with local stakeholders. Three candidate sites have been evaluated to date: the Corniche Site, the Royal Yacht Club (RYC) site and the Berenice site. The assessments confirmed the presence of suitable hard substrate, evidence of natural coral recruitment, existing coral growth and environmental conditions capable of supporting transplanted corals.

The available capacity within these candidate sites exceeds the Project's currently identified requirements. The Corniche Site is estimated to provide approximately 8,000 to 10,000 m² of suitable restoration area, the RYC site approximately 15,000 m², and the Berenice site a further 3,000 to 5,000 m². Combined, these sites provide substantially more capacity than the estimated 12,217 m² translocation requirement identified for construction and plume-affected areas. This confirms that sufficient area is available not only to accommodate translocation activities but also to support the transplantation and habitat restoration measures required to offset residual impacts. The current assessment therefore demonstrates that the Project has commenced practical planning for translocation and offset implementation and has identified suitable recipient locations with adequate capacity to meet the Project's anticipated biodiversity management needs.

Next Steps

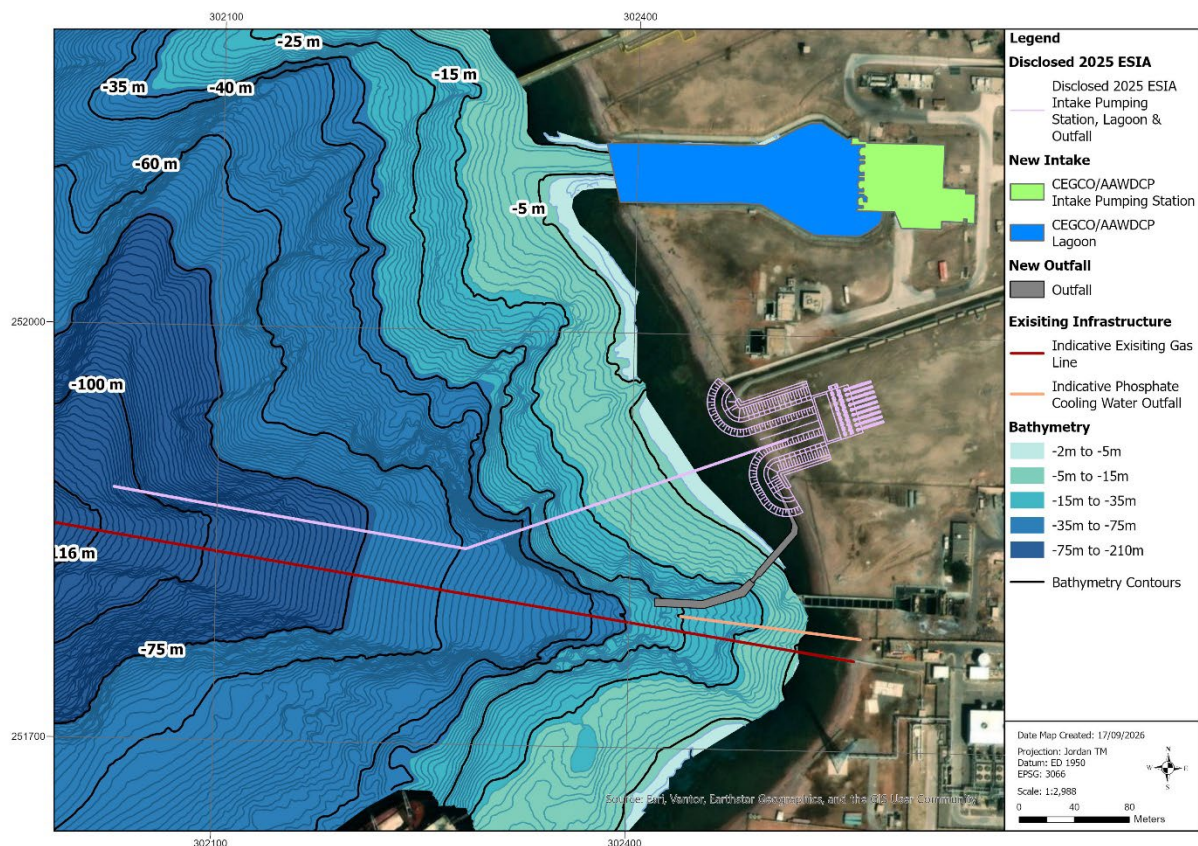
The next phase of the AAWDCP marine programme will focus on reducing uncertainty, strengthening the biodiversity evidence base and confirming the assumptions that underpin this Interim ESIA Addendum. Priority activities include completing the additional ROV survey of the brine plume area, sediment and water quality sampling, laboratory-based coral exposure studies, and coral settlement monitoring. These studies will refine habitat mapping, improve understanding of coral tolerance to salinity and iron, and provide the information needed to finalise monitoring thresholds and adaptive management measures.

In parallel, detailed engineering design will continue, including refining marine construction methods, confirming environmental performance requirements, and developing monitoring and operational control systems. Planning for coral translocation and biodiversity offsets will also advance, with further site investigations and implementation planning undertaken for the identified recipient sites. The outcomes of these activities will support finalisation of the Biodiversity Action Plan, ESMS and Adaptive Management Plan, ensuring that mitigation, monitoring, restoration and offset measures are fully integrated into construction and operational planning

1 Introduction

This report focuses on the assessment of the impacts associated with the new outfall and seawater intake system. The change in outfall and intake location is summarised in Figure 1-1. The intake and outfall design has been ongoing since the 2025 AAWDCP ESIA was disclosed in December 2025.

Figure 1-1: Change in Intake and Outfall Location¹



This report provides an assessment of the impacts resulting from changes to the seawater intake system and brine outfall location and design. The assessment is based on new information generated following disclosure of the ESIA in December 2025 and reflects the continued development of the Project design, engineering studies, environmental surveys and stakeholder engagement. Key sources of information include:

- Detailed bathymetric, offshore geophysical, hydrographic and diver surveys undertaken to improve understanding of seabed conditions, topography and existing submarine infrastructure, including the gas pipeline and phosphate outfall
- Ongoing engagement with neighbouring facility operators, SEPCO, ASEZA, the Ministry of Environment, the Port Authority and other stakeholders to confirm constructability requirements, construction exclusion zones, operational constraints and safety considerations

¹ Term 'CEGCO' has been retained in the maps within this document, noting the recent renaming to Samra Electric Power Company - SEPCO

- Engineering design development and constructability assessments that identified technical constraints associated with the outfall design assessed in the Disclosed 2025 ESIA
- Analysis of alternative outfall locations, designs and construction methodologies, including micro-tunnelling options
- Additional marine biodiversity surveys completed in 2026 to refine habitat mapping, coral cover estimates and impact quantification
- A desk-based review of coral and seagrass salinity tolerance to support the selection of an appropriate salinity threshold for impact assessment and monitoring
- Updated near-field CFD modelling and far-field brine plume dispersion modelling undertaken by Deltares using the revised outfall location, design and high-resolution bathymetric data

2 Project Description and Description of Change

2.1 Introduction

Intake and outfall design development and construction planning have been ongoing since the 2025 AAWDCP ESIA was disclosed in December 2025. The work has focused on minimising environmental impact, specifically biodiversity impacts in the sensitive marine environment, while ensuring technical, constructability, cost, schedule and stakeholder objectives are met.

Two key changes to the marine component of the Project have been identified:

- Change of seawater intake system location
- Change of brine outfall location and design

The assessment of these changes has considered the ESIA and 2025 baseline survey and the following additional studies available since ESIA disclosure in December 2025:

- Completion of updated bathymetric, offshore geophysical studies, hydrographic and diver surveys to improve the mapping of existing submarine assets, including the existing gas pipeline and phosphate outfall
- Ongoing liaison with stakeholders, including Aqaba Special Economic Zone Authority (ASEZA), the Ministry of Environment, neighbouring facility operators, SEPCO and authorities (including the Port Authority) to confirm constructability, construction exclusion zones and safety precautions
 - Approval has been received from the competent authorities for the changes presented
- An analysis of alternative techniques focusing on tunnelling options
- Additional baseline surveys
- A desk-based study of the salinity tolerance of corals and seagrass to increased salinity
- Further detailed modelling of the brine plume

2.2 Seawater Intake System Change

2.2.1 Disclosed 2025 ESIA Abstraction Lagoon and Intake Pumping Station

At the time the Disclosed 2025 ESIA was prepared, the design assumed the seawater intake system comprised a new intake lagoon with a seawall extending 10m inshore from the current shoreline, creating an inlet for a new Project Intake Pumping Station (IPS), see Figure 2-1 below. The lagoon was designed with the following mitigations:

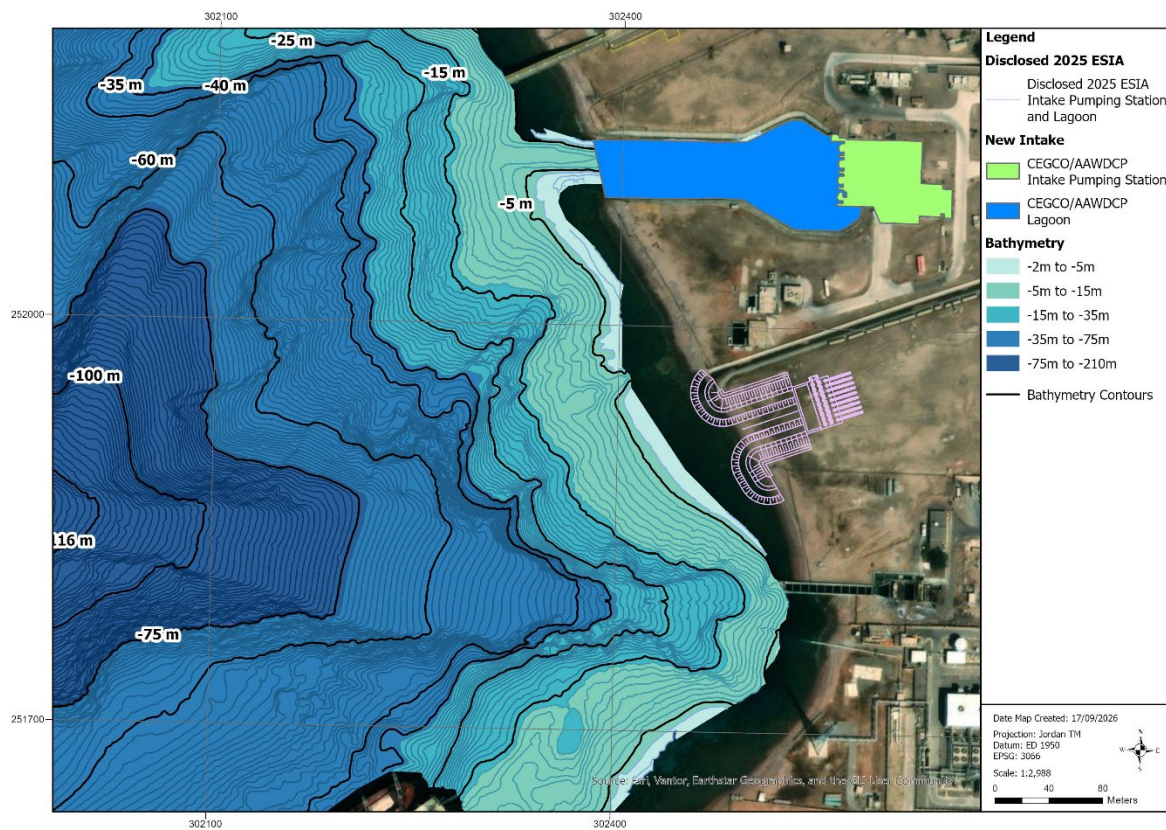
- A floating oil boom to protect the IPS and inlet water quality from oil spill contamination
- A bubble curtain system at the lagoon mouth to protect the intake from jellyfish and also reduce entrainment of other mobile marine life
- A fish catcher and return system to prevent fish from fouling the intake system

2.2.2 Rationale for Change to the Seawater Intake System

To avoid construction of a new intake lagoon and IPS, engagement with SEPCO and asset condition surveys undertaken by the EPC Contractor confirmed that the existing lagoon and IPS were a viable alternative for the Project. The Jordanian authorities and SEPCO confirmed and endorsed the change in the location of the lagoon and IPS in 2026. As a result, the impacts previously identified in the Disclosed 2025 ESIA from constructing a new marine intake system, including an intake lagoon, will be avoided.

Figure 2-1 shows the location of the Disclosed 2025 ESIA IPS and lagoon and the new location of the lagoon and IPS. Lagoon mitigations will not change: the floating oil boom, bubble curtain, and fish catcher and return system will be installed at the new lagoon and IPS location.

Figure 2-1: Disclosed 2025 ESIA Intake Facilities



Section 6.2 presents a detailed assessment of the abstraction system operation.

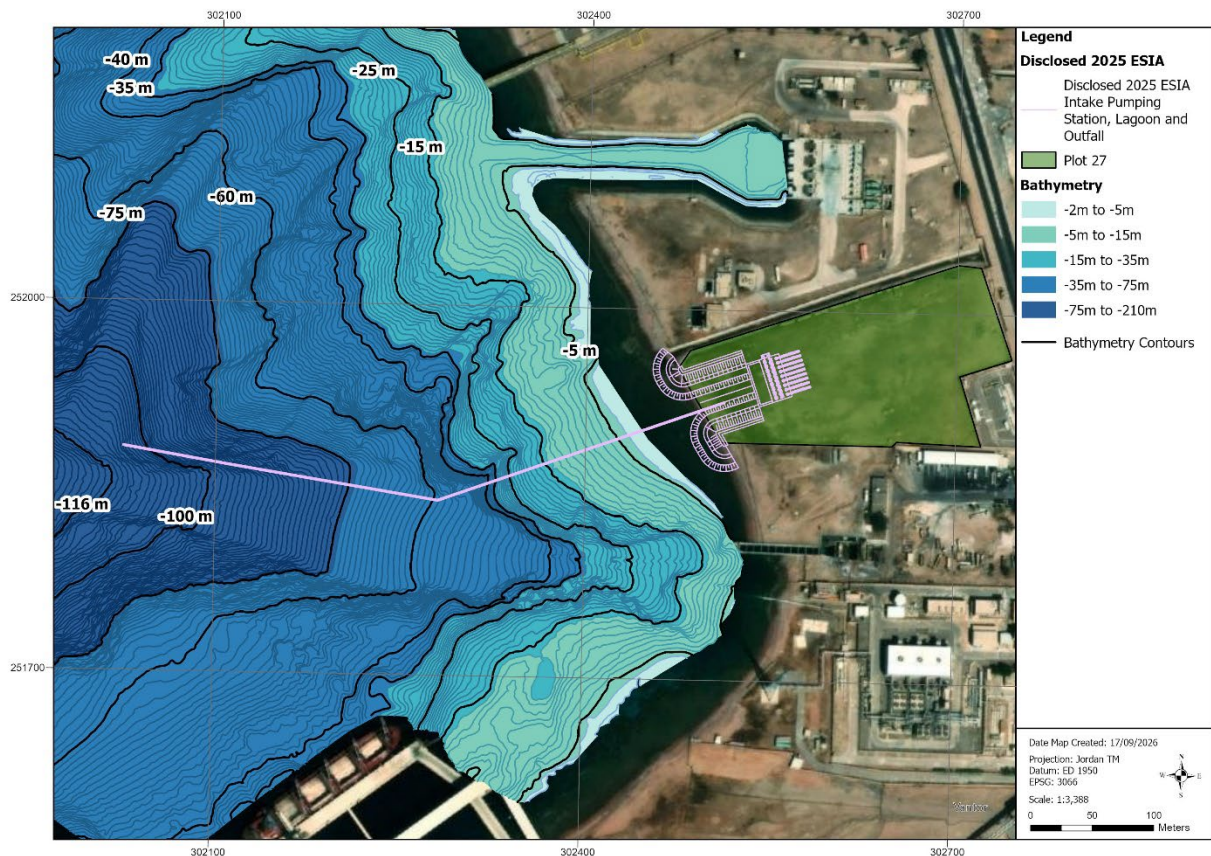
2.3 Brine Outfall Location and Design Change

2.3.1 Disclosed 2025 ESIA Outfall Location and Design

The Disclosed 2025 ESIA presented a single outfall extended by a subsea multiport diffuser with 32 ports. The outfall was to be laid from the shoreline within a 104 m long and 5 m wide trench and then along the seabed surface, stabilised by concrete ballast collars spaced at 5 m intervals; see Figure 2-2.

The preliminary outfall construction methodology envisaged using a temporary nearshore jetty with floating equipment, barges, and vessels to support trenching, installation, backfill, and protection activities in deeper waters. Excavated marine sediment from outfall trenching was to be stored onshore and used for backfilling. Mitigation measures included translocating coral from within the construction zone and use of silt curtains to reduce impacts from sedimentation and increased turbidity.

Figure 2-2: Disclosed 2025 ESIA Outfall and Construction Area



2.3.2 Rationale for Change to Outfall Location and Design

After completing a detailed bathymetric survey, analysing the survey data, and further design development, the EPC Contractor reassessed the construction methodologies described in the Disclosed 2025 ESIA. The reassessment identified several technical constraints and additional impacts not foreseen at the time of the Disclosed 2025 ESIA preparation:

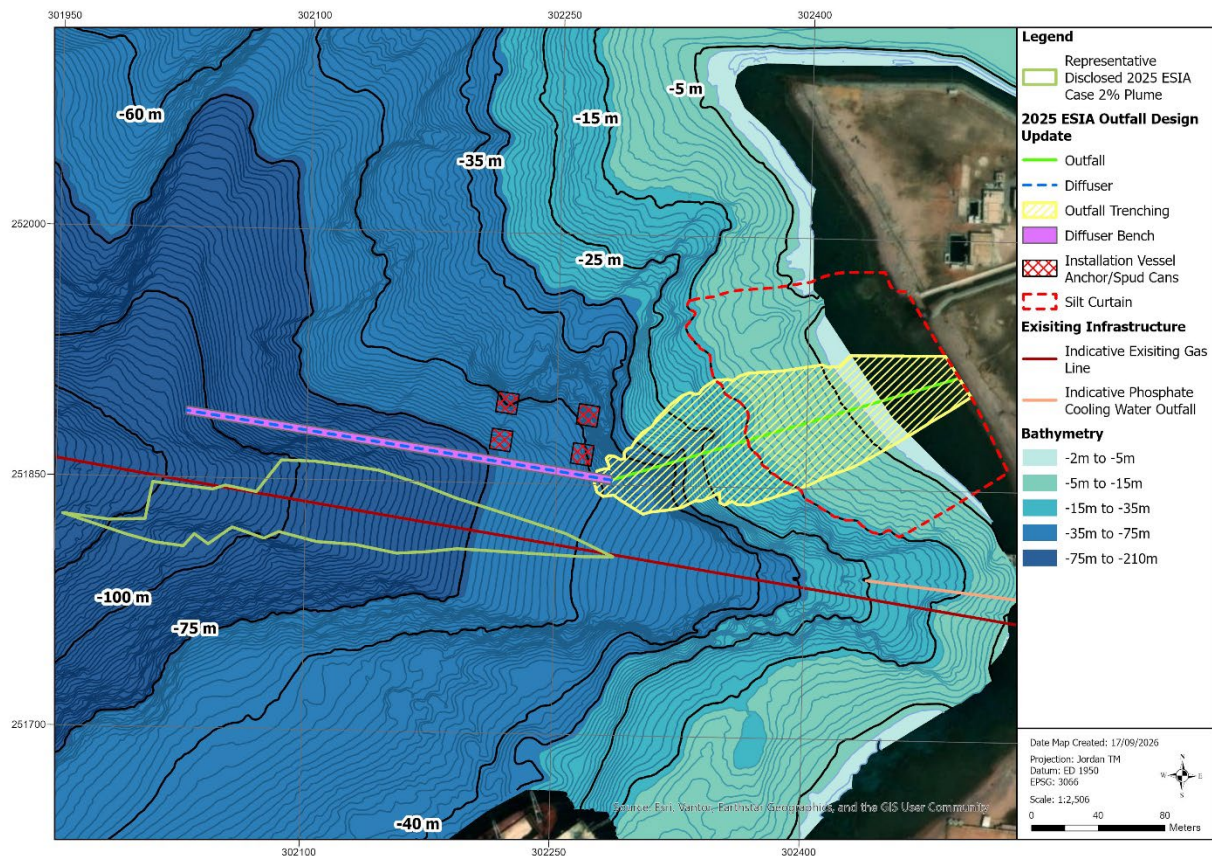
- Trenching will be extended from 15 m depth to 60 m depth, and the width of the trenching zone would need to be increased from 5 m to a maximum of 75 m
- A bench into the seabed would need to be dredged to support the outfall installation and provide a level surface
- The use of silt curtains in these water depths of up to 15 m will present performance and operational challenges, reducing their effectiveness and creating impacts beyond the trenching and dredging area

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- Outfall and diffuser installation would require vessels with limited market availability and diving at water depths greater than 35 m, which exceeds the Project's diving depth limit (all diving work is restricted to depths of 35 m or less). Working beyond that limit would require saturation diving, with the associated technical complexity and risk
- The marine installation support vessels needed for the work will be in very close proximity to the Floating Storage and Regasification Unit (FSRU)

Figure 2-3 illustrates the design development implications for seabed impacts from outfall construction presented in the Disclosed 2025 ESIA. It is noted that the modelling output shown in Figure 2-3 is consistent with the Disclosed 2025 ESIA; the modelling has not been rerun using CFD and high-resolution bathymetry presented in Section 5.

Figure 2-3: Disclosed 2025 ESIA Outfall Design Update with 2% Plume



The unmitigated seabed footprint impacts² from trenching are summarised in Table 2-1, which also includes the brine plume as presented in the Disclosed 2025 ESIA. The construction area quantification assumes silt curtains can be deployed and are effective in water depths up to 15 m, but not beyond this depth.

² To support the comparison of the changes to outfall location and design, unmitigated seabed footprint impacts are provided without considering substrate type, coral or seagrass cover, or coral translocation mitigation; the total seabed impact area is provided with no other variables included.

Table 2-1: Unmitigated Seabed Footprint Impact Area (2025 ESIA Outfall Design Update)

Impact Aspect	Unmitigated Seabed Footprint Impact Area (m ²)
Construction	
Trenching	12,536
Diffuser Bench	1,225
Installation Vessel Anchor/Spud Cans	614
Silt Curtain	11,751
Total Construction Area (m²)	26,126
Plume	
2% Plume	9,076
Construction and Plume	
Total Area (m²)	35,202

Given these technical and environmental challenges, a change in the outfall location and design was required. Two new alternatives were analysed as discussed below.

2.3.3 Analysis of Alternatives

Following the conclusion that the Disclosed 2025 ESIA outfall was not technically viable, two alternatives were assessed:

- Alternative 1: Outfall within the canyon and change in outfall design
- Alternative 2: A micro-tunnelling option and no change in outfall design

The analysis of the alternatives utilised a range of studies and internal and external engagement activities to strengthen it. Updated bathymetric, hydrographic and diver surveys have refined the mapping of existing submarine assets and seabed topography, including the gas pipeline and phosphate outfall, defining the physical constraints on routing. Ongoing liaison with ASEZA, the Ministry of Environment, neighbouring facility operators, SEPCO and the Port Authority has confirmed constructability, construction exclusion zones and safety precautions. An analysis of alternative techniques, focused on micro-tunnelling, broadened the engineering options considered. Additional baseline surveys, a desk-based study of coral and seagrass salinity tolerance, and further brine plume modelling provided a robust environmental basis for a final decision.

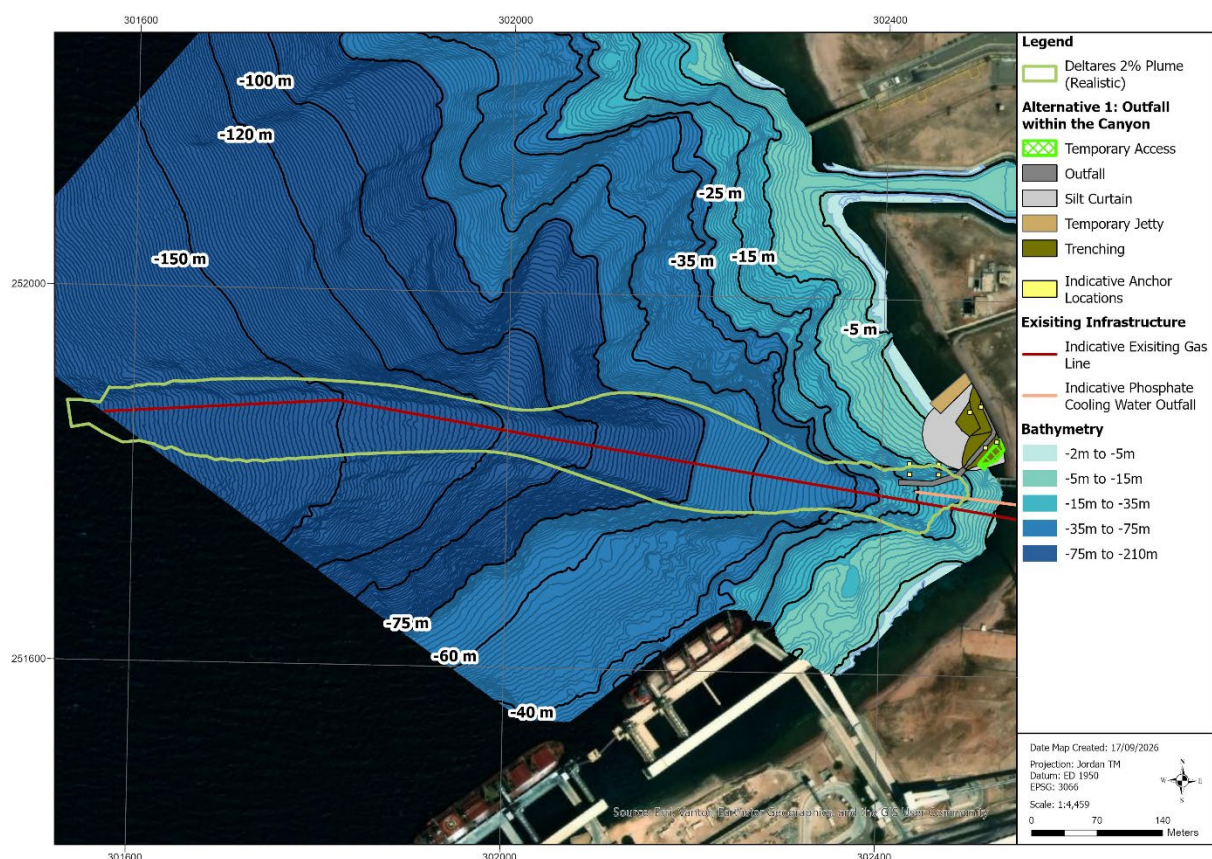
2.3.3.1 Alternative 1: Outfall within the canyon

This alternative option relocates the outfall to a new location within the dominant seabed feature in the industrial zone, a naturally occurring canyon (Figure 2-4) characterised by a substantially higher proportion of soft substrate (that does not support coral growth) than the Disclosed 2025 ESIA outfall route. The canyon therefore provides an opportunity to utilise a natural feature that minimises construction within areas of higher coral abundance and reduces potential impacts on coral reef habitats.

The selected diffuser location is the deepest practicable position (16 m to 27 m) within the canyon that remains accessible for installation by conventional air-diving systems, in accordance with the Project's decision to avoid more complex deep-water diving methods. At this location, the diffuser design was also modified to incorporate fewer ports.

Unlike the Disclosed 2025 ESIA diffuser, which was designed to maximise near-field mixing, the diffuser design was changed to purposefully direct the brine plume within the canyon and promote transport within this natural feature to deeper water where coral presence and abundance are lowest. This approach limits plume dispersion up the canyon walls and into the fringing reef area, where coral communities are more abundant, thereby reducing the extent of coral exposure while also avoiding disturbance to reef habitats during construction.

Figure 2-4: Alternative 1: Outfall within the Canyon with 2% Plume



The quantification of the unmitigated seabed footprint impacts for Alternative 1 is provided in Table 2-2. Section 6 assesses these impacts in detail, including the appropriate salinity threshold for the brine plume.

Table 2-2: Unmitigated Seabed Footprint Impact Area (Alternative 1: Outfall within the Canyon)

Impact Aspect	Unmitigated Seabed Footprint Impact Area (m ²)
Construction	
Trenching	2,065
Outfall	789
Temporary Jetty	683
Temporary Access	31
Silt Curtain	2,787

Impact Aspect	Unmitigated Seabed Footprint Impact Area (m ²)
Anchors	86
Total Construction Area (m²)	6,441
Plume	
2% Plume	69,027
Construction and Plume	
Total Area (m²)	75,468

2.3.3.2 Alternative 2: Micro-Tunnelling of the outfall

The AAWDCP Technical Advisor led a study of micro-tunnelled alternatives to install the outfall beneath the coral reef rather than across it. Three micro-tunnelled alignments were considered, with offshore exit points at approximately 25 m, 60 m and 120 m water depths, positioned no closer than 50 m from the existing gas pipeline. The 60 m exit point was considered the micro-tunnel alignment with the lowest environmental impact.

The micro-tunnelling work would require a 3.4 m diameter slurry shield micro-tunnel boring machine to install the 2.8 m outer-diameter High-density polyethylene (HDPE) outfall pipeline along a drive of approximately 220 m, following a 6% downward gradient from an onshore launch shaft to an offshore exit point at approximately 60 m water depth. The pipeline would be placed beneath the reef rather than in a dredged trench, avoiding associated seabed impacts. Construction impacts are not 100% avoided with the micro-tunnelling option; three types of impact were identified (see Figure 2-5) and quantified in Table 2-3:

- Installation anchors for the diffuser installation vessel
- Geotechnical survey vessel anchors
- Diffuser bench dredging

Detailed location-specific dispersion modelling of the brine plume at the 60 m water depth exit point was not completed for this alternative; however, to support the Disclosed 2025 ESIA, a number of plume modelling scenarios were modelled and the representative scenario is shown in Figure 2-5. The plume footprint is comparable to that of the Disclosed 2025 ESIA and is smaller than the plume for Alternative 1.

Figure 2-5: Alternative 2: Micro-Tunnelling of the Outfall (60 m) with 2% Plume

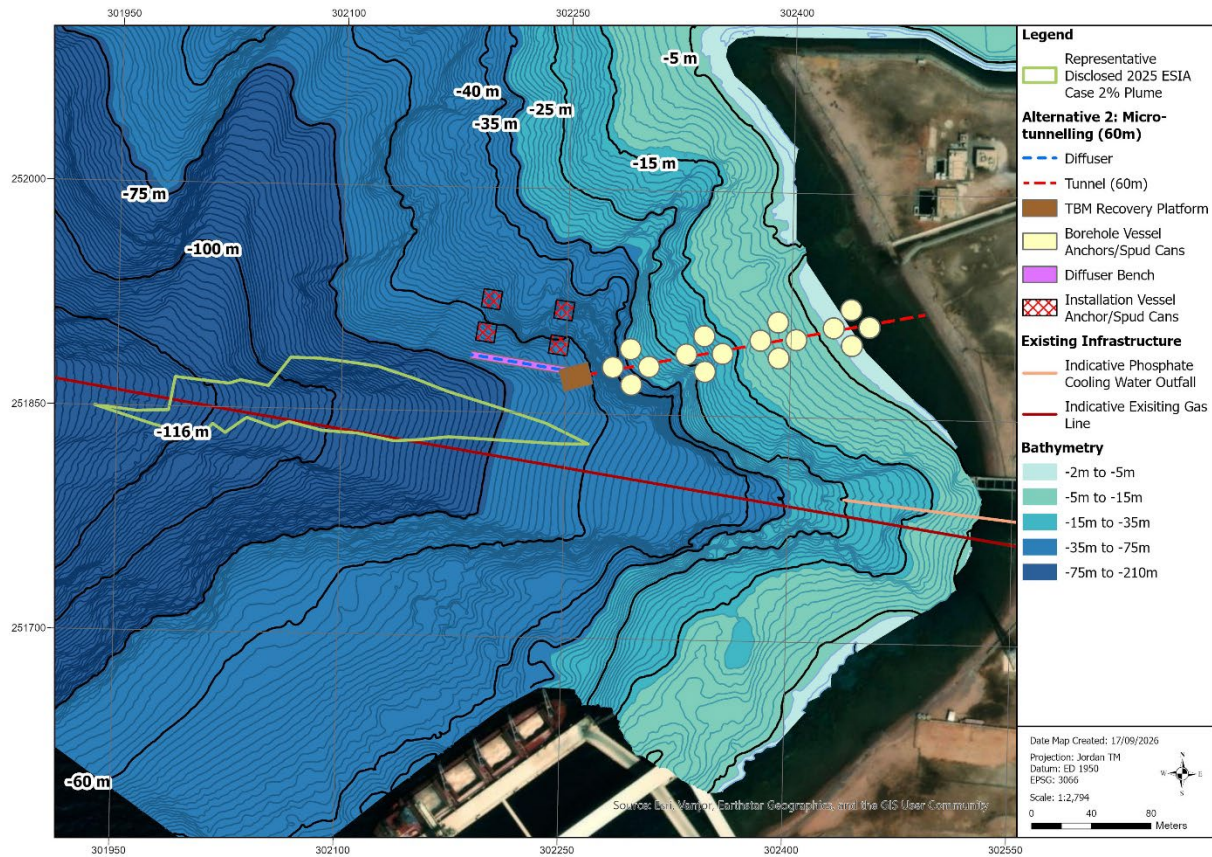


Table 2-3: Unmitigated Seabed Footprint Impact Area (Alternative 2: Micro-Tunnelling of the Outfall - 60 m)

Impact Aspect	Unmitigated Seabed Footprint Impact Area (m ²)
Construction	
Borehole Vessel Anchors/Spud Cans	2,463
Diffuser Bench	309
Installation Vessel Anchor/Spud Cans	613
Tunnel Boring Machine (TBM) Recovery Platform	298
Total Construction Area (m²)	3,683
Plume	
2% Plume	9,076
Construction and Plume	
Total Area (m²)	12,759

The reduction in construction impacts and the plume footprint compared to Alternative 1 is, however, outweighed by a series of technical constraints that render the option not viable:

- At the tunnelling depth, the machine would operate under face pressures of the order of 6 bar, beyond the range of standard micro-tunnelling equipment, so a project-specific machine would require selection, adaptation, or bespoke design, creating significant procurement lead time, cost, and technical risk
- The launch shaft would extend from existing ground level to approximately -47 m and would require diaphragm walls, as secant piles are unable to achieve the verticality necessary to guarantee watertightness at such depth, together with continuous dewatering and treatment prior to any discharge to sea
- Shaft excavation alone would generate 10,000 to 12,000 m³ of spoil which, combined with the micro-tunnel arisings, exceeds the storage capacity of Plot 27
- Saturation diving would be required for the -60 and -120 m; this is beyond the technical limit of the Project

2.4 Design Development and Alternative Analysis Conclusion

An overview of the design development process and analysis of alternatives undertaken since the disclosure of the 2025 ESIA is provided in Figure 2-6.

Figure 2-6: Summary of Design Development and Alternative Analysis

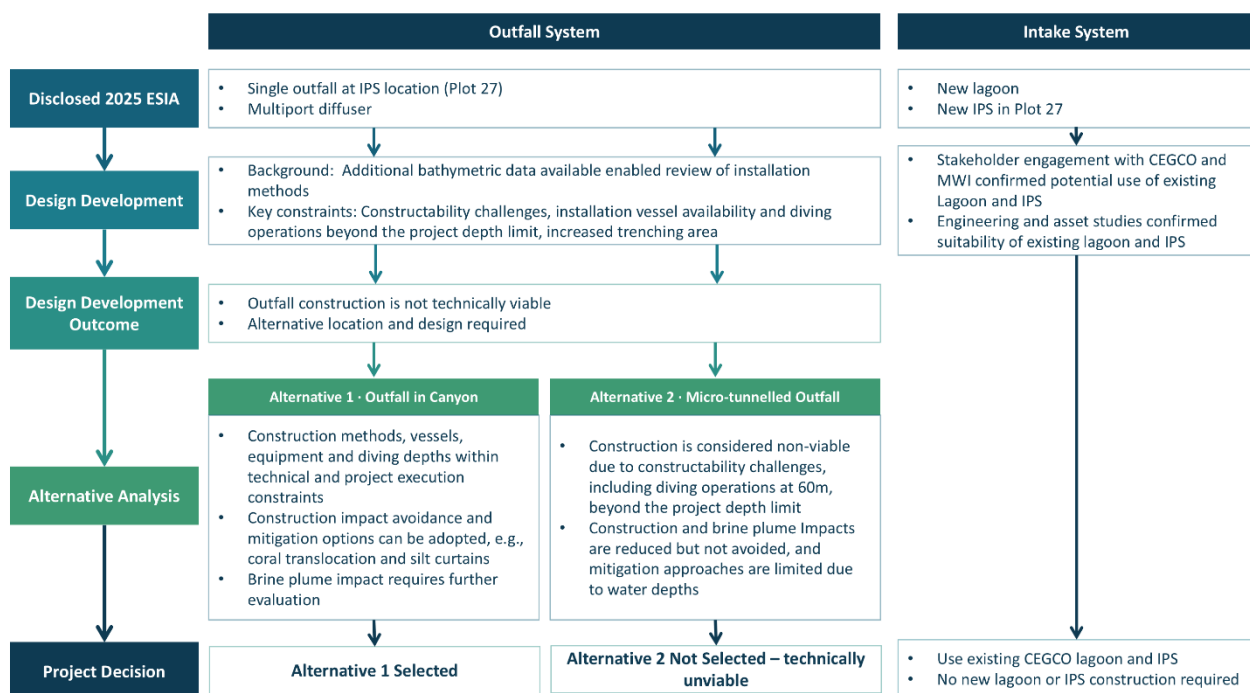


Table 2-4 below summarises the construction unmitigated seabed footprint impacts for the full range of options assessed during the design development phase since the Disclosed 2025 ESIA.

Table 2-4: Summary of Unmitigated Seabed Footprint Impact Areas

Option	Constructi on Intake m ²	Construction Outfall m ²	Total construction intake and outfall m ²	Plume area m ²	Total Unmitigated Seabed Footprint Impact Area m ²
Disclosed 2025 ESIA	3,500	2,646	6,146	9,076	15,222
Alternative 1: Outfall within the canyon	0	6,441	6,441	69,027	75,468
Alternative 2: Micro tunnel	0	3,683	3,683	9,076	12,759

Alternative 1 was selected as the only viable technical option, with recognition that the new outfall location and design would need the following additional studies to support the further design and construction planning, including:

- Brine diffusion modelling, see Section 5
- Engagement with the gas pipeline operator
- Additional environmental baseline surveys with the plume area and laboratory coral exposure studies, see Section 3.1, to support finalisation of the long-term environmental monitoring plan
- Finalisation of the Biodiversity Action Plan
- Finalisation of the adaptive management plan

2.5 New Outfall Construction Methodology

This section presents the construction methodology for the selected marine outfall works following the conclusion of the alternatives analysis (refer to Section 2.4). Modifications to the existing SEPCO lagoon and intake pumping station will not create physical impacts to marine habitats; therefore, this section does not discuss the construction methodology for the seawater intake system.

The methodology outlined in this section is based on the EPC Contractor's indicative construction methodology received in August 2026 and is subject to further development during detailed design and following the appointment of the marine works subcontractor. Details such as anchor plans and their location and number, or how sections of the outfall will be connected, have not been developed in detail; the available information has been incorporated into the impact assessment. While the final execution methods, equipment selection and sequencing may differ from those described, the overall construction scope, complexity and associated Project impacts are expected to remain of a similar magnitude. The dredged material management strategy will comprise the following measures:

- Reuse of suitable excavated material as trench backfill, where practicable
- Temporary storage, handling and transport of excavated material in accordance with the High-Level Construction Methodology
- Transportation of surplus excavated material to the designated onshore disposal site

2.5.1 Overview of the Marine Outfall Works

The marine outfall works comprise installation of a DN2800 HDPE outfall pipeline running seaward from the Desalination Plant connection point at the shore, with the dredging, bedding, ballasting, backfill and rock protection needed to secure it. The pipeline will consist of prepared strings, a pre-assembled bend section, and a transition precast element, joined by bolted flange connections and fitted with ballast blocks. Work will be organised by chainage (i.e. the distance in metres along the pipeline): chainage 0 to 60 executed from the shore, chainage 60 to 110 executed offshore from a crane barge, with pipeline placement continued seaward to approximately chainage 195.

The marine spread comprises a dredger, crane and flat deck barges, front and rear tugboats and a dive team, with material and logistical support from the Royal Navy Port some 1.5 nautical miles from the Project site.

2.5.2 Temporary Facilities and Port Logistics

Onshore support will be provided by a temporary office and laydown area of approximately 6,500 m² on a footprint of about 84 m by 76 m, accommodating the contractor office, mess hall and rest area, warehouse and material stock area, precast production and stock areas, a rebar production area, an equipment park and car park, generators, a fuel tank and water and septic tanks (Figure 2-7).

The marine logistics arrangement within the Royal Navy Port is still under discussion; nevertheless, all planned facilities will remain within the Royal Navy Port site boundary. Marine logistics comprise three areas at the Royal Navy Port (Figure 2-8):

- Area 12-A for pipe storage and preparation, including the welding area where strings are made up
- Area 12-B for precast storage
- Area 12-C for rock loading and unloading, where a long-reach excavator works over the quay edge to load the flat deck barge

Figure 2-7: Temporary Facilities

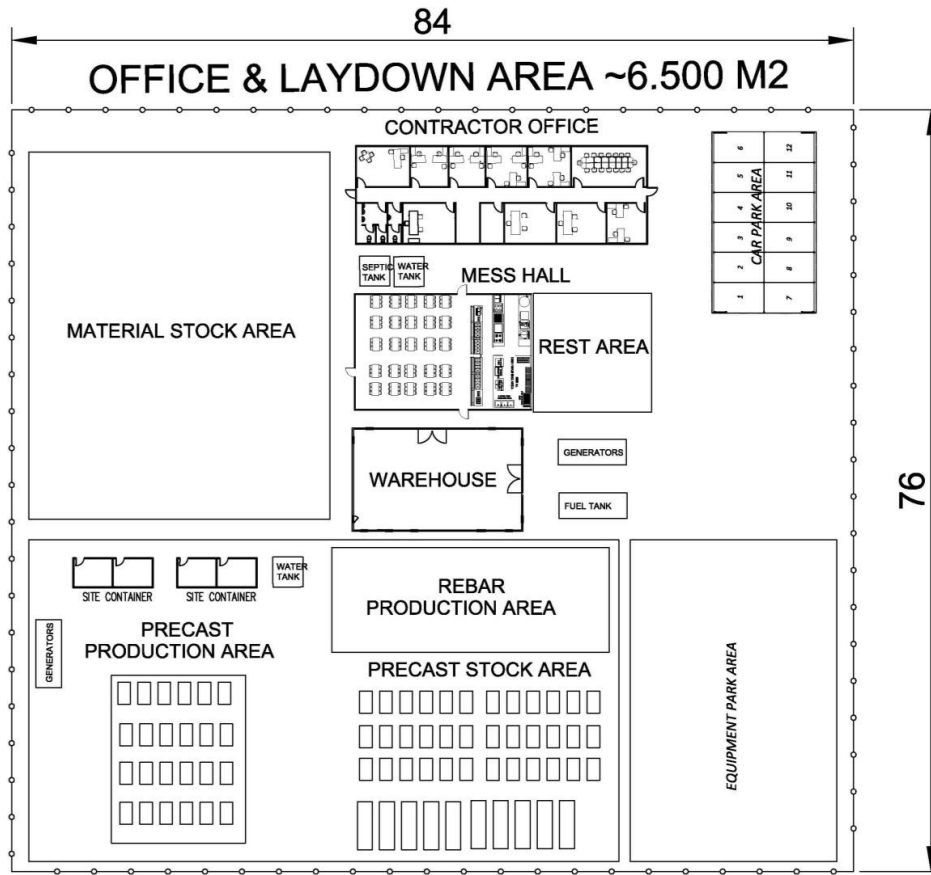
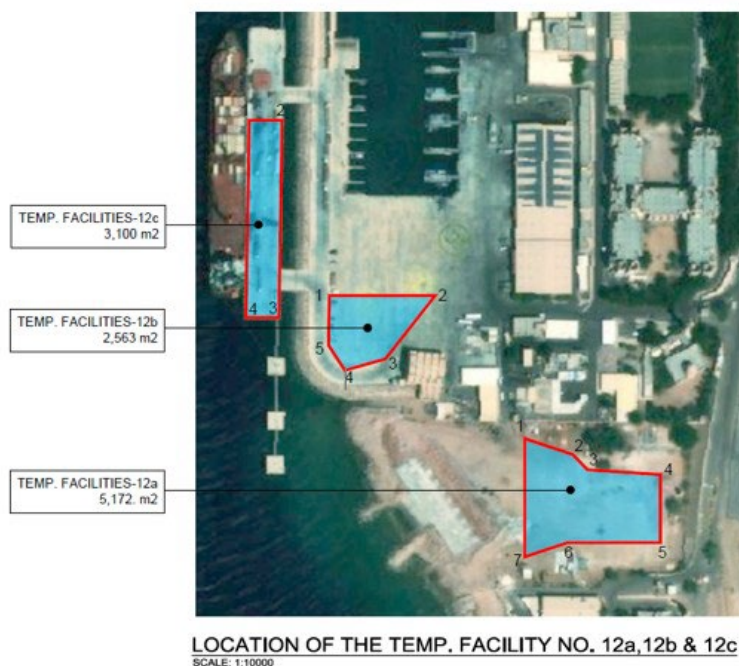


Figure 2-8: Marine Logistics at the Royal Navy Port



2.5.3 Dredging and Dredged Material Handling

Dredging will be carried out with a dredger, fitted with an underwater breaker attachment where the seabed is hard or rocky. A silt curtain will be installed around the work area and maintained throughout the construction activities to minimise turbidity and protect the marine environment. Before dredging, the Project will remove and translocate hard corals within the footprint to be enclosed by the silt curtain, see Figure 2-9.

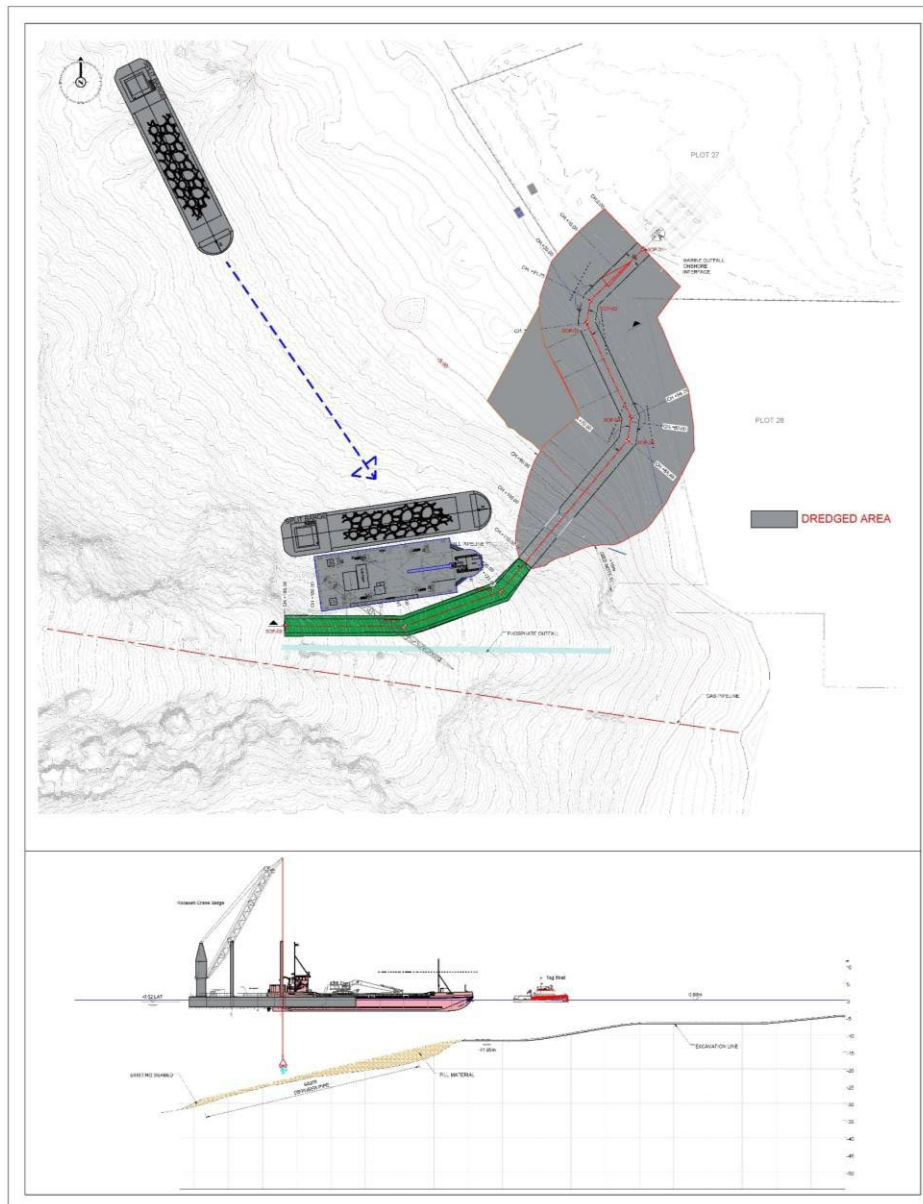
The total volume of material to be excavated for installation of the marine outfall is conservatively estimated at approximately 20,000 m³. Based on the available geotechnical investigations, the excavated material is expected to consist predominantly of dense sandy beach deposits and coral-derived sediments. No rock strata were encountered within the investigated depth profile and, accordingly, no hard rock dredging is anticipated. The excavated material is therefore expected to comprise essentially unconsolidated granular sediments. Of the total excavated volume, approximately 8,500 m³ is expected to be reused as trench backfill following installation of the outfall pipeline. The native material is considered suitable for this purpose, and its engineering properties are not deemed critical, as the backfill does not perform a structural function. The remaining approximately 11,500 m³ of surplus excavated material will require off-site disposal at the designated onshore disposal site.

The final dredged volume will depend on the detailed design, the subcontractor's final construction methodology, and the actual ground conditions encountered during construction.

2.5.4 Pipeline Installation

Gravel bedding, for stable foundation and support of the pipeline when laid on the seabed, will be loaded onto a flat deck barge at the Royal Navy Port and transported offshore, where the flat deck barge will be positioned alongside the crane barge (Figure 2-10). The crane barge will transfer the gravel with a hydraulic clamshell and place it underwater along the alignment, controlled and adjusted on the basis of survey data.

Figure 2-10: Gravel Bedding Placement



2.5.4.2 First Pipe, Bended Pipe and Remaining Pipeline

The first prepared HDPE string will be towed from the Royal Navy Port to the connection area by front and rear tugboats. On arrival, the front tugboat will hand the pulling line to the crane barge, positioned inside the dredged trench near the Desalination Plant connection point. The crane barge and rear tugboat will align the ballasted string, which will then be gradually sunk and connected to the Desalination Plant interface (Figure 2-11).

The pre-assembled bend section, with its ballast blocks and underlying bedding material, will be delivered by the flat deck barge, lifted by the crane barge and lowered into position with diver assistance (Figure 2-12).

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Remaining pipeline sections, pre-fitted with ballast blocks, will be installed following the same method (Figure 2-13). Each pipe section will be lowered and aligned underwater by the crane barge, with divers supporting positioning and connection and enhanced controls and monitoring in deeper water.

The pipeline system will be assembled using flanged connections: individual pipe sections, bends and transition pieces will be connected through bolted flange joints, enabling controlled offshore installation and facilitating alignment during assembly.

Figure 2-11: First Pipe Installation

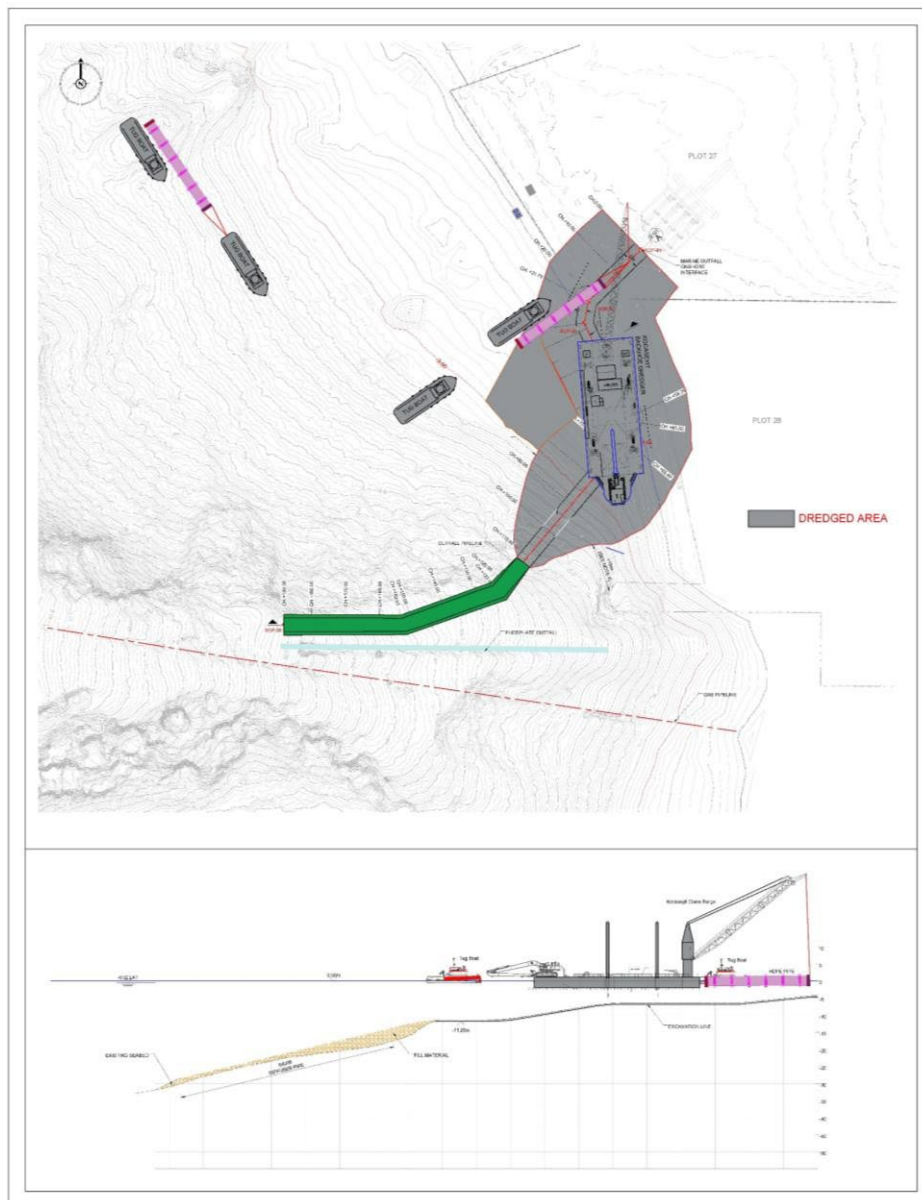
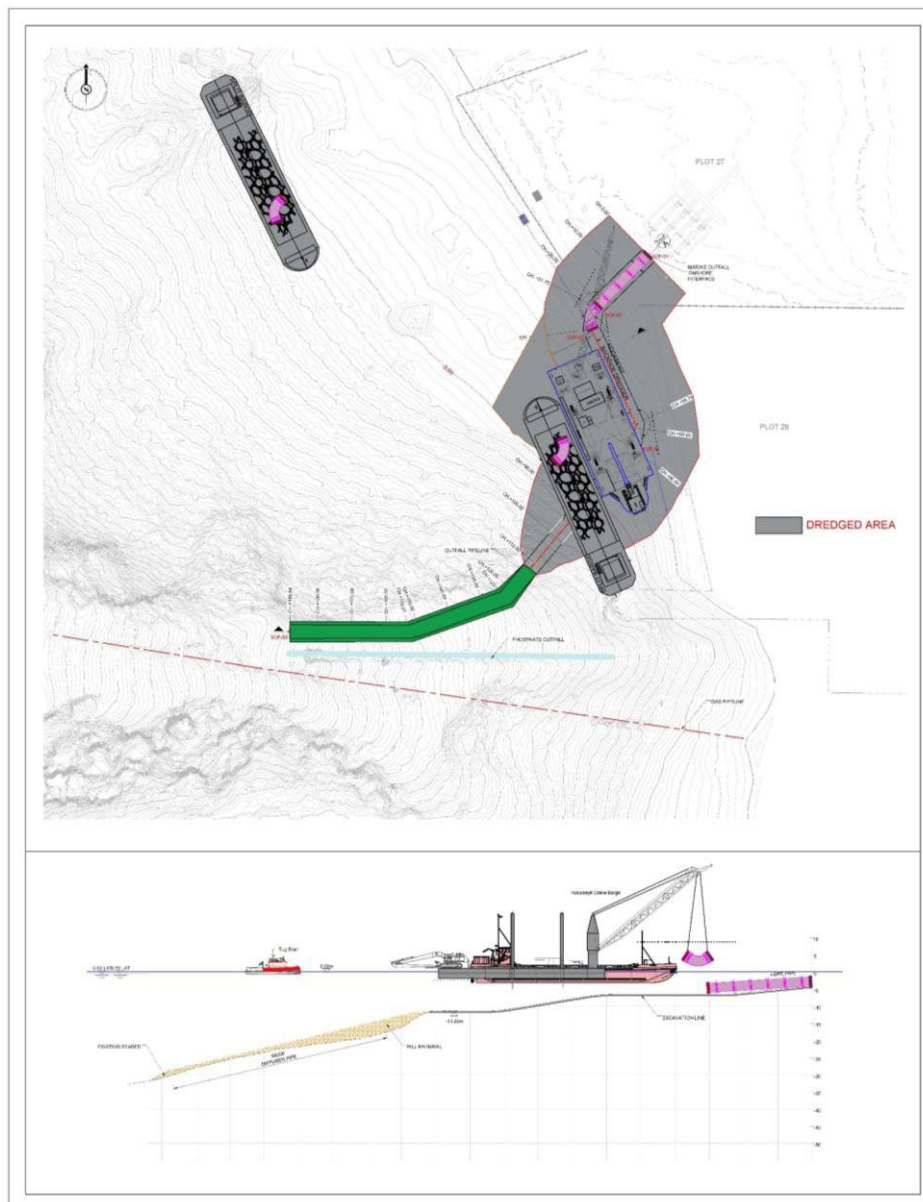


Figure 2-12: Bended Pipe Installation



The figure consists of two parts: a plan view (top) and a profile view (bottom).

Plan View: This view shows the layout of the proposed pipeline (green line) and the existing pipeline (blue line) relative to the dredged area (red shaded region). The dredged area is located near the shore, with a depth of 10 meters. The proposed pipeline is shown with a 100m section and a 200m section. The existing pipeline is shown with a 100m section. The plan view also includes a north arrow and a scale bar.

Profile View: This view shows the cross-section of the pipeline, including the existing seabed, the proposed pipeline, and the dredged area. The vertical axis represents depth in meters, ranging from 0 to -50. The horizontal axis represents the distance along the pipeline. The profile view shows the existing seabed (dashed line), the proposed pipeline (solid line), and the dredged area (shaded region). The proposed pipeline is shown with a 100m section and a 200m section. The profile view also includes a scale bar and a north arrow.

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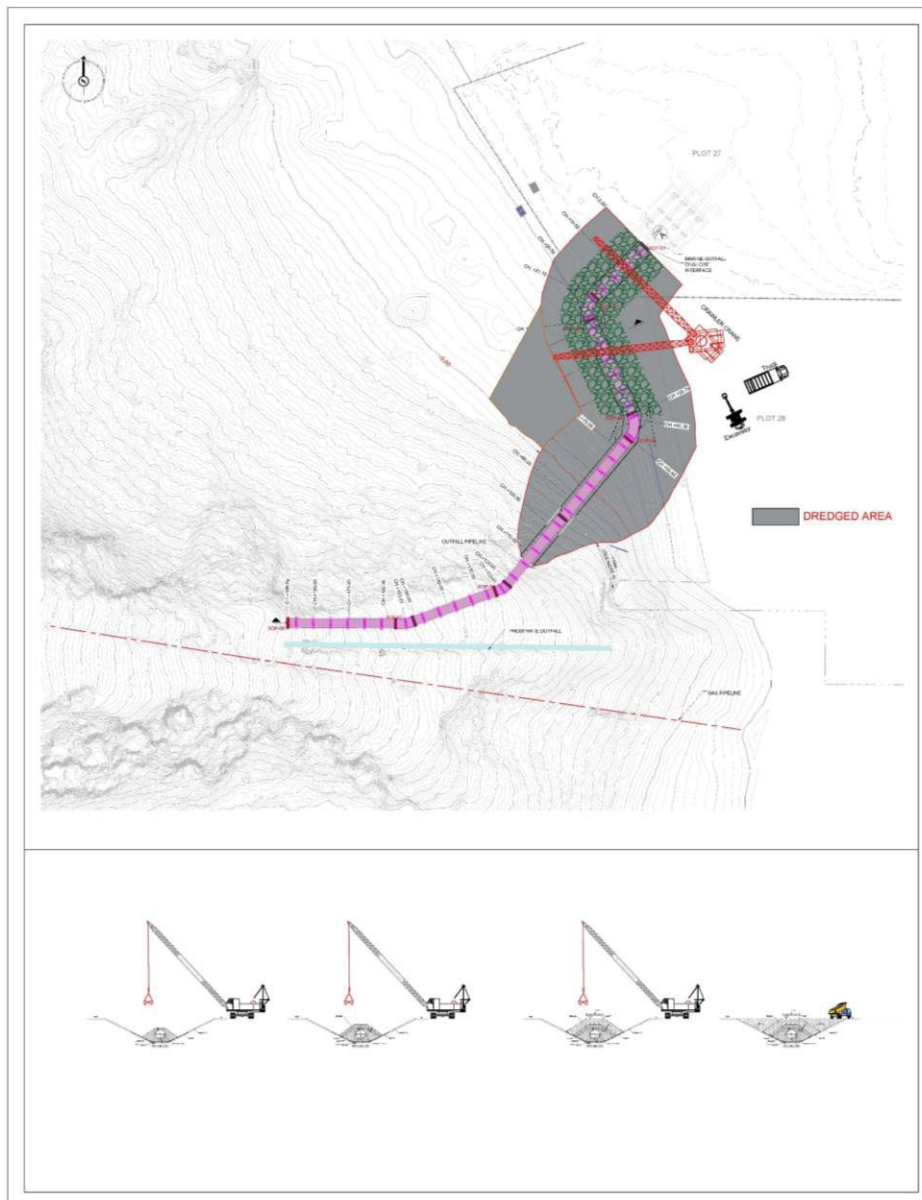
2.5.5 Backfill, Rock Protection and Transition Structures

Between chainage 0 and 60, rock protection and backfill are placed from the shore using a crawler crane with a clamshell or grab, material delivered from the stockpile by truck and handled with excavator support, placement areas surveyed beforehand and works executed within the specified alignment and tolerances (Figure 2-14).

The transition precast element will be brought from the Royal Navy Port by the flat deck barge, lifted and lowered into position by the crane barge and set with diver assistance (Figure 2-15).

Between chainage 60 and 110, the equivalent works are carried out offshore from the crane barge, with materials brought by the flat deck barge and placed underwater under survey control (Figure 2-16).

Figure 2-14: Rock Protection and Backfill (Chainage 0-60)



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Figure 2-15: Transition Precast Installation

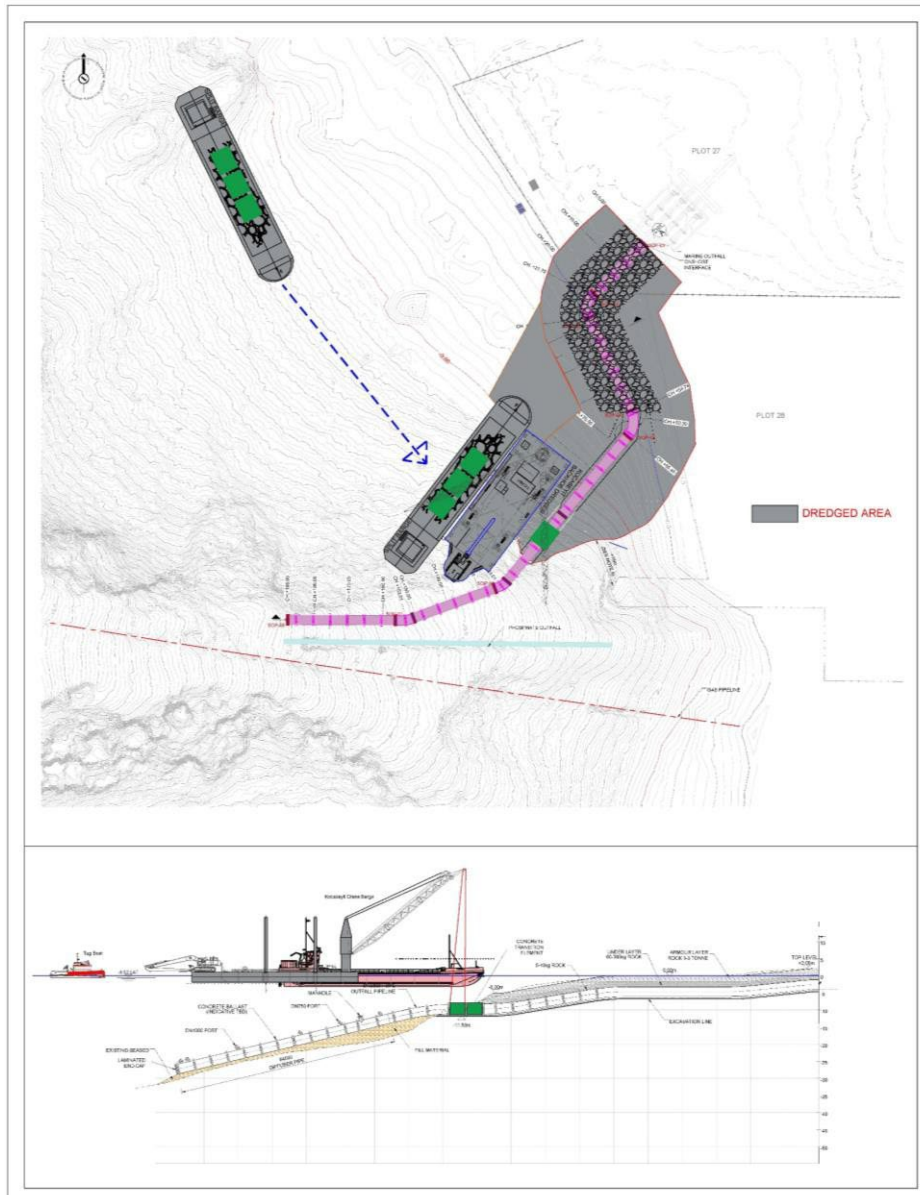
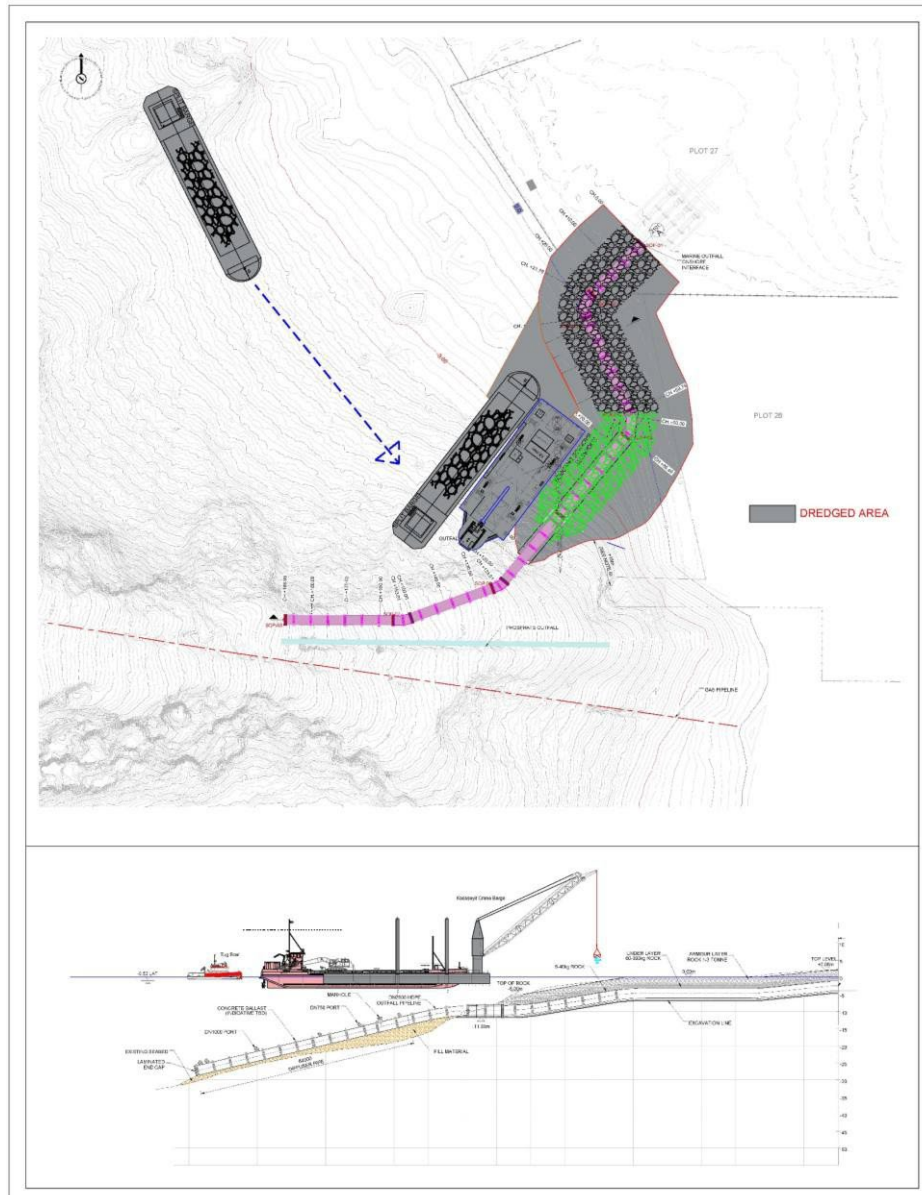


Figure 2-16: Rock Protection and Backfill (Chainage 60-110)



3 Baseline Information

3.1 Limitations and Next Steps

The environmental survey and study work that is planned to provide additional pre-construction baseline data is summarised below in Table 3-1. This information is designed to strengthen the biodiversity baseline data. It will provide the information needed to refine impact assessment, biodiversity action planning, habitat management, long-term environmental monitoring plan, marine construction works management plan (that will focus on dredging management and effectiveness of controls such as the silt curtains) and support the adaptive management plan described in Section 7.

Table 3-1: Summary of Additional Pre-Construction Environmental Survey and Studies

Activity	Status	Summary of scope	How it will support the assessment
Sediment and water sampling monitoring	Survey to be completed 4Q 2026	- Sediment and water sampling - Establish long-term monitoring stations	Provide additional baseline data on the physicochemical properties of sediment and water
Brine plume ROV survey – to support the drop-down video survey completed	- ROV under repair - Survey to be completed in 4Q 2026	- Underwater photography transects - Establish long-term monitoring stations	- Collect detailed, quantifiable, baseline data on substrate coral conditions and health to support higher-resolution impact quantification and Biodiversity Action Plan (BAP) loss/gain assessment - Establish long-term monitoring locations, operational impacts and determine the need for adaptive management if monitoring impacts exceed those predicted
Laboratory-based coral exposure study	- Study: To start in 4Q 2026 - Rapid analysis: Interim results available in late Q4 - Detailed analysis: In Q4 2027	- Select coral species/growth forms from within the modelled brine plume and establish laboratory arrays/test conditions - Monitor coral response using non-destructive indicators at planned and regular intervals	Assess coral tolerance to predicted environmental salinity and iron concentrations within the brine plume and confirm tolerance

Activity	Status	Summary of scope	How it will support the assessment
Field based coral settlement study	- Study: To start in 4Q 2026 - Rapid analysis: Interim results available in late Q4 - Detailed analysis: In Q4 2027	- Install settlement plates within the inlet lagoon and brine plume impact area and at control stations - Monitor coral settlement at planned and regular intervals	- Confirm if there are seasonal fluctuations in coral reproduction - Record the settlement patterns for corals in the study area, focusing on the intake entrainment impact area and long-term brine plume impacts to coral settlement and survival

The brine plume area drop-down video mapping is intended to represent the broadscale distribution of seabed habitats within the brine plume survey area. It should not be interpreted as a precise delineation of individual coral colonies, isolated reef outcrops or small sediment patches. As recognised elsewhere in the Project habitat mapping, predicted habitat boundaries should be regarded as transitional rather than abrupt and uncertainty increases between directly observed sampling locations.

The mapping assumes that the three to five still images selected at each Drop-down video (DDV) station are representative of the habitat observed at that station and that the resulting habitat classification adequately represents the dominant seabed character at that location. Small-scale heterogeneity occurring outside the selected images may therefore not be fully represented within the assigned station classification. The use of only multibeam echosounder derived information and Terrain Ruggedness Index (TRI) as predictor variables also means that habitat prediction is primarily based on seabed morphology and structural complexity. Other environmental variables that may influence benthic habitat distribution, such as sediment character, slope, backscatter intensity, depth, hydrodynamic conditions or water quality, were not explicitly incorporated into this classification unless represented indirectly within the input datasets. The map should therefore be interpreted as a prediction based on the relationship between the observed habitats and the available geophysical variables rather than a deterministic representation of habitat occurrence.

Uncertainty within the habitat map is expected to be greatest between widely spaced DDV stations, around transitions between habitat types, where the seabed camera position may differ materially from the recorded vessel GPS position, and where different habitats have similar Multibeam echosounder (MBES) or terrain-ruggedness characteristics.

Overall, the method provides a reproducible means of integrating discrete DDV observations with continuous MBES-derived seabed information to produce a broadscale habitat map of the brine plume area. The map is appropriate for identifying the principal spatial distribution of the mapped deep-water habitat classes and for informing the interim assessment of habitat exposure within the predicted plume footprint. It should be refined, where appropriate, once the additional ground-truth information from the planned ROV survey is available.

3.2 Seawater Intake System

This section presents a summary of the approach and results from the diver transect survey completed in July 2026 (Figure 3-1), focused on seawater intake system abstraction zone. A technical baseline report will be issued. The survey followed a structured plan to characterise existing biota characteristics across the area of the intake abstraction zone modelling; see Figure 3-2. The structured design enabled data on

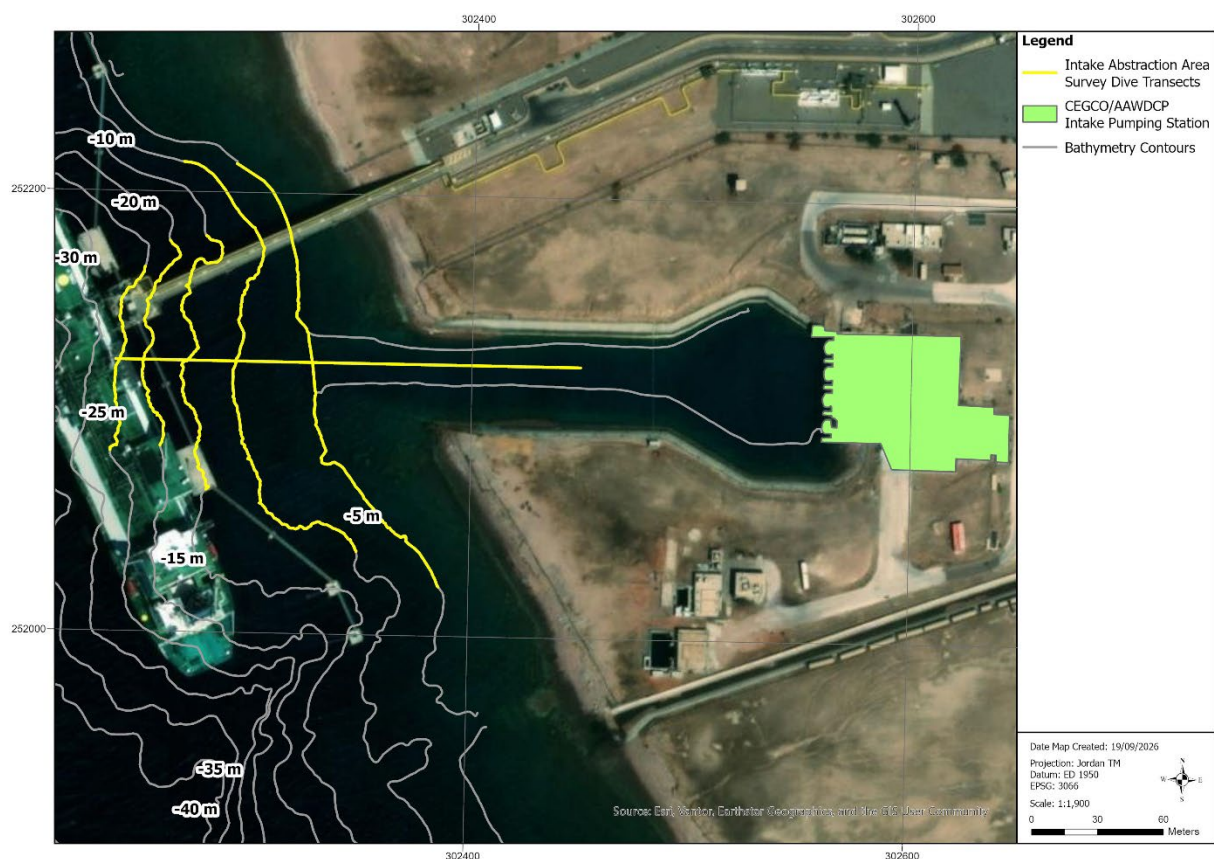
biota present to be collected from known positions and depths relative to the different flow-rate zones identified by the modelling.

The University of Jordan's Marine Science Station collected habitat mapping data using dive transects: four depth contours (5–20 m) plus a perpendicular lagoon transect spanning all intake flow zones. Divers photographed 0.5 m quadrats every 2 m and geo-referenced 1 m quadrats every 10 m. BIIGLE analysis was completed, and quality assurance was conducted to verify the assigned habitat categories and percentage cover estimates.

Habitat distribution across the Intake Lagoon and adjacent waters was predicted by statistically relating ground-truth samples to geophysical layers. The 521 survey images were scored for coral cover, seagrass cover and substrate type, then manually assigned to one of six categories: Coral, Coral and Seagrass, Rock, Mixed Substrate, Sand, and Seagrass, reflecting dominant habitat rather than fixed thresholds. Buffered training areas generated statistical signatures, and the machine learning tool 'Random Forest classification' produced the final map.

The overarching strategy for interpreting the data was to assess how flow rates affect biota within the intake lagoon and abstraction zone. An additional feature was to establish a series of permanent site locations that could be periodically monitored to determine any longer-term impacts of water abstraction once the IPS becomes operational.

Figure 3-1: Intake Abstraction Area Survey Transects

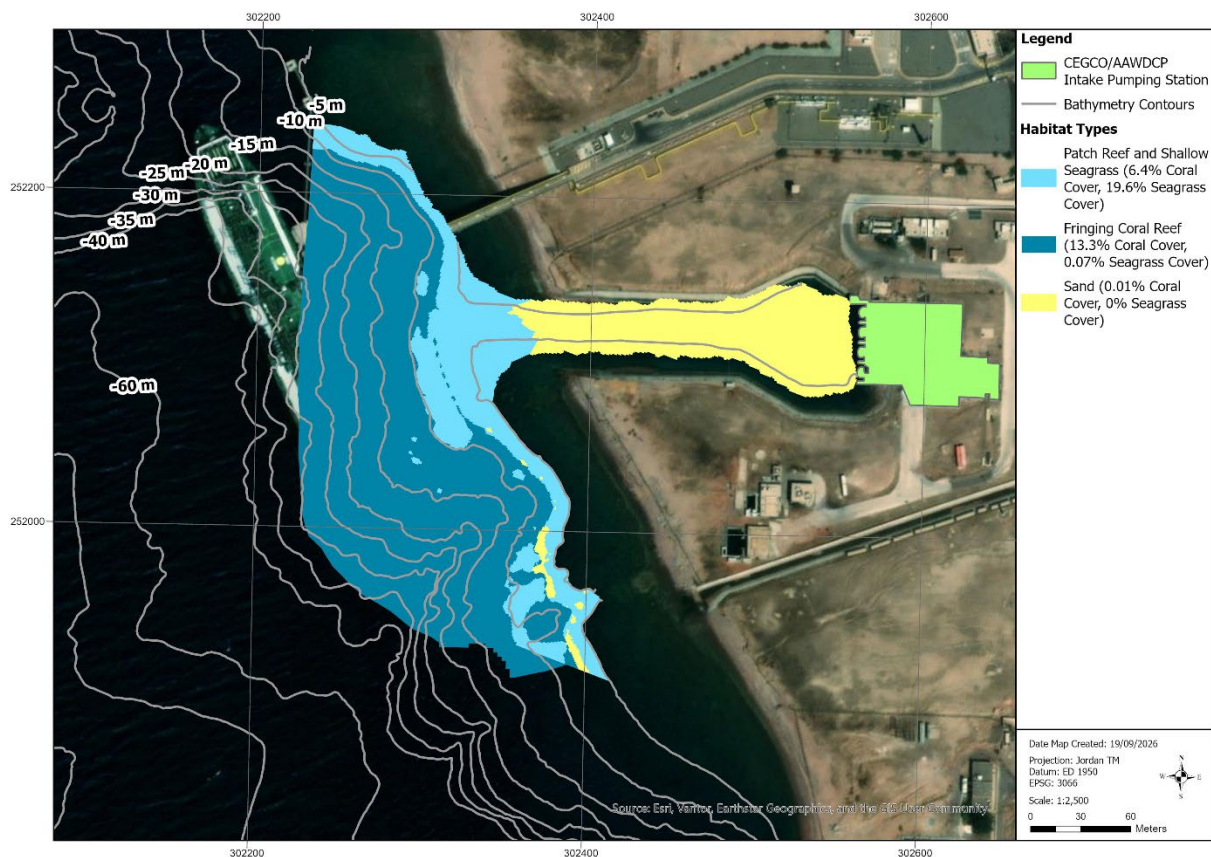


3.2.1 Survey Results

The resulting habitat interpretation is presented in Figure 3-2. Within the intake abstraction area, three habitats have been identified:

- Sand, average coral cover is 0.01%; seagrass cover was zero
- Patch reef and shallow seagrass, average coral cover is 6.4%; seagrass cover was 19.6%
- Fringing coral reef, average coral cover is 13.3%; seagrass cover was 0.07%

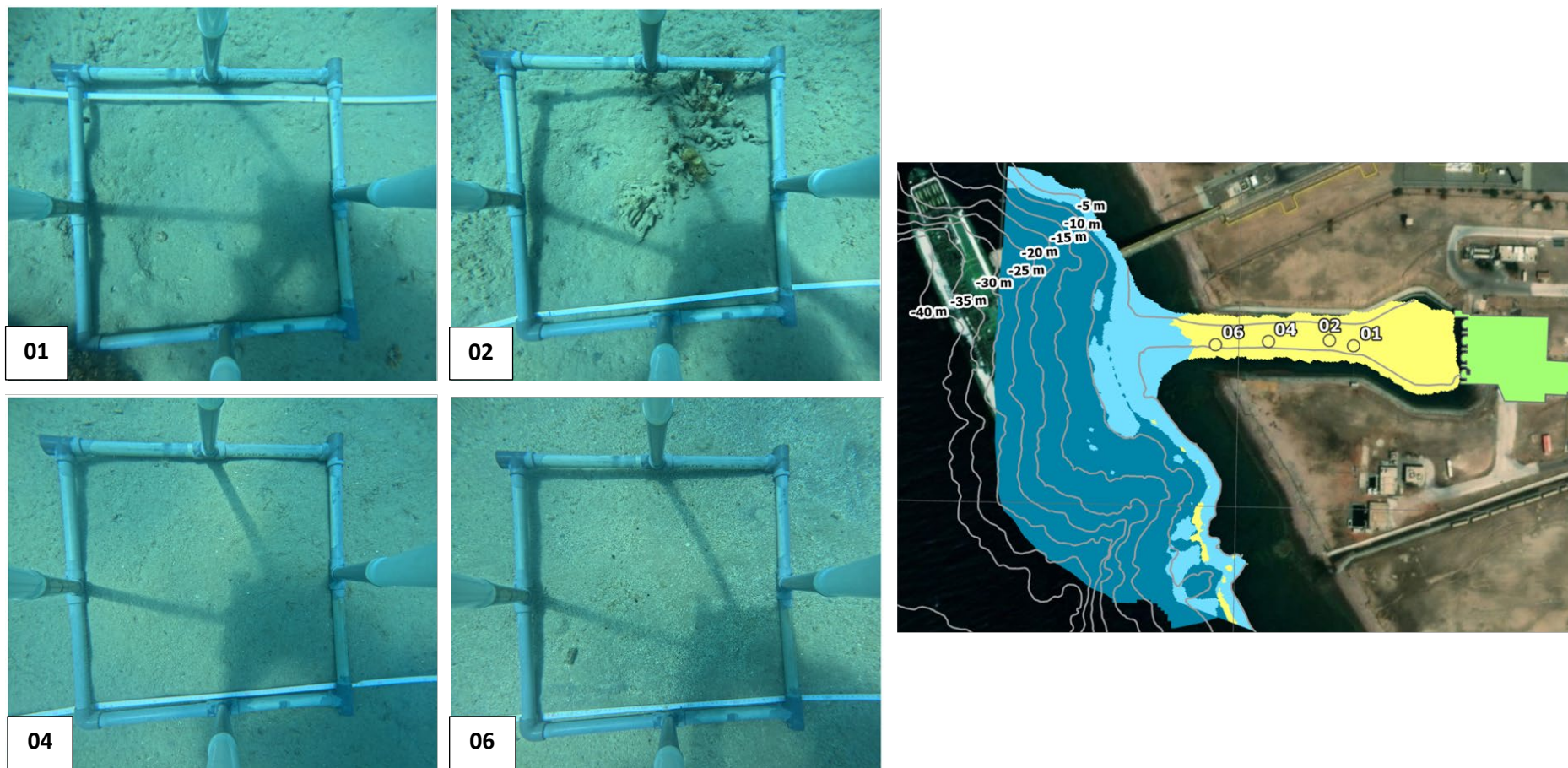
Figure 3-2: Intake Abstraction Area Habitat Mapping



3.2.1.1 Sand

Sand habitat was characterised by an almost entirely unconsolidated seabed, with soft substrate averaging $99.8 \pm 1.4\%$ and hard substrate only $0.2 \pm 1.4\%$. Seagrass was absent from all samples assigned to this habitat, giving a mean cover of 0%. Hard coral was also effectively absent, with a mean overall coral cover of only $0.01 \pm 0.12\%$ and coral recorded in just one of the 63 images. Although calculated coral occupancy of available hard substrate was approximately $4.7 \pm 6.6\%$, this was based on only two samples containing any hard substrate and is therefore not representative of the habitat generally. The class is consequently best characterised as predominantly bare sandy seabed with very limited biological structure. Example images and the locations of these images are presented below in Figure 3-3.

Figure 3-3: Images Illustrating the Sand Habitat Category



3.2.1.2 Patch Reef and Shallow Seagrass

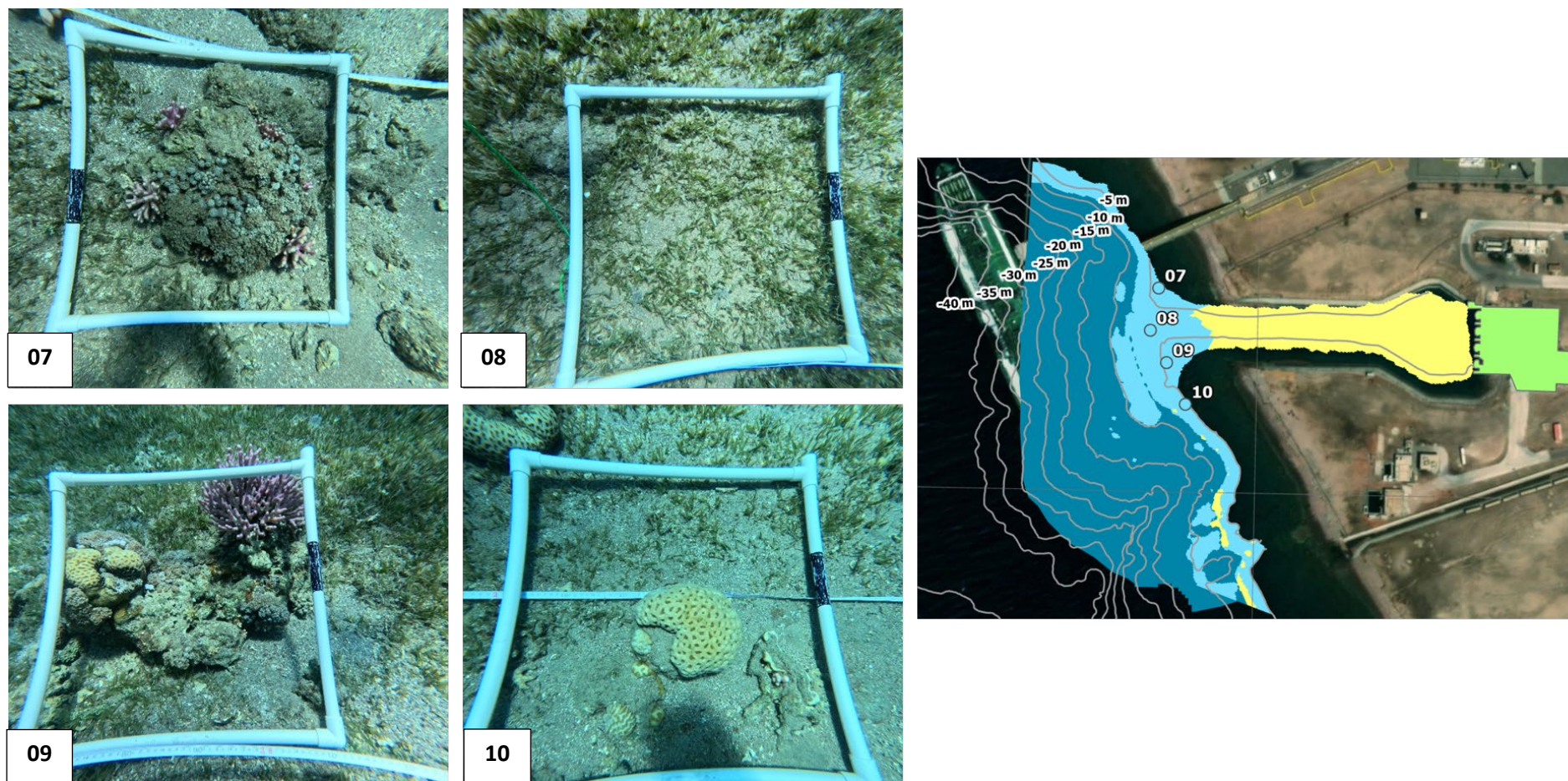
Patch Reef and Shallow Seagrass habitat formed a heterogeneous shallow-water mosaic of predominantly soft substrate interspersed with discrete patches of hard substrate. Soft substrate accounted for an average of $80.5 \pm 29.6\%$ of the image area, with hard substrate averaging $19.5 \pm 29.6\%$.

Seagrass was a characteristic habitat component, with a mean overall cover of $19.6 \pm 22.3\%$, although its high variability reflected the patchy distribution of seagrass within the mapped area.

Hard coral had a lower mean overall cover of $6.4 \pm 13.2\%$, but was locally well developed on the available reef patches. Where hard substrate was present, coral occupied an average of $32.9 \pm 26.4\%$ of the available hard substrate, while seagrass occupied $22.5 \pm 23.5\%$ of available soft substrate.

The habitat therefore represents a mixed and spatially variable assemblage of shallow seagrass habitat with scattered coral-bearing patch reefs rather than either a continuous seagrass bed or a continuous reef. Example images and the locations of these images are presented below in Figure 3-4.

Figure 3-4: Images Illustrating the Patch Reef and Shallow Seagrass Habitat Category



3.2.1.3 Fringing Coral Reef

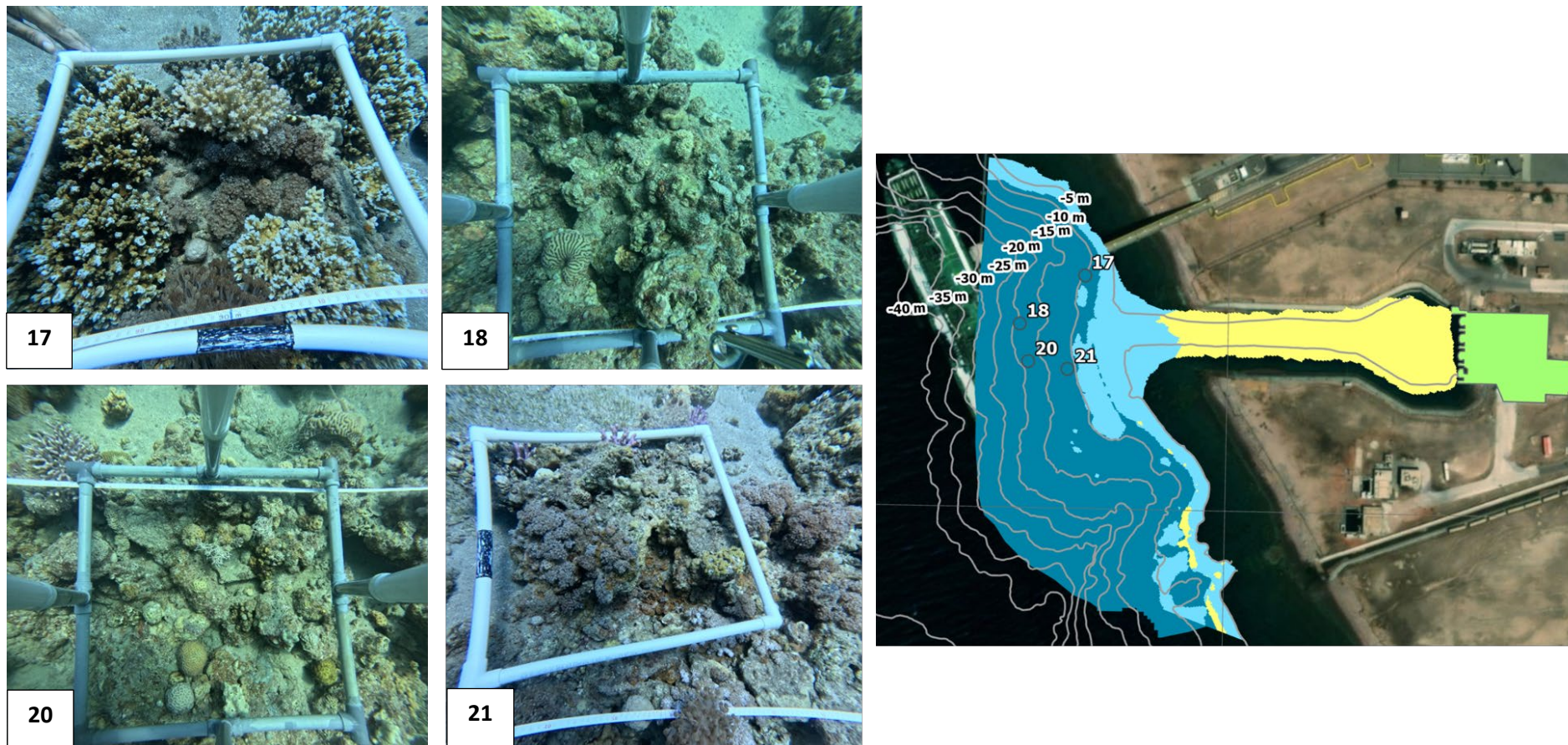
Fringing Coral Reef habitat represented the principal reef-dominated habitat and contained a substantially greater proportion of exposed hard substrate, averaging $45.8 \pm 37.8\%$, with soft substrate averaging $54.0 \pm 37.7\%$ between reef features and within sediment-filled depressions.

Hard coral was widespread, with mean overall cover of $13.3 \pm 14.5\%$ and coral recorded in approximately 68% of samples. Where hard substrate occurred, coral occupied an average of $30.0 \pm 19.9\%$ of the available hard substrate.

In contrast, seagrass was effectively absent, with a mean overall cover of only $0.07 \pm 0.70\%$, and was recorded in only four of the 279 images.

This habitat therefore represents a comparatively continuous coral-bearing reef environment distinguished by greater hard-substrate availability and substantially higher overall coral cover than the other mapped classes. Example images and the locations of these images are presented below in Figure 3-5.

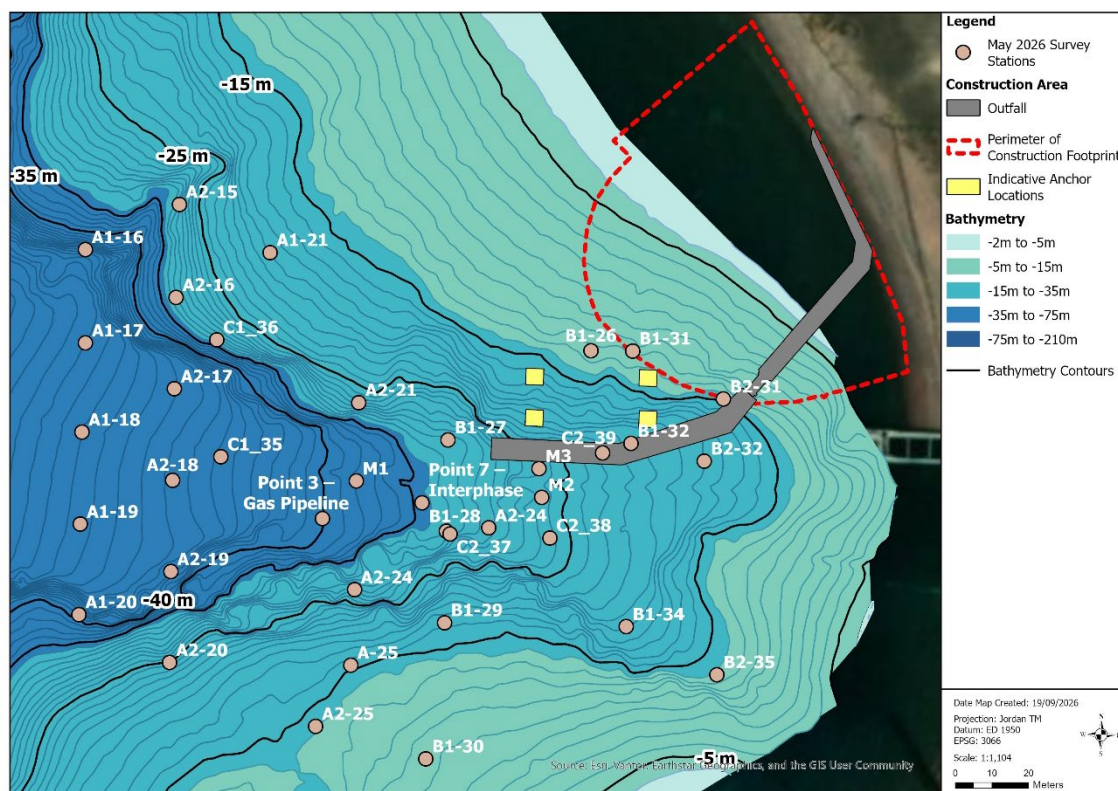
Figure 3-5: Images Illustrating the Fringing Coral Reef Habitat Category



3.3 Construction Area

This section combines ESIA baseline survey data with data from a survey completed in May 2026 to provide a detailed characterisation of seabed habitats at the proposed new outfall location, particularly the sandy canyon and the transition zones where sandy habitats transition into coral communities. Divers collected high-resolution video footage across the survey area, and a ROV with low-resolution video provided direct visual observations of habitat conditions, extent, and ecological features, Figure 3-6.

Figure 3-6: May 2026 Survey ROV/Diver Sampling Stations



The information gathered during the survey has been used to refine and enhance the habitat mapping completed as part of the Disclosed 2025 ESIA baseline survey, with particular emphasis on improving the spatial resolution and delineation of habitats within the sandy canyon that was not surveyed in 2025. Updated habitat maps were produced by interpreting video data and integrating the latest bathymetric information provided by the EPC contractor, resulting in a more accurate and comprehensive representation of seabed habitats near the proposed outfall than provided in the Disclosed 2025 ESIA.

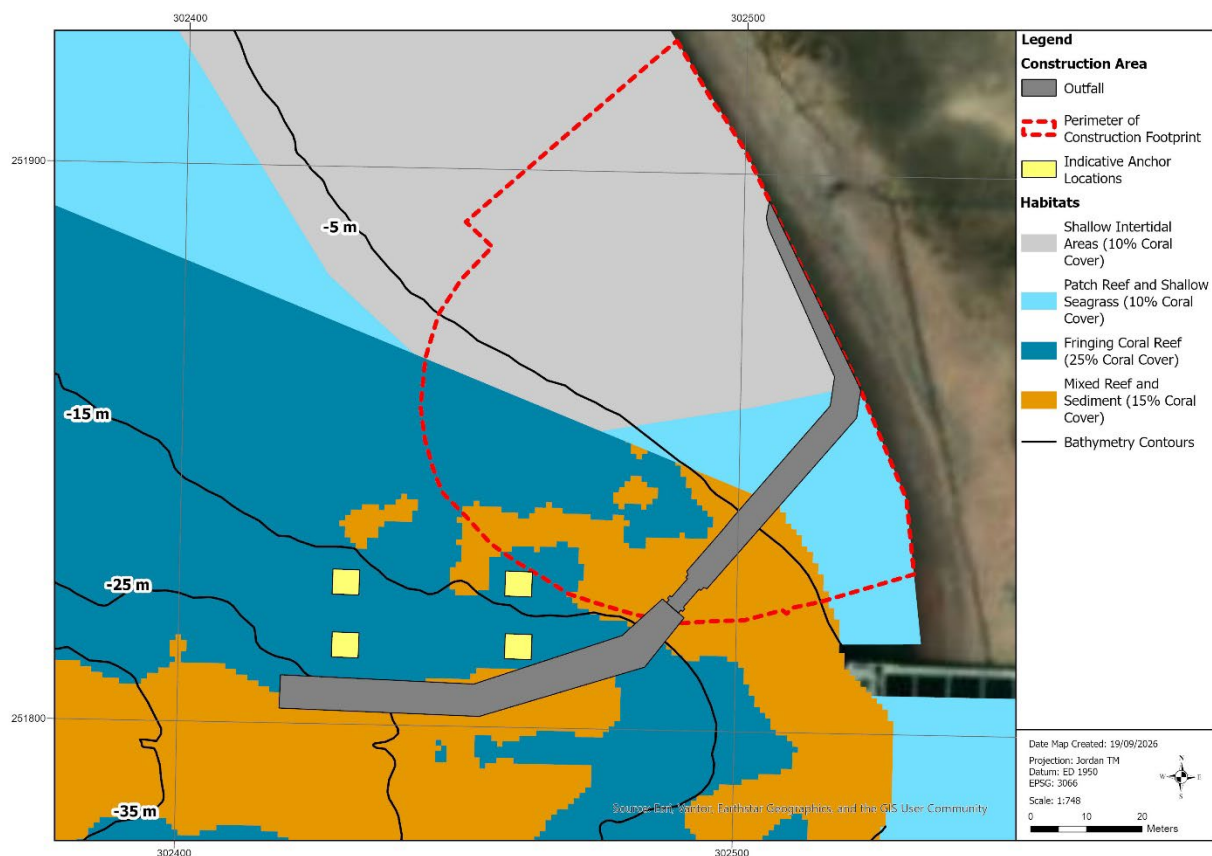
An additional diver transect survey was completed in August 2026, similar in design to the intake abstraction area survey. The data from this survey are being analysed, and the results and technical baseline report will be issued in 4Q 2026 and integrated into an update of this interim report.

3.3.1 Survey Results

The resulting habitat interpretation is presented in Figure 3-7. The map uses qualitative diver techniques and will be enhanced in the next version of the report with data from the diver transect survey completed in August 2026. Within the construction area, four habitats have been identified:

- Shallow Intertidal Habitat: The intertidal environment in the construction area consists of a gravel- and rock-dominated, industrially bordered shoreline with fragmented coral habitats. Further pre-construction surveys are recommended in this area. Average coral cover is 10%.
- Patch reef and shallow seagrass: Shallow seagrass beds are interspersed with sand and low-relief coral patches on rubble, giving way to a transitional zone where coral dominates and forms a patchwork mosaic. Burrowed sediments indicate active infauna. Average coral cover is 10%.
- Mixed reef: See below, based on information from the May 2026 survey. Average coral cover is 15%. Photos from the survey completed in May 2026 are provided in section 3.3.1.1
- Fringing coral reef: See below, based on information from the May 2026 survey. Average coral cover is 25%. Photos from the survey completed in May 2026 are provided in section 3.3.1.2

Figure 3-7: Updated Habitat Map and Construction Area



3.3.1.1 Mixed Reef

In the shallow canyon area, the seabed comprised a mix of bare sandy bottom and dispersed coral outcrops. Coral density varied from isolated colonies in the centre of the canyon, such as station B2-32, to more extensive rocky outcrops at stations including B1-32 and C2-39. These outcrops became more numerous and contiguous towards the boundaries with the fringing reef and were observed to support greater diversity of coral types, colony sizes, and coral cover. Representative images are presented in Figure 3-8 and Figure 3-9.

Figure 3-8: Images Illustrating the Mixed Reef Habitat Category (12-19 m)

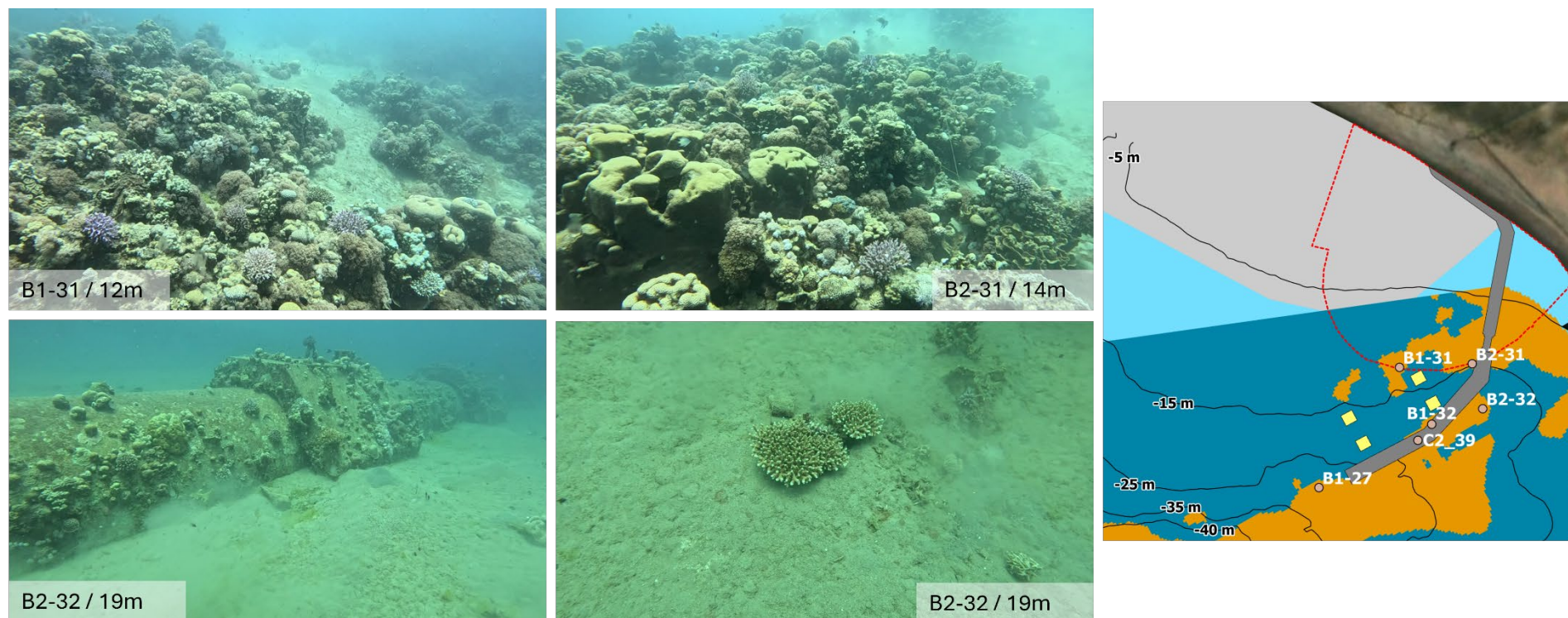
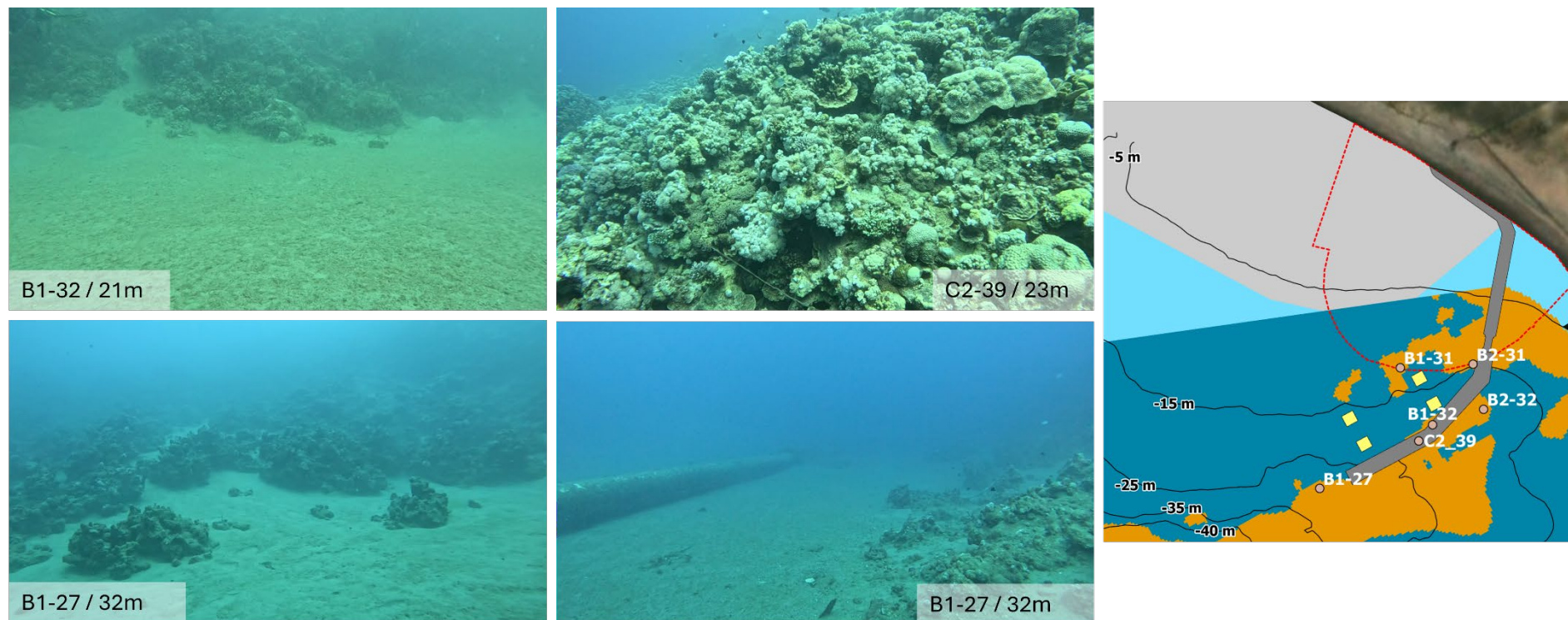


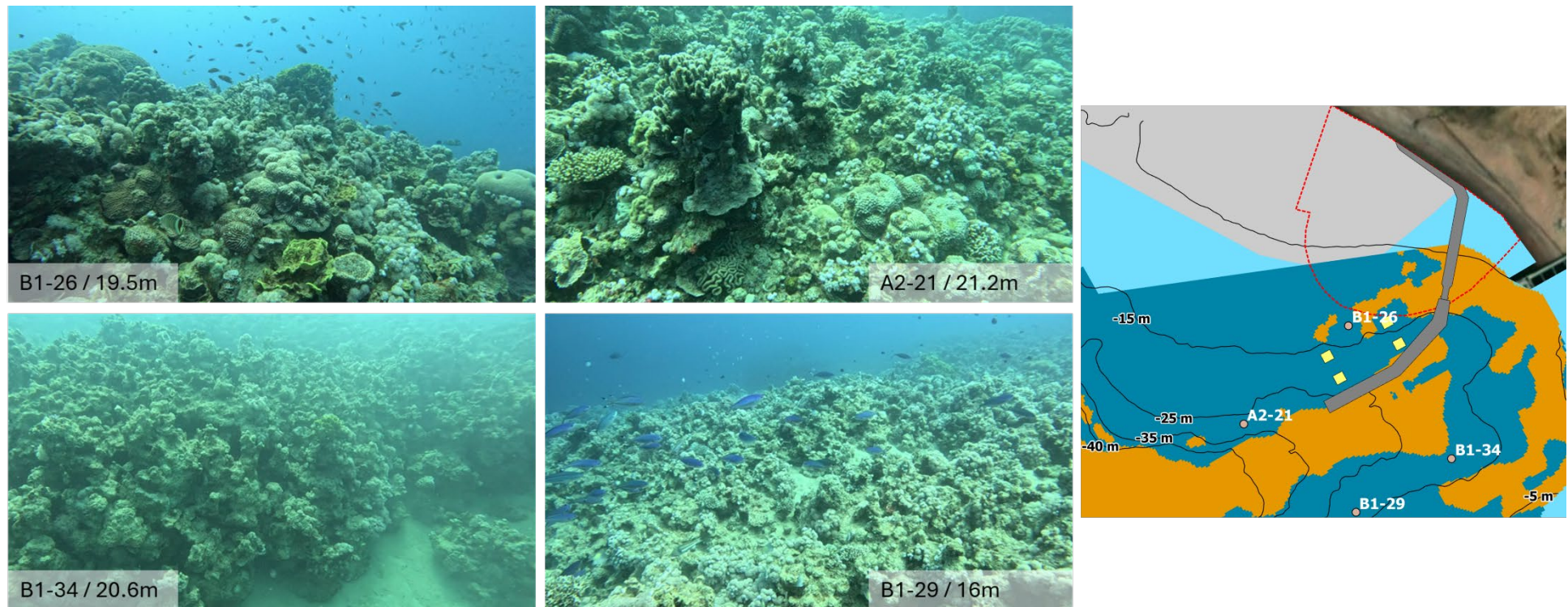
Figure 3-9: Images Illustrating the Mixed Reef Habitat Category (21-39 m)



3.3.1.2 Fringing Coral Reef

The shallow fringing coral reef comprised generally solid reef substrate with occasional sand depressions, and the reef edge occurring at approximately -20 m. The northern side of the canyon, including stations B1-26 and A2-21, supported high diversity of hard and soft corals with a range of colony sizes. The southern side of the canyon, including stations B1-34 and B1-29, supported relatively lower coral cover and diversity, with colonies tending to be smaller. Representative images are presented in Figure 3-10.

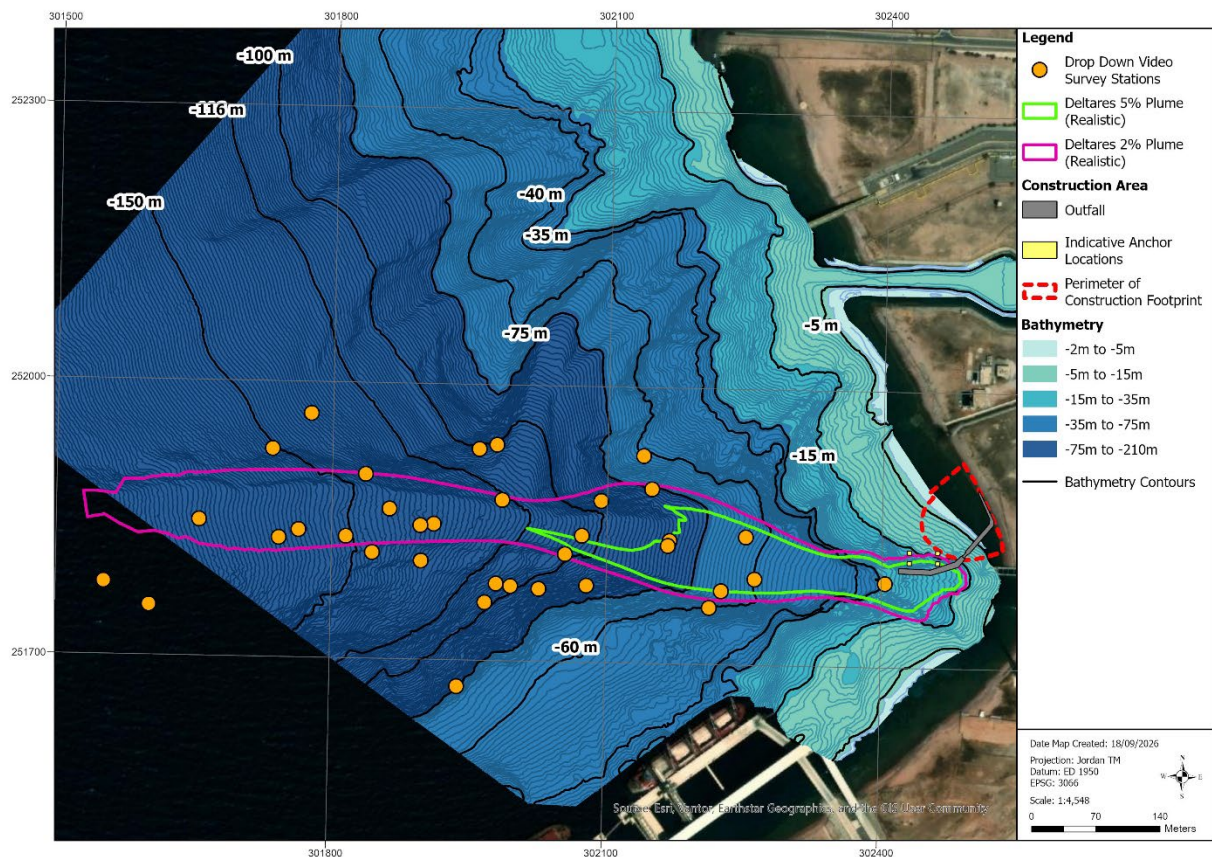
Figure 3-10: Images Illustrating the Shallow Fringing Coral Reef Habitat Category (16-21 m)



3.4 Brine Plume Area Drop-down Video Survey

The survey is planned to start on September 13; results of the survey are intended to enable confirmation of the substrate types and better inform the assessment of impacts from the plume. The survey area is provided in Figure 3-11.

Figure 3-11: Dropdown video survey locations



3.4.1 Survey Results

The resulting habitat map indicates a heterogeneous seabed within the brine plume survey area, with the three mapped habitat classes forming broad but intergrading zones rather than discrete, sharply bounded units:

- Sand, average coral cover is 0.05%
- Deep sand/sediment and isolated reef outcrops, average coral cover is 0.07 %
- Mixed reef and sediment, average coral cover 3.79 %

Overall, the habitat pattern is characterised by a mosaic of sedimentary seabed and areas of increased seabed complexity rather than a simple shore-to-offshore zonation; see Figure 3-12. The principal habitat boundaries broadly follow elongated seabed features visible within the MBES-derived terrain data, indicating that seabed morphology and rugosity are important controls on the predicted classification.

The occurrence of narrow bands and interspersed patches is consistent with the DDV observations of sediment-dominated seabed containing variable amounts of reef outcrop.

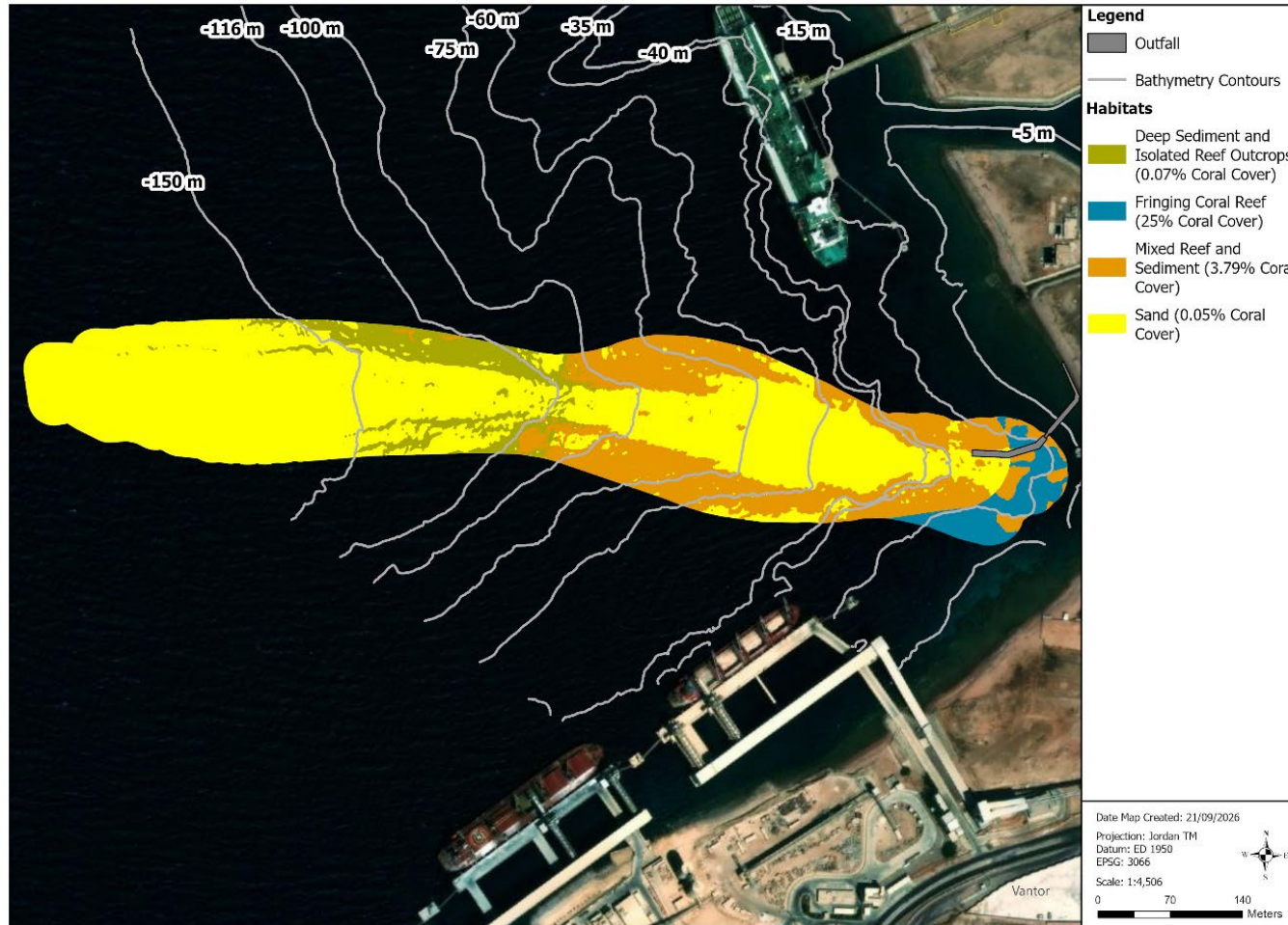
The mapped boundaries should be regarded as transitional rather than exact ecological boundaries. In particular, the classification identifies the dominant habitat predicted from the relationship between the DDV observations, MBES data and terrain ruggedness. It therefore represents the broadscale distribution of habitat types and should not be interpreted as indicating that reef outcrops or other hard-substrate features occur continuously throughout areas classified as 'Deep sand/sediment and isolated reef outcrops' or 'Mixed reef and sediment' mapped habitat classes.

In the deeper parts of the survey area where complete MBES coverage was not available, habitat distribution was mapped predictively using available DDV observations from comparable depths and seabed settings. These deeper sample locations were consistently characterised by sand-dominated seabed with limited topographic variation or exposed hard substrate. On this basis, unsurveyed areas at similar depths have been classified as sand. This interpretation is considered consistent with the generally homogeneous character of the deeper seabed observed in the DDV imagery, although these areas should be regarded as having a higher level of mapping uncertainty than areas where habitat predictions are supported directly by both ground-truth observations and continuous MBES-derived terrain data.

In the shallower inshore sections of the study area that were not sampled during the current DDV survey, habitat distribution has been represented using the habitat mapping developed from the May 2026 survey programme. That survey provided direct visual observations from diver and ROV/DDV video and was used to refine the spatial interpretation of shallow reef, mixed reef and sediment habitats within the construction and nearshore areas. More detailed survey data have subsequently been collected from these shallower areas, including the additional diver transect survey completed in August 2026, but analysis of these data has not yet been finalised. The habitat mapping presented at this stage should therefore be regarded as interim. It will be reviewed and updated following completion of the remaining sample processing and analysis so that the final habitat map incorporates all available ground-truth data from both the shallow and deep-water survey areas.

The habitat map for the brine plume area has been spatially restricted to the vicinity of the modelled plume in order to focus the interpretation on the area relevant to the impact assessment. However, DDV sample locations outside the mapped plume extent were also used during development of the map. These additional observations provided further ground-truth information across a broader range of depths and seabed conditions and were used to help interpret the wider MBES and terrain-ruggedness datasets. Although these sample locations are not shown within the final mapped plume extent, they contributed to defining the relationship between observed habitat classes and the geophysical characteristics used in the predictive mapping process.

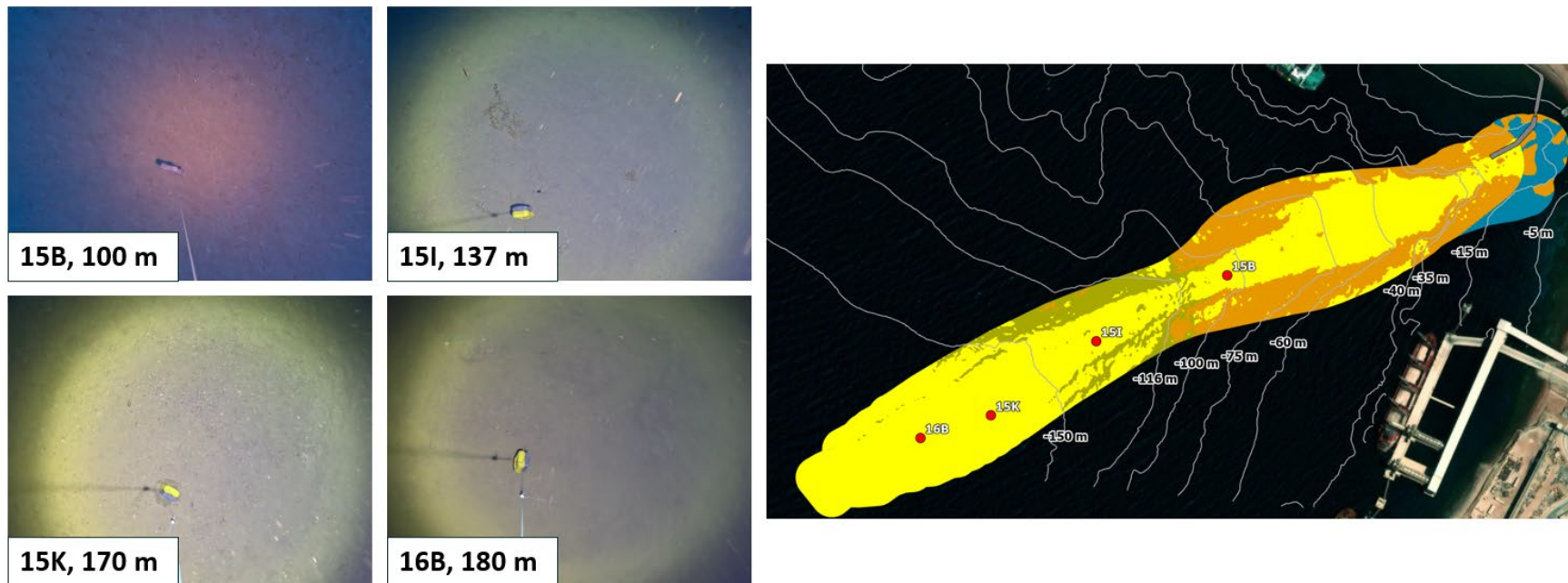
Figure 3-12: Brine Plume Area Habitat Mapping



3.4.1.1 Sand

Sand habitat forms an extensive component of the mapped area. It is particularly widespread across the western, more offshore part of the survey extent, where it forms a relatively continuous area, and also occurs as a broad east-west corridor/valley through the central and eastern parts of the survey area. Smaller areas of sand are interspersed with the other habitat classes, particularly towards the centre of the mapped extent. Example images and the locations of these images are presented below in Figure 3-13.

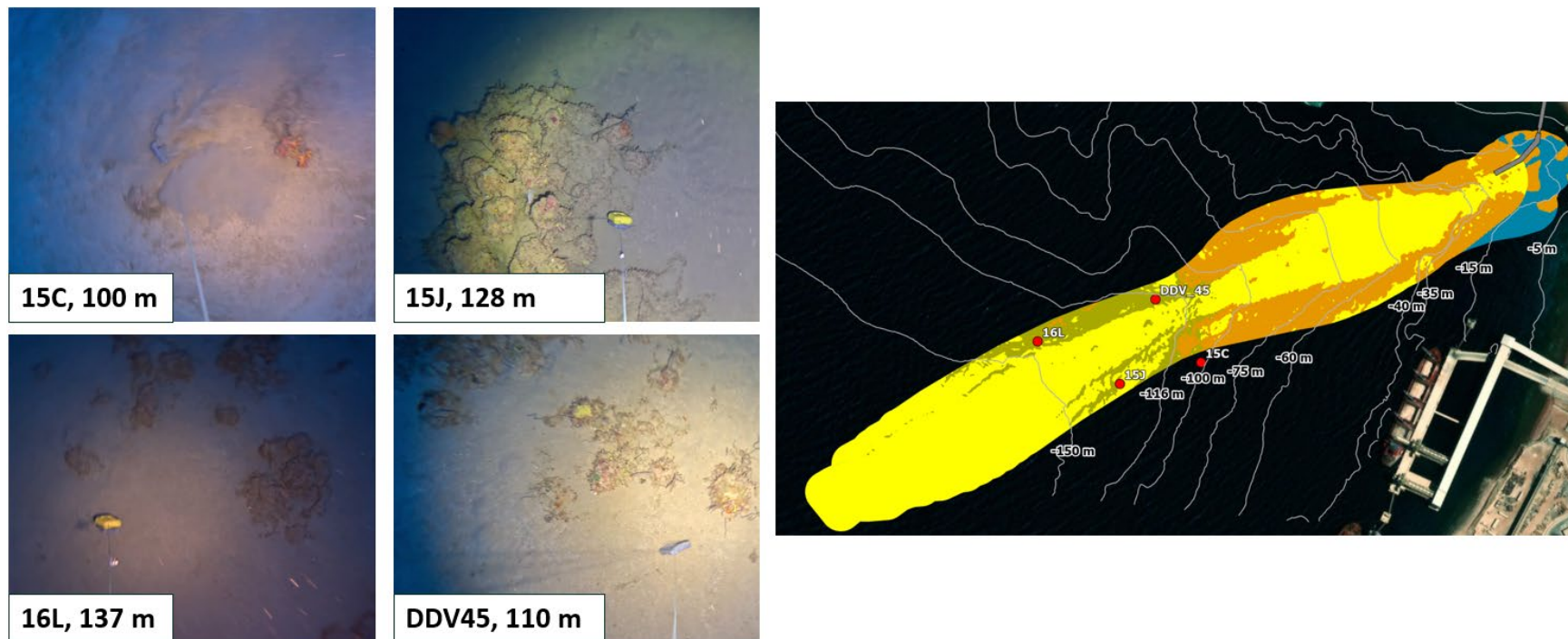
Figure 3-13: Images Illustrating the Sand Habitat Category (100-180 m)



3.4.1.2 Deep Sand/Sediment and Isolated Reef Outcrops

Deep sand/sediment and isolated reef outcrops are also extensively distributed and occur principally as broad, elongated areas through the central, northern and southern parts of the mapped area. A relatively continuous zone occurs across much of the northern-central and north-eastern part of the survey area, with another substantial band extending through the southern-central area towards the eastern end of the plume survey extent. The irregular margins and internal patches within these areas are consistent with a heterogeneous seabed comprising predominantly sediment interspersed with areas of greater seabed relief and hard substrate outcrop. Example images and the locations of these images are presented below in Figure 3-14.

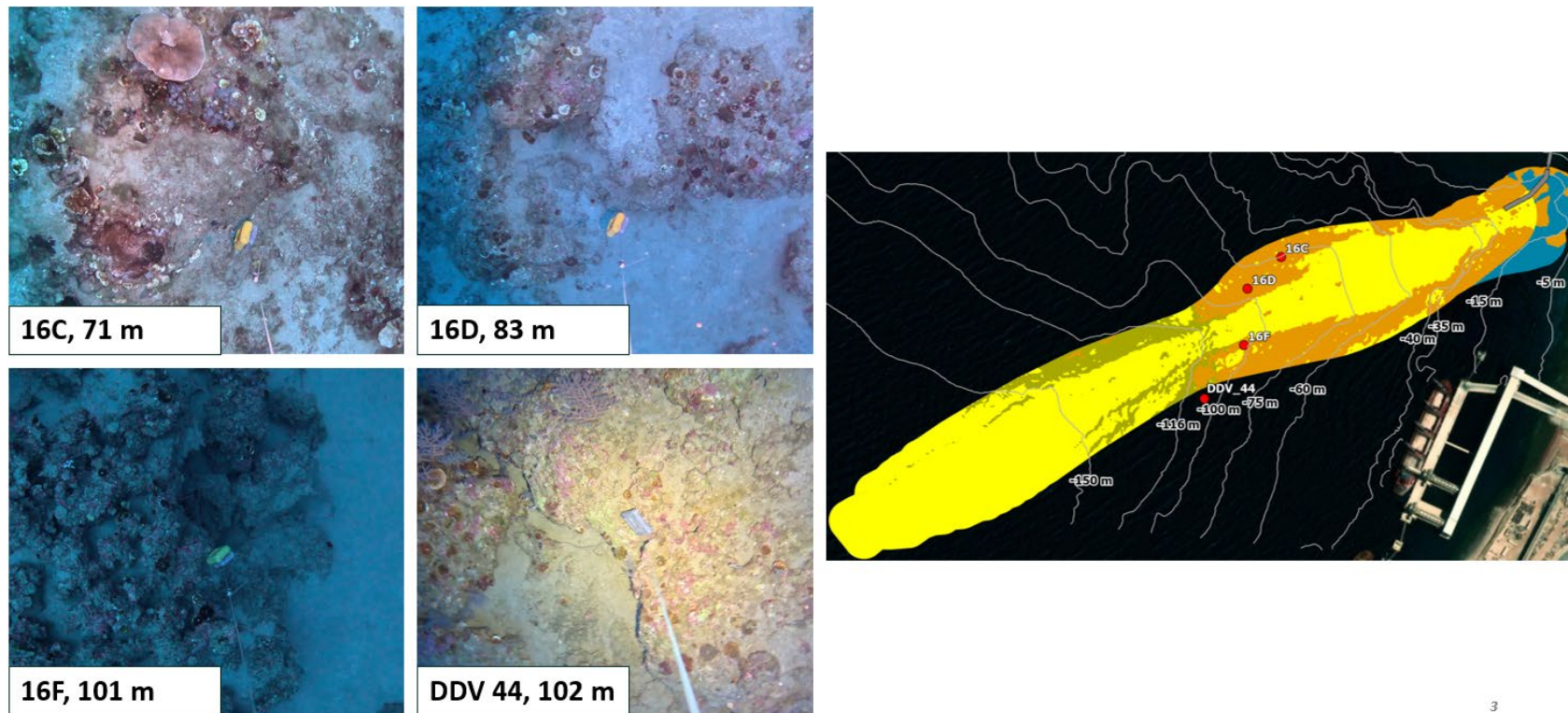
Figure 3-14: Images Illustrating the Deep Sand/Sediment and Isolated Reef Outcrops Habitat Category (100-137 m)



3.4.1.3 Mixed Reef and Sediment

Mixed reef and sediment habitats are less extensive and has a more restricted and fragmented distribution. It occurs predominantly in the western-central and north-western parts of the mapped area, generally associated with transitions between the more extensive sand and Deep sand/sediment and isolated reef outcrops habitats. Smaller patches also occur within the central part of the survey area. Its distribution suggests that this class principally represents transitional seabed where hard substrate or reef features are present but do not form the dominant physical character across larger areas. . Example images and the locations of these images are presented below in Figure 3-15.

Figure 3-15: Images Illustrating the Mixed Reef and Sediment Habitat Category (71-102 m)



4 Desk-Based Salinity Study

4.1 Background

The Disclosed 2025 AAWDCP ESIA presented the results of the brine plume modelling using a 2% change in salinity above ground as a reference benchmark, not a compliance standard. Below is an extract from Chapter 9.2.5 of the ESIA:

- For salinity, the criteria applied in the 2022 AAWDCP ESIA at the boundary of the mixing zone were based on no exceedance greater than 2% of the natural ambient concentration in the receiving water; however:
 - No specific reference is provided in the 2022 AAWDCP ESIA for this 2% value.
 - This 2% level is understood to likely refer to the ambient environment's monthly average salinity in the Environmental Controls for the industrial development of Jubail and Yanbu (which is a special case in Saudi Arabia)
 - Applying a 2% criterion requires that the salinity is no more than 0.82 ppt (0.82 psu) above the monthly average value. This value is less than the measured natural variation in salinity and is considered highly conservative
- For other chemical components in the brine discharge (excluding salinity): A consistent approach has been adopted with other jurisdictions in the Gulf of Aqaba. The criteria applied at the boundary of the mixing zone were based on the requirement that no more than 5% of the natural ambient concentrations in the mixing zone can be exceeded

Adopting a 2% benchmark aligns with conservative environmental standards to protect sensitive species; however, the natural annual salinity range of 2.8‰ (1.17 psu) will make detection of seawater salinity values and extrapolation to ecological change in sensitive species, compared with background changes, unreliable. Environmental monitoring standards should be set outside of natural annual variation to accurately detect pollution and isolate impact from background noise. Any ecological change taking place within the plume will need to be compared to ecological conditions from areas that are known to be outside of the brine plume, however, there remains a risk of false positives and missed ecological damage if a 2% compliance standard is applied to characterise any change attributable solely to the saline plume.

To support the selection of a salinity threshold to assess AAWDCP brine impacts associated with the change in outfall location and design, and to support planning of monitoring and offset projects, a desk-based review has been completed; this will be supported by laboratory studies at the Jordan Marine Science Station.

The salinity threshold was discussed with ASEZA in a Taskforce meeting on 16 April 2026. The outcome of the meeting was:

- ASEZA: Confirmed that this is a new type of project and that no specific national standard exists for acceptable salinity increase thresholds
- Jordan Marine Science Station (MSS): Highlighted that acceptable salinity limits vary by location, and that the Gulf of Aqaba has unique environmental conditions requiring site-specific assessment
- MSS / National Carrier Project Company (NCPC) / Marine Experts Consultants: Were to conduct a desktop coral salinity sensitivity study

- This has been completed; see Section 3.1
- NCPC / Marine Experts Consultants: Undertake brine dispersion modelling of the brine plume
 - This has been completed; see Section 5
- NCPC / MSS / Marine Experts Consultants: Develop and propose acceptable project-specific salinity thresholds based on assessed impacts for each plume increase scenario:
 - The desk-based study has been completed; See section 4
- NCPC (in coordination with Marine Science Station and Marine Experts Consultants): To develop and implement a comprehensive monitoring program covering both construction and operation phase
 - This is in progress

4.2 Introduction

A review was undertaken to assess the tolerance of corals and associated reef communities potentially exposed to hypersaline brine discharge from the AAWDCP and to support the derivation of ecologically protective salinity thresholds for environmental assessment. The study combined project-specific information on predicted plume characteristics with a structured review of published scientific literature, environmental impact assessments, regulatory guidance documents, and regional monitoring data.

The *Environmental Appraisal of the Jordanian Coast of the Gulf of Aqaba, Red Sea for the year 2024* report from Jordan's National Monitoring Program records that salinity varied from a minimum of 40.13 psu to a maximum of 41.30 psu, giving an ambient salinity average of 40.7 psu, which has been used in modelling of the salinity discharge plume. This represents a 1.5% variation in salinity levels around the mean, and there is no indication that this variation leads to any detrimental effect upon coral, coral reefs and other biota on an intra- or inter-annual basis.

Corals in the Gulf of Jordan are acclimated to salinity levels that typically range between 40 psu and 41 psu, which is higher than coral reefs in other regions, where salinity more typically ranges from 32 psu to 35 psu. Corals' capacity to acclimate to elevated salinity levels is determined by physiological limits and prior salinity exposure. The literature records that corals in typical oceanic seawater (32-35 psu) can survive exposure to salinity levels up to 42 psu (approx. 17% above ambient maxima). An extreme example of coral tolerance and acclimation to elevated salinity is from the Persian Gulf, where there are healthy corals and reef systems where salinity levels reach between 48 psu and 50 psu. The ability of corals in other regions to survive elevated salinity exposures of 17% above ambient does not directly translate to the ability of corals already acclimated to higher salinity levels.

However, in laboratory tests, corals from the Gulf of Aqaba have been shown to survive exposure to 42 psu, and some species in localised areas affected by desalination brine discharge have survived salinities averaging between 41.8 and 49.4 psu. The assessment from the literature strongly indicates that corals from the Gulf of Jordan will at least survive exposure to 42 psu (3% above ambient mean of 40.7 psu) and some species can be expected to have capacity to survive even higher salinity levels. This will be tested through monitoring of the brine plume and by laboratory-controlled exposure experiments on coral taxa most exposed to the brine plume.

The review drew upon available peer-reviewed literature, including studies on Red Sea and Arabian Gulf corals, desalination brine impacts, mesophotic reef ecology, coral microbiome adaptation, seagrass sensitivity, and trace metal toxicity. Key sources included investigations of salinity tolerance in Gulf of Aqaba corals, microbiome adaptation studies, in situ experiments exposing desalination plumes, regional

coral ecology references, and recent reviews of desalination plant impacts on marine ecosystems. The review considered evidence from laboratory experiments, field observations, and review papers addressing both acute and chronic exposure to elevated salinity. Regional baseline information was supplemented with Jordanian marine monitoring data and project-specific habitat surveys. The full report is provided in the Appendix to this report, and a summary is provided below.

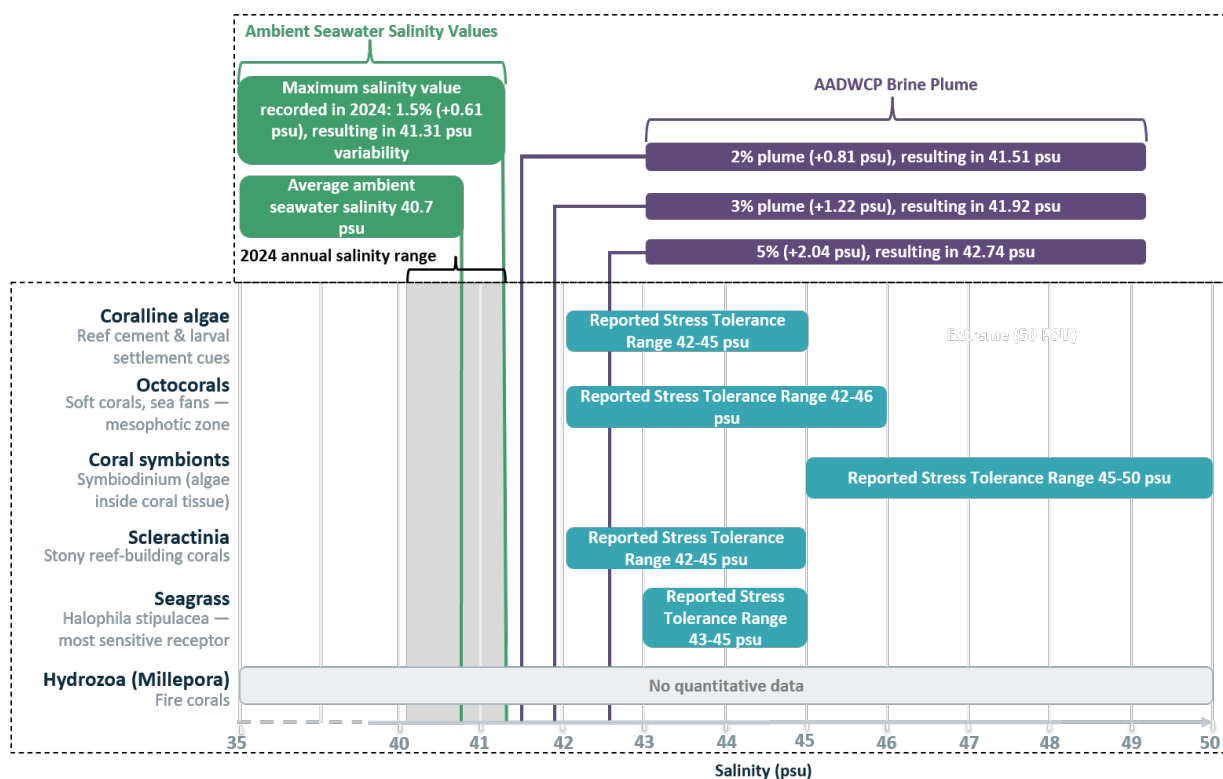
4.3 Summary of the Review

Overall, the literature suggests that corals exhibit broad tolerance limits for salinity, consistent with evidence suggesting that corals' metabolic performance is only weakly sensitive to changes in this variable³ until salinity levels increase 2 to 4 psu above ambient. This represents an increase to 42.7 (3.3%) to 44.7 (7.6%) psu above annual maxima in the Jordanian waters.

The literature demonstrates that elevated salinity above tolerance levels can affect coral physiology, metabolism, growth, reproduction and community structure. Reported responses include coral bleaching, tissue damage, reduced calcification rates, impaired photosynthesis, altered microbial communities, and reduced resilience to other environmental stressors. Experimental studies indicate that many Gulf of Aqaba corals are more tolerant of elevated salinity than coral populations elsewhere due to long-term acclimation. Short-term studies suggest that some reef-building corals can tolerate salinities of approximately 48–50 psu, while bleaching and severe stress generally occur above 51–55 psu.

However, measurable physiological stress commonly begins at salinity increases of approximately 5–10% above ambient conditions. Seagrasses were identified as potentially more sensitive than corals, with stress responses recorded at approximately 5% above ambient salinity and significant damage occurring near 10% above ambient salinity. The review concluded that while acute mortality within the modelled plume may be low up to 5% above ambient conditions, albeit species-specific, chronic sub-lethal effects remain a concern under long-term exposure. Table 4-1 summarises quantitative salinity tolerances, exposure conditions, and observed physiological responses reported in the literature, with an emphasis on studies relevant to the Gulf of Aqaba and comparable environments, an overview is provided in Figure 4-1.

³ Guan Y, Hohn S, Merico A (2015) Suitable Environmental Ranges for Potential Coral Reef Habitats in the Tropical Ocean. PLOS ONE 10(6): e0128831. <https://doi.org/10.1371/journal.pone.0128831>.

Figure 4-1: Overview of Ambient Salinity Values, Brine Plume and Coral and Seagrass Tolerance

4.4 Key Limitations

A major limitation identified by the review is the lack of long-term field-based studies investigating chronic exposure to elevated salinity. Most available evidence is derived from short-term laboratory experiments lasting from a few hours to one month, with limited ability to replicate natural ecological conditions. There is also a scarcity of information for deeper mesophotic reef communities (>60 m depth), hydrozoans, and several benthic taxa likely to occur near the proposed outfall. Species-specific tolerances remain uncertain, particularly under combined exposure to salinity, temperature variation, antiscalants and trace metals. Furthermore, the detailed composition and distribution of coral assemblages within the canyon and deeper reef habitats potentially affected by the plume were still being characterised at the time of the review and are likely to affect final conclusions regarding species and ecosystem sensitivities.

4.5 Recommendations

The review indicates that, in Jordanian waters, natural background salinity oscillates around a mean of approximately 40.7 psu with a small periodic annual range, which in 2024 was 1.17 psu between a low of 40.13 psu and a high of 41.3 psu, and is an annual range of approximately 2.8%. This indicates that corals are acclimated to and can tolerate intra-annual (changes in salinity from one month or season to another within the same year) salinity variability of approximately 3%. The literature suggests that Gulf of Aqaba corals can tolerate exposure to salinity of at least 42 psu, which is 3% above ambient, and additional salinity stress should be kept below 10% above ambient (approx. 45 psu).

The review recommends adoption of a precautionary salinity threshold of no more than 5% above ambient conditions (approximately 42–43 psu under typical Gulf of Aqaba conditions) to protect sensitive

reef ecosystems. 5% falls between known tolerance levels and suggested maximum salinity stress values for Gulf of Jordan corals, and environmental impacts beyond background variation are likely to be distinguishable. Additional ecological surveys are recommended to characterise the biological communities present within the canyon and deeper reef habitats potentially affected by the discharge.

The study also recommends:

- Targeted laboratory and field exposure experiments using locally occurring coral species under representative light and water chemistry conditions to better understand long-term sensitivity, acclimation potential and ecological risk, see Section 3.1
- Implementation of an operational monitoring programme to validate model predictions, assess actual impacts and support adaptive management of the outfall system, see Section 7

Table 4-1: Appraisal of Salinity Tolerance Thresholds and Responses for Major Reef Taxa

Group	Reported Stress Tolerance Range (psu)	Evidence Type & Duration	Observed Effect	Study Quality & Limitations	Applicability to AAWDCP	Weight of Evidence	Implication for Threshold
Scleractinia (reef-building corals)	Stress threshold 42 to 45 psu	Lab + short-term incubation (hours–1 month)	Reduced calcification (up to ~8×), mucus release, bleaching, mortality at +10%	Strong experimental base but short duration; limited long-term field validation	High (dominant reef builders in plume depth range)	High (short-term), Moderate (long-term)	Chronic stress begins ≥ +5%; significant risk ≥ +10% Tolerance overlaps with predicted plume (~44 psu), but long-term exposure risk remains uncertain
Coral symbionts (Symbiodinium)	Stress threshold 45 to 50 psu	Laboratory studies	High tolerance; supports host adaptation	Lab-based; highest values of indirect ecological relevance	High (controls coral resilience)	Moderate	Adaptation of symbionts underpins coral tolerance in GoA Extends tolerance but does not remove coral stress thresholds
Octocorals	Stress threshold 42 to 46 psu	Experimental (short-term)	High resilience; viable symbionts at 50 psu	Limited quantitative thresholds for mortality; few long-term studies	Moderate–High (present in mesophotic zones)	Moderate	Likely equally and potentially higher tolerance than reef-building corals under the same conditions Likely tolerate > modelled plume; not limiting receptor
Hydrozoa (Millepora)	No quantitative data	Observational	High plasticity inferred	Major data gap; no salinity thresholds	Unknown	Low	Uncertainty—cannot constrain threshold
Coralline algae	Stress threshold 42 to 45 psu	Mixed studies (lab + field)	Maintain function under high salinity	Generalised algal data; not all reef-specific	Moderate (reef stabilisation role)	Moderate	Some evidence of highly resilient; may increase dominance under disturbance
Seagrass	Stress tolerance 43 to 45 psu	Lab + medium-term (weeks)	Oxidative stress, impaired photosynthesis, mortality	Good experimental data; some duration relevance	Moderate (shallower zones mainly)	High	More sensitive than corals; shallow habitats most at risk Sensitive receptor: threshold likely ≤ +5%

5 Modelling Results and Impact Quantification

5.1 Introduction

This section provides the summary from the final Deltares report issued in September 2026. The results were presented to the lenders and their advisors in July 2026. Deltares conducted modelling of the new outfall to quantify plume salinity impacts, using the latest bathymetry data, the outfall location, and input from the EPC contractor, including the outfall design summarised below in Table 5-1.

Table 5-1: Modelling Outfall Parameters

Parameter	Disclosed 2025 ESIA Outfall	New outfall
Flow rate	11.7 m ³ /s	11.7 m ³ /s
Excess salinity (psu)	+34.8 psu	+34.8 psu
Excess temperature (°C)	+1 °C	+1 °C
Diffuser length (m)	261	60
Depth at diffuser	About -50 m Mean Sea Level (MSL) to -80 m MSL	About -16 m MSL to -27 m MSL
Outfall pipeline length (m)	~230	~60
Number of risers	16 (2 diffuser lines with 8 risers)	6
Number of ports per riser	2 ports per riser	1 port per riser
Horizontal orientation of the ports	45° orientation in westward direction relative to the diffuser pipe	3 onshore ports: 45° 1m diameter 30% of flow 3 offshore ports: 45° 0.75m diameter – 70% of flow
Vertical orientation of the ports	60°	45°
Port diameter	0.29 m	0.75 m (first 3 ports), 1 m (last 3 ports)

The Deltares report details the modelling assessment undertaken to assess the proposed diffuser and near-field plume behaviour and compares modelling approaches using ATM's detailed CFD results for the immediate outfall area, and Deltares' Delft3D-FM model for the broader far-field plume dispersion. This includes sensitivity analysis of the expected brine plume dispersion to test how numerical and physical parameters affect the predicted plume extent, especially the 2% and 5% excess-salinity contours. The work builds on the original rapid assessment Delft3D-FM far-field modelling conducted in Q4 2025, and incorporates additional analysis to assess the robustness of the plume predictions, the suitability of the proposed diffuser design, and the consistency between Deltares' far-field modelling and the detailed CFD modelling undertaken by ATM.

The modelling work developed progressively throughout the project's lifecycle that started in October 2025, in response to requirements raised by the project sponsors, regulators, and to support the project proponent (The National Carrier Project Company) in achieving the necessary environmental approvals. It was initially set up as a rapid assessment, based on the information available at the time, to provide an early indication of plume behaviour. As the project design evolved, additional questions arose regarding a different diffuser outfall location and design, the diffuser performance, near-field behaviour, interaction with the submarine canyon bathymetry, and the potential extent of far-field dispersion. The assessment was therefore expanded to include a systematic sensitivity analysis, comparison with the ATM CFD simulations, and additional model simulations that define the Most Realistic and Conservative model settings and uses them to assess final plume behaviour, including side-slope intrusion, offshore transport, transboundary effects, and recirculation risk.

The outfall concept that was studied in the present project was proposed by and received from the EPC contractor and consists of a multiport diffuser discharging into a submarine canyon, see Table 5-1. The EPC design philosophy is intended to keep the dense brine plume largely confined within the canyon, thereby reducing the likelihood of interaction with nearby coral communities outside the canyon. The diffuser comprises six ports, with three smaller onshore ports and three larger offshore ports. Near-field analysis indicates that the discharge undergoes initial momentum-driven mixing close to the diffuser before collapsing back towards the seabed and continuing downslope as a dense gravity current. This transition from near-field jet behaviour to far-field density-current behaviour is central to the interpretation of the modelling results.

ATM's CFD model provides a detailed representation of the immediate outfall zone (in the first tens of metres around the outfall), where jet momentum, negative buoyancy, and entrainment dominate plume behaviour. Deltares' Delft3D-FM model provides the broader hydrodynamic and salinity-transport modelling approach needed to assess transport and dispersion beyond.

A Simplified Delft3D-FM model was developed alongside the Full Model to efficiently test key numerical, physical and operational sensitivities, after confirming that it sufficiently accurately reproduced the relevant plume behaviour; the results were then used to define the most realistic model settings, intended to provide the best estimate of expected plume behaviour, plume spreading and side-slope intrusion.

The overall findings indicate that the plume behaviour is governed primarily by the dense nature of the brine discharge and the local canyon geometry and slope. The proposed diffuser results in initial dilution close to the outfall, after which the plume follows the seabed downslope as a density current. The canyon acts as an important controlling feature for plume transport, helping to guide the plume towards deeper water. It is noted that the computed density-current velocities of about 1 m/s may mobilise fine bed material, potentially causing local seabed morphology changes and suspended sediment generation, although this has not been quantified in the present study and may require further assessment for environmental evaluation (to be further assessed, see Section 9.1 Next Steps). The comparison between the Delft3D-FM and CFD results shows a broadly consistent prediction of plume behaviour in the overlapping region, supporting the robustness of the modelling approach.

The CFD modelling is considered most applicable in the immediate vicinity of the diffuser, where detailed jet-scale processes are important. Further away from the diffuser (from about 100 m), the Delft3D-FM model is more appropriate because it better represents larger-scale bathymetry, stratification, ambient circulation, and far-field density-current behaviour. The combined use of both tools therefore provides a stronger basis for assessment than either model would provide in isolation. Although the CFD model has limitations for long-distance dispersion assessment, it remains a valuable independent benchmark for the near-field and transition-zone behaviour.

The final Full Model simulations using the most realistic model settings obtained from the sensitivity analysis provide the basis for assessing the expected plume extent at excess-salinity levels of 2% and 5% above background salinity. Based on the modelling results, the assessment indicates that the plume is expected to remain primarily within the canyon pathway. These simulations also support evaluation of potential transboundary transport (approximately 0.1 to 0.15 psu increase (i.e., a dilution factor of about 250-350), corresponding to about 0.25% to 0.35% of the background salinity) and recirculation towards the intake (<0.1 psu increase).

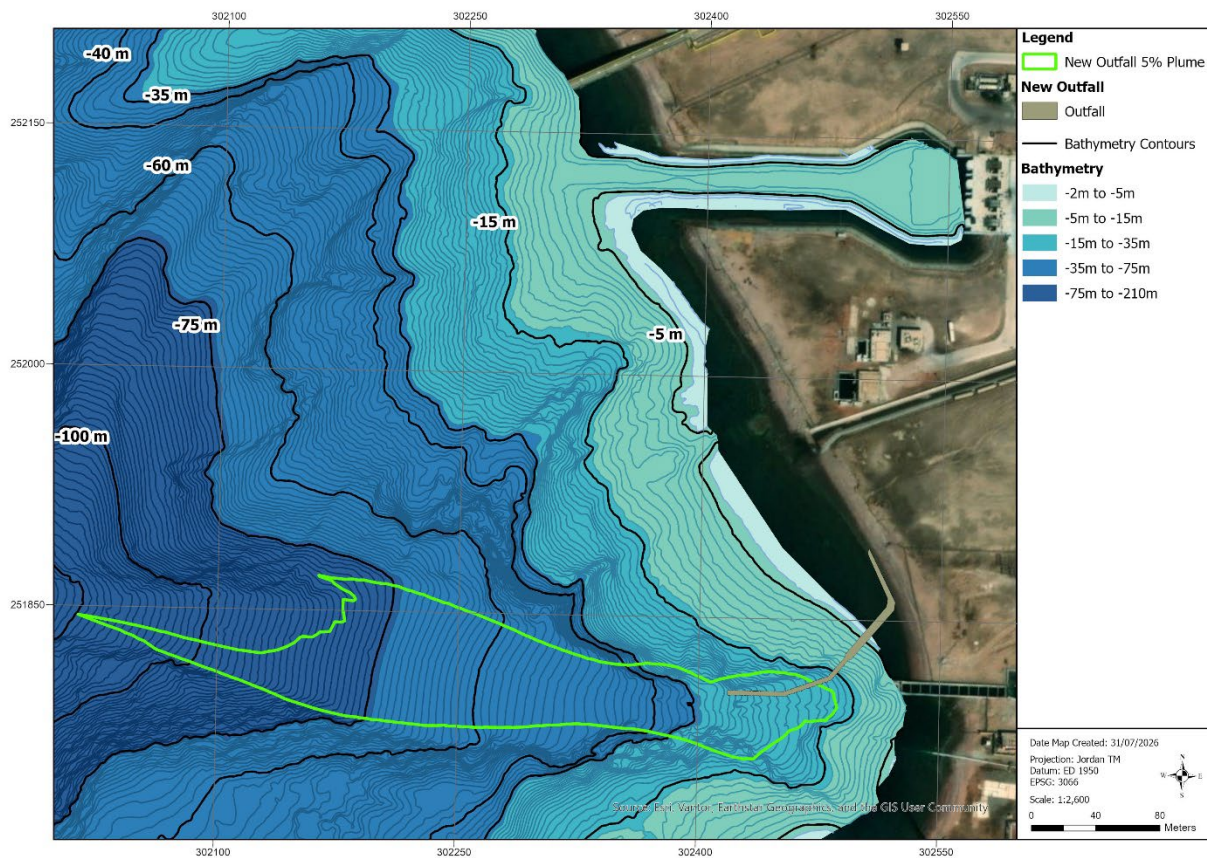
Overall, the robustness of the modelling results has been demonstrated through a comprehensive sensitivity analysis of the Delft3D-FM model and an independent comparison with detailed CFD simulations undertaken by ATM. While direct validation against field measurements is not yet possible because the outfall has not been constructed or operated, the study benefits from a unique opportunity to compare two fundamentally different numerical modelling approaches. Such detailed inter-model comparisons are rarely available during the pre-construction phase of major infrastructure projects. The strong level of agreement between the Delft3D-FM and CFD predictions therefore provides a high degree of confidence in the reliability of the modelling results and the predicted behaviour of the brine plume, and for supporting the environmental assessment of the proposed discharge.

5.2 Modelling Results

Figure 5-1 presents the modelled brine plume for the most realistic configuration, showing the near-bed 5% salinity above the ambient contour line. In this most realistic configuration, the plume's side-slope extent along the canyon walls is very similar to the CFD results in the Transition Zone. The offshore extent predicted by all of the Delft3D-FM scenarios is larger than that predicted by the CFD model, which is attributed to the less diffusive sigma-layer scheme and to differences between the two models in their numerical mixing schemes.

For the most realistic model settings, the maximum height of the 5% salinity above ambient contour line up the canyon slope is limited to about 1 to 2 m in the Transition Zone. The 5% salinity above ambient plume contour extends offshore to a depth of about 116 m.

Figure 5-1: Brine Plume Area Exceeding 5% Salinity Above Ambient



5.2.1 Potential Cumulative Impacts of the KEMPACO Cooling Water Outfall

The potential cumulative effect of the nearby KEMPACO cooling water outfall was tested as part of the sensitivity analysis to determine the impact of the warmer-than-ambient seawater plume from the KEMPACO system on the AAWDCP brine plume.

The results show that the effluent discharge from the KEMPACO outfall does not significantly affect the plume behaviour of the AAWDCP effluent, and no material cumulative interaction between the two discharges is therefore expected.

5.2.2 Duration of the Modelling

A time-series analysis of the modelling results was used to establish the simulation duration required for the AAWDCP brine plume to reach stable conditions; the Deltares model was run for several weeks. The density current and the associated salinity levels within the AAWDCP brine plume reach equilibrium within a few minutes to several hours or days after the start of the release, depending on the distance from the outfall. No significant build-up of the discharge is expected: because the discharged water is denser than the surrounding seawater, it sinks and moves downslope to depths of several hundred metres, mixing with the surrounding water until the density difference reduces and it settles at a stable depth, from where natural currents gradually transport and disperse it over a large area. Even over long periods of operation, substantial local salinity accumulation is therefore not expected.

5.2.3 Transboundary Impacts

The modelling assessed potential transboundary effects of the AAWDCP brine plume at the maritime borders within the Gulf of Aqaba. At the border between Saudi Arabia and Jordan, the computed maximum excess salinity is about 0.1 to 0.15 psu, equivalent to approximately 0.25% to 0.35% of the background salinity. The model simulation is dynamic and includes ambient currents, tides and winds. Where the density current is strong in the near-field areas, these ambient conditions have little influence on the result. Further afield, however, the plume has diluted substantially, and its dispersion becomes governed by the ambient flow field rather than its own density. As those ambient conditions vary in time, so does the plume signal arriving at the boundary, producing dilutions that fluctuate between roughly 250 and 350 rather than settling at a single value.

At the borders with Israel and Egypt, the excess salinity is less than 0.02 psu. These transboundary values are of the same order of magnitude as those reported in the Disclosed 2025 ESIA and are considered insignificant and well within the natural variation.

5.2.4 Recirculation

Modelling with both CFD and Delft3D-FM shows that the effluent flows offshore and downslope as a density current; consequently, no recirculation of the saline discharge towards the seawater intake is expected. The maximum computed excess salinity at the intake is less than 0.1 psu.

6 Impact Assessment

6.1 Approach to Impact Quantification

The same approach as presented in the Disclosed 2025 ESIA to quantify impacts has been adopted, using the information below to assess the seabed area of impacts:

- The impact seabed area of the brine plume has been quantified based on the Deltares modelling output
 - Noting that, since the 2025 ESIA was disclosed, the modelling has been revised for the new outfall in the canyon, and the Deltares realistic case has been used and compared with the Disclosed 2025 ESIA modelling output
- The impacted seabed area from the seawater intake system has been quantified using the modelling of the intake velocity
 - The same modelling used for the Disclosed 2025 ESIA has been utilised, as the input data has not changed
- The habitat types and % of coral cover, and where available, seagrass % cover has also been used
 - The % cover numbers and distribution of habitats for the new locations of the seawater intake, outfall construction and brine plume have used survey data available in 2026, not used in the Disclosed 2025 ESIA
- The latest EPC-provided data on the construction area has been used and includes:
 - Trenching of the outfall, on the assumption that the trenched material will be temporarily stored onshore, not in the marine environment, and used to backfill the trench
 - The use of silt curtains has been assumed to contain the plume impacts, and the area within the curtains will be impacted, with hard corals translocated
 - Anchoring of the installation vessels within the silt curtains and an additional four anchoring locations to support outfall installation
- There are no construction impacts associated with the use of the CEGCO lagoon
 - Operational impacts from abstraction of seawater have been assessed
- A review of the current desalination plant design to derive normal and abnormal plant operational iron concentrations in the brine
 - The Disclosed 2025 ESIA previously used a compliance standard, and design development work completed to date supports a more realistic iron concentration based on a range of plant operational conditions
- As per the Disclosed 2025 ESIA, the assumption is that in water depths less than 35m, coral translocation will occur with a survival rate of 80%; in water depths greater than 35 m, translocation is not possible

Impacts have been quantified using two definitions:

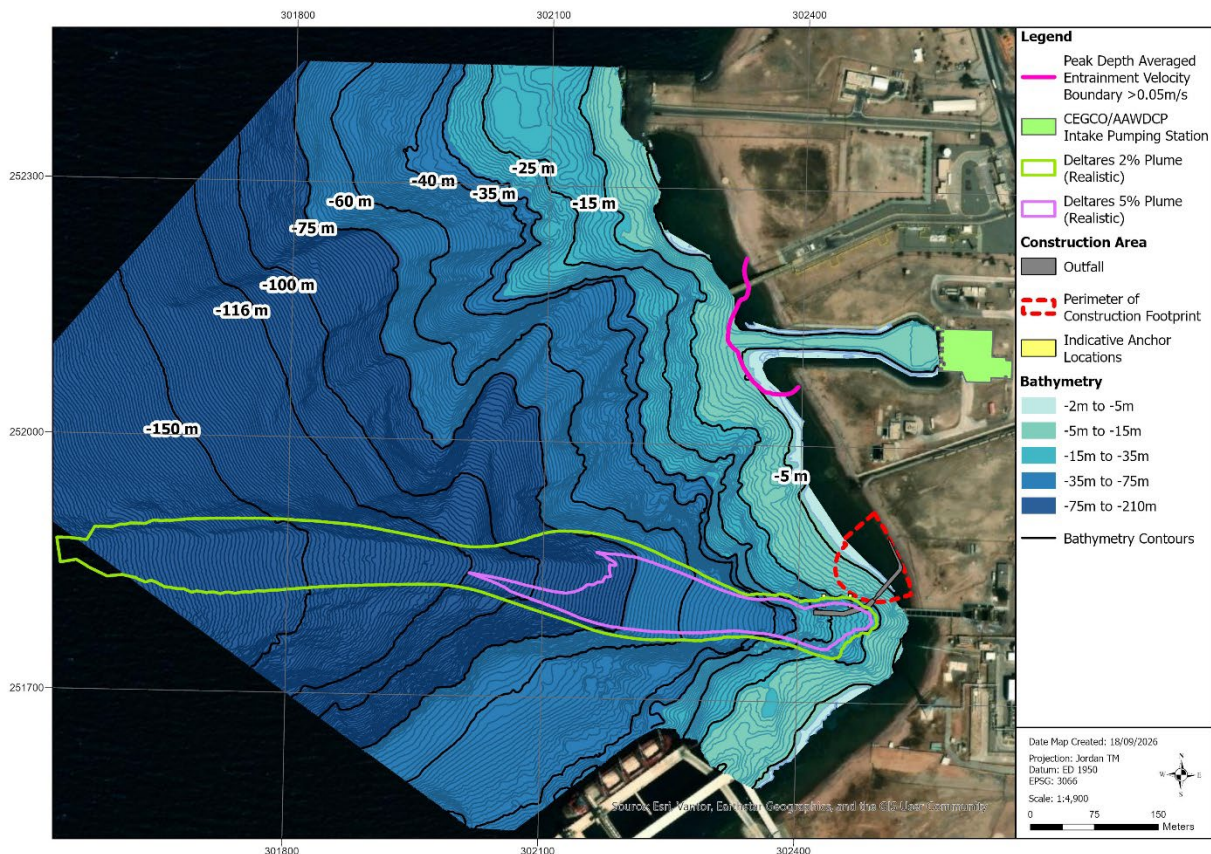
- Unmitigated Seabed Footprint Impact Area:
 - Without considering substrate type, coral or seagrass cover, or coral translocation mitigation.

- The total seabed impact area is provided with no other variables included
- Residual Impact:
 - Considers coral or seagrass cover and coral translocation mitigation:
 - All hard coral within the impact footprint at water depths of less than 35 m will be translocated. Translocated coral is assumed to achieve an 80% survival rate, giving a net loss of 20% of the hard coral present

The impacts assessed within this section are shown on Figure 6-1 and listed below:

- Seawater intake system
 - Key input data: Modelling of entrainment velocity and environmental diver transect survey completed in July 2026
- Outfall construction in new canyon location
 - Key input data: EPC Contractor indicative construction methodology received in August 2026 and summarised in Section 2, and environmental diver survey completed in May 2026
- Brine plume discharge
 - Key input data: Deltares model issued in September 2026, environmental diver survey completed in May 2026 and environmental drop-down video completed in September 2026

Figure 6-1: New Outfall Construction Area and Abstraction Lagoon



The quantification of impacts in this section benefits from more robust and complete design data, pre-construction environmental baseline data and modelling, reflecting the normal course of an ESIA prepared alongside ongoing project planning and design: as the design matures and baseline data collection continues, assumed values are progressively replaced by design-based and measured ones, and modelling is updated accordingly to support a more rigorous assessment.

6.2 Seawater Intake System

The potential for the seawater intake system flow rates to have an impact on the ecosystems present has to be considered in the context of the prevailing conditions of the Gulf of Aqaba, which are characterised by:

- Generally oligotrophic waters
- Low nutrient concentrations
- Generally low ambient currents of approximately 0.05 m/s running parallel to the shoreline (Marine Science Station, 2024)
- Episodic variations in currents
- Coral communities adapted to relatively well-flushed conditions

Moderate water movement for coral reefs and seagrass is generally considered to be approximately 0.08-0.20 m/s (8-20 cm/s) (Koch et al., 2007, Lentz et al., 2017 and Comeau et al., 2014). This range typically provides enough water movement to promote oxygen exchange, nutrient delivery, waste removal, sediment transport, and larval dispersal without causing significant physical stress to corals, recruits, or seagrass meadows.

For coral reefs, moderate flow is usually considered desirable because it:

- Enhances coral respiration and calcification
- Improves plankton and nutrient delivery
- Reduces thermal and salinity micro-boundary layers
- Limits sediment accumulation on coral surfaces
- Supports reef resilience and recovery processes
- For coral larvae, moderate flow provides the best balance between:
 - Local settlement and retention
 - Regional dispersal and reef connectivity

Very low currents increase retention but may reduce connectivity, while increasingly energetic flows promote dispersal at the expense of local retention.

For seagrass, moderate flow promotes:

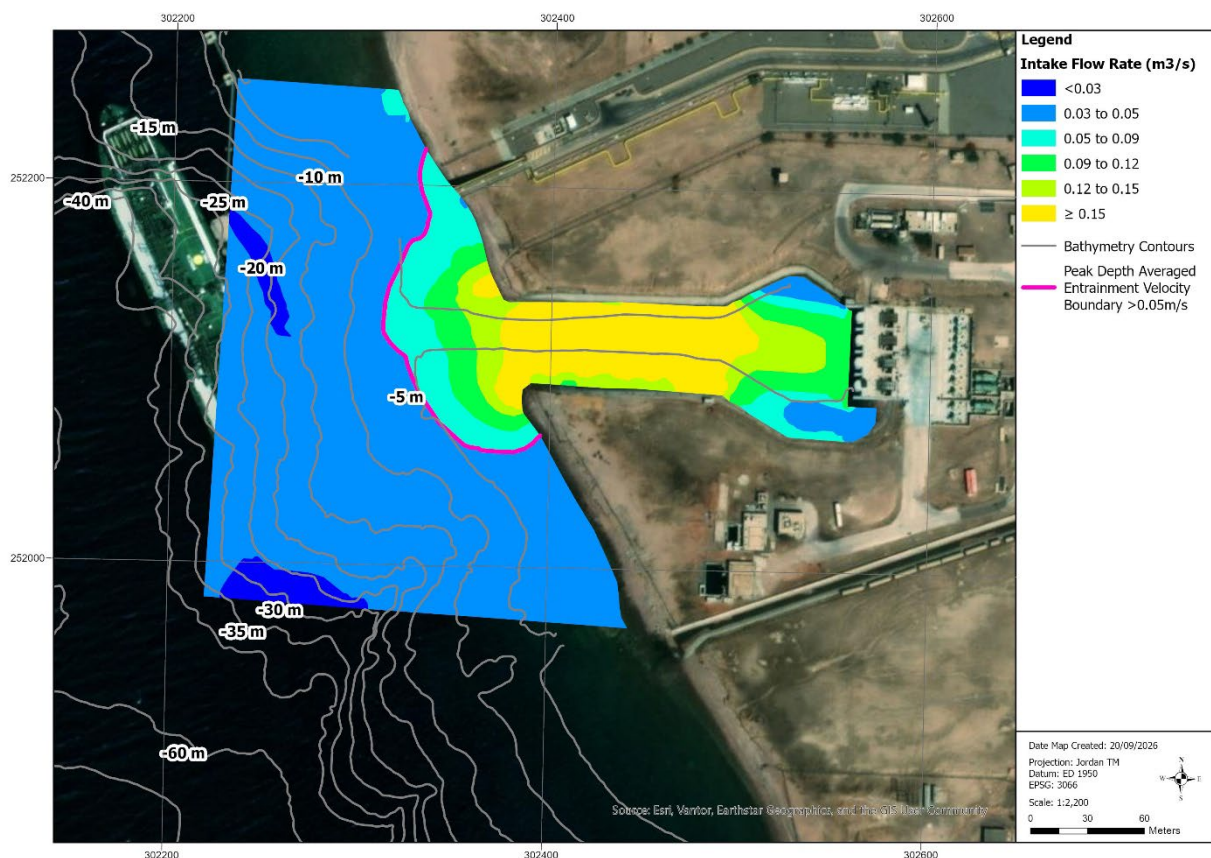
- Oxygenation of sediments
- Removal of epiphytic algae from leaves
- Nutrient exchange
- Prevention of excessive fine-sediment accumulation

Although the predicted intake flow rates fall within a generally ecosystem-favourable moderate flow regime, some ecological risk may arise from entrainment, water quality change, and associated construction impacts that would require monitoring. This would arise if the intake flow rate deflects larvae and other waterborne biota from a longshore pathway towards the intake lagoon. For the predicted intake flow rates and ambient current flow, the likely degree of deflection is shown in Table 6-1 and Figure 6-2.

Table 6-1: Deflection angles for intake flow rate bands

Intake Velocity (m/s)	Deflection Angle
0.03	31.0°
0.05	45.0°
0.09	60.9°
0.12	67.4°

Figure 6-2: Water Intake Velocities



Based on the likely deflection angles and considering the effect of ambient water currents, a summary of the predicted response of coral and seagrass to the deflection angles is provided in Table 6-2.

Table 6-2: Response of Seagrass and Coral to the Deflection Angles

Intake Current (m/s)	Adult Coral Impact	Coral Larvae Impact	Ecological Significance
<0.03	Negligible. No measurable effect on growth, survival, or coral cover	Negligible-Minor. Natural dispersal patterns maintained	Negligible
0.03-0.05	Negligible to minor. Slight increase in water exchange, generally beneficial	Minor. Small changes in transport pathways; recruitment largely unaffected	Negligible to minor
0.05-0.09	Negligible-Minor. Improved flushing and sediment removal; no physical stress expected	Minor-Moderate. Some alteration of larval pathways and settlement locations	Minor
0.09-0.12	Minor. Little effect on adult colony condition	Moderate. Noticeable modification of recruitment pathways and local connectivity	Low-moderate
> 0.12	Minor-Moderate. Long-term changes in hydrodynamic conditions may influence community structure	Moderate-High. Recruitment patterns will be measurably altered; larval corridor displacement	Moderate

For impact quantification, seabed habitats exposed to modelled intake velocities greater than 0.05 m/s are considered to experience a measurable alteration in water movement capable of materially deflecting larvae and other seagrass planktonic life forms from their natural longshore transport pathway. The area exceeding this threshold is therefore defined as the quantifiable impact area; see Figure 6-3.

The impact quantification presented here is precautionary; impact from the abstraction system is not expected to have any direct material impact on the existing coral population, so coral cover and larval settlement are expected to maintain the existing coral habitat. The recommendation is to monitor coral settlement before and during operations, along with benthic habitat monitoring, to confirm impacts from inlet lagoon operations.

Figure 6-3: Abstraction Lagoon with Habitat Mapping and Entrainment Velocity Boundary >0.05 m/s

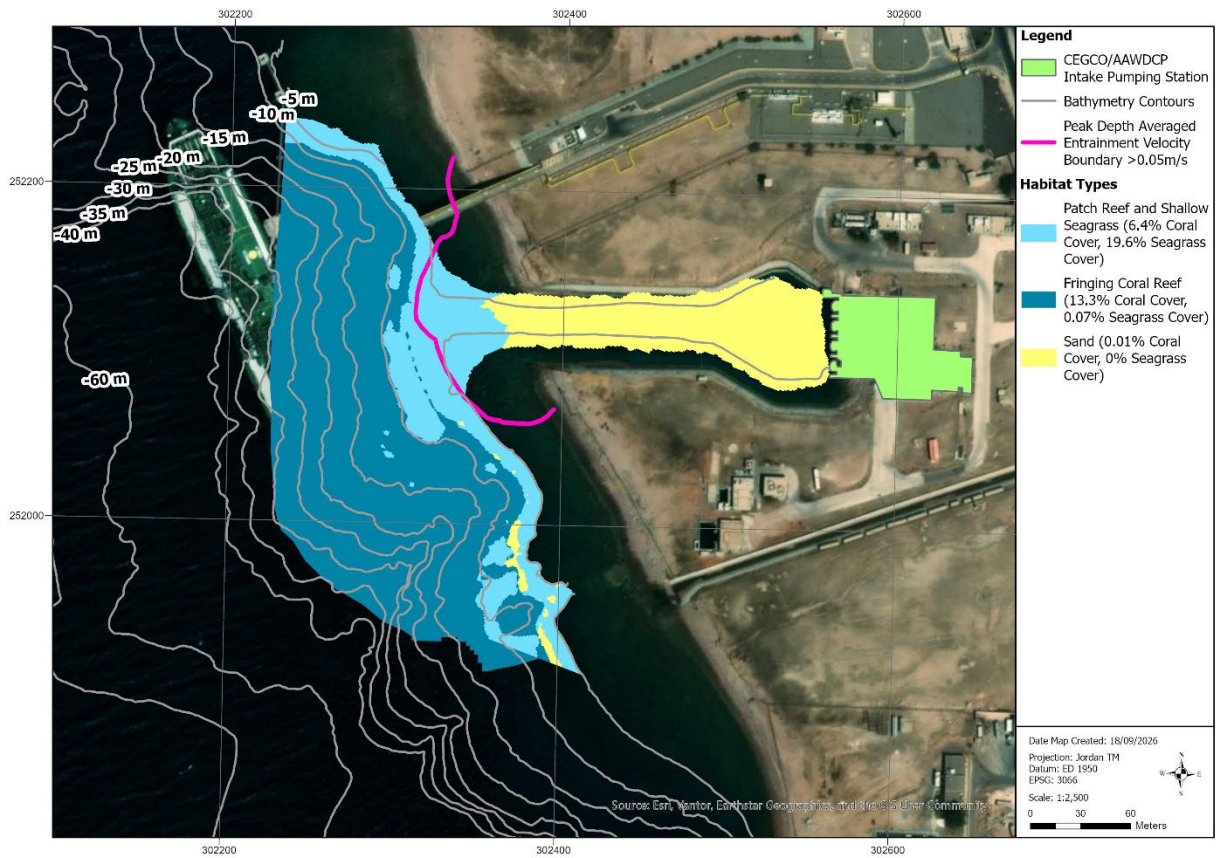


Table 6-3 provides the Unmitigated Seabed Footprint Impact Area (without considering substrate type, coral or seagrass cover, or coral translocation mitigation) and the Residual Impact (considering coral and seagrass cover and assuming coral translocation is implemented). Note, as explained in Section 6.7 the coral colonies present in the residual impact area will not be translocated as they will sustain and maintain existing coral habitat. However, to be precautionary the offset calculation will consider the coral residual impact in Table 6-3.

Table 6-3: Quantification of New Abstraction Lagoon Construction and Operational Impacts

Habitat Type	Coral Cover %	Seagrass Cover %	Unmitigated Seabed Footprint Impact Area (m ²)	Seagrass Residual Impact Area (m ²)	Coral Residual Impact Area (m ²)
Patch Reef and Shallow Seagrass (<35m Depth)	6.4%	19.6%	2,393	469	30.6
Sand (<35m Depth)	0.01%	0%	7,522	0	0.15
Total Areas (m²)			9,915	469	31

A direct comparison of residual impacts between the Disclosed 2025 ESIA and the revised intake lagoon assessment is not possible because the baseline dataset used in the Disclosed 2025 ESIA did not include seagrass cover information. Furthermore, the impact assessment methodology applied in this section is more detailed and robust, incorporating habitat-specific coral and seagrass cover data and updated survey information. By contrast, the Disclosed 2025 ESIA quantified impacts primarily through predicted reductions in coral and giant clam gamete recruitment. No giant clam gametes were identified during the 2026 survey of the intake area. Nevertheless, a comparison of the operational-phase impacts presented in the Disclosed 2025 ESIA and those associated with the revised intake lagoon location is provided in Table 6-4.

Table 6-4: Comparison of Disclosed 2025 ESIA and New Intake Lagoon Operational Impact

Reference case	Unmitigated Seabed Footprint Impact Area (m ²)	Residual Impact Area (m ²)
Disclosed 2025 ESIA	35,946	21,447
New intake lagoon	9,915	500 (includes seagrass)

The mitigation measures presented in the Disclosed 2025 ESIA and described in Section 2 will be retained:

- A floating oil boom to protect the IPS and inlet water quality from oil spill contamination
- A bubble curtain system at the lagoon mouth to protect the intake from jellyfish and also reduce entrainment of other mobile marine life
- A fish catcher and return system to prevent fish from fouling the intake system

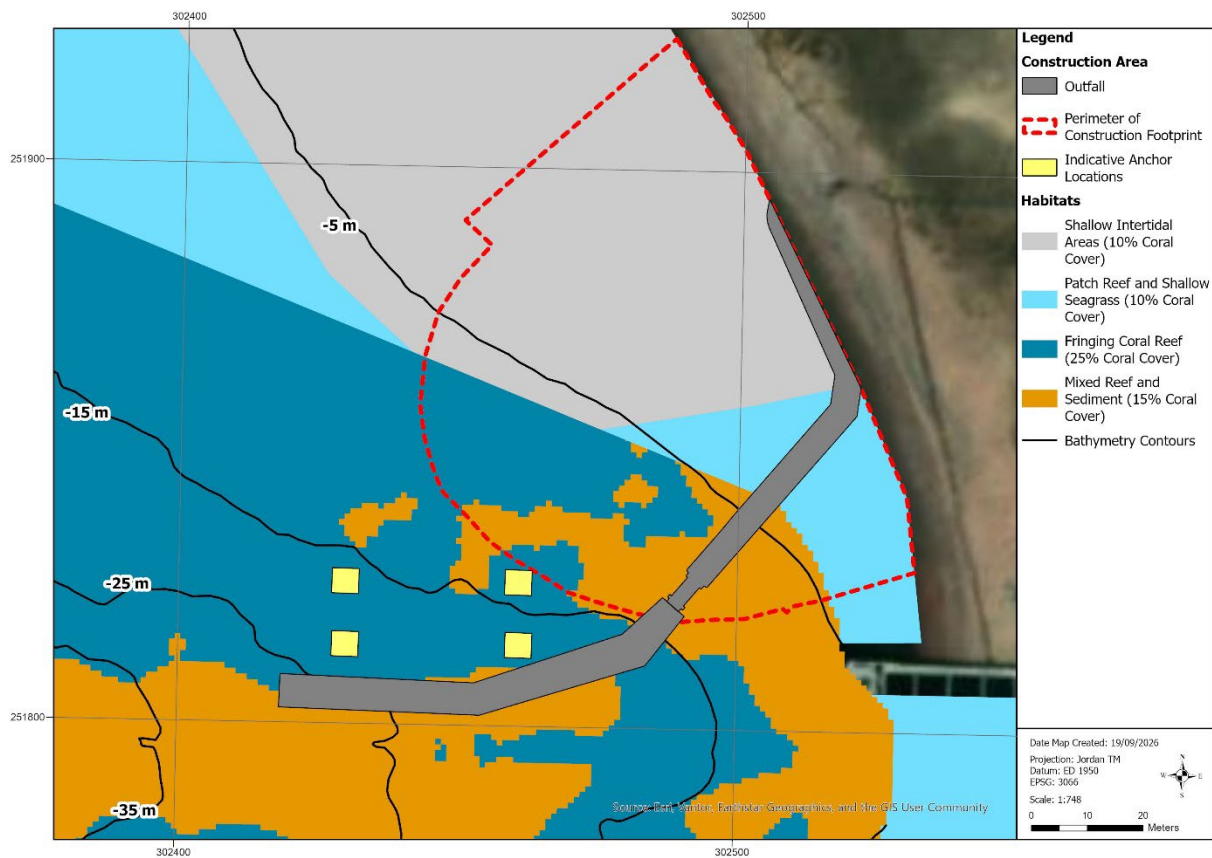
Coral settlement studies will provide additional data to support the adaptive management plan and verify the impacts presented in this section.

6.3 Construction

Construction of the outfall will disturb the seabed through dredging, gravel bedding, pipeline placement, anchoring, backfilling, rock protection and temporary construction works. The works will use a dredger, a crane barge, a flat deck barge, tugboats and divers, with pipeline sections transported from the Royal Navy Port and lowered into position under survey control. An additional area will be dredged to improve vessel manoeuvrability.

For impact quantification, the seabed area enclosed by the silt curtain has been adopted as the construction impact footprint; see Figure 6-4. This provides a conservative basis because it captures the area potentially affected by direct works and sediment disturbance. The silt curtain will be installed around the work area and maintained during construction to minimise the spread of suspended sediment and turbidity.

Figure 6-4: New Outfall Construction Area



Before construction starts, all hard coral located within the area enclosed by the silt curtain will be removed and translocated to suitable receptor areas. This measure will reduce direct loss of coral colonies within the construction footprint. Dredged material will be transferred ashore for controlled stockpiling, reuse or disposal, while gravel, backfill and rock protection will be placed within the specified alignment and tolerances.

The Disclosed 2025 ESIA includes commitments requiring the EPC Contractor to select and handle marine construction materials, including aggregate, fill, and concrete, in a way that avoids leaching pollutants and adverse effects on water quality, including turbidity.

Table 6-5 provides the Unmitigated Seabed Footprint Impact Area (without considering substrate type, coral or seagrass cover, or coral translocation mitigation) and the Residual Impact (considering coral and seagrass cover and assuming coral translocation is implemented). A comparison with the Disclosed 2025 ESIA is also provided. The residual impact of the new outfall is marginally lower than in the 2025 Disclosed ESIA, primarily because the new outfall is located in shallower water accessible to divers for coral translocation.

Table 6-5: Construction Impact Quantification

		Disclosed 2025 ESIA Construction Impacts		New Outfall Construction Impacts	
Habitat Type	Coral Cover %	Unmitigated Seabed Footprint Impact Area (m ²)	Residual Impact Area (m ²)	Unmitigated Seabed Footprint Impact Area (m ²)	Residual Impact Area (m ²)
Shallow Intertidal Areas (<35m Depth)	10%	754	15	3,125	63
Patch Reef and Shallow Seagrass (<35m Depth)	10%	491	10	954	19
Fringing Coral Reef (<35m Depth)	ESIA = 40% New Outfall = 25%	396	32	1,185	59
Mixed Reef and Sediment (<35m depth)	15%	0	0	1,177	35
Mixed Reef and Sediment (>35m depth)	15%	752	113	0	0
Deep Sand and Isolated Reef Outcrops (>35m depth)	15%	253	38	0	0
Total Areas (m²)		2,646	207	6,441	176

6.4 Impact Quantification of the Deltares Realistic Plume

Impact quantification in this section is based on the Deltares Realistic Case modelling scenario described in Section 5 and has used the latest plume habitat map from the drop-down video survey and the associated % coral cover data within the plume area. A map of the plume area, presenting the 5% and 2% salinity contour above the ambient contour line, is provided in Figure 6-5. The quantification of the impacts is provided in Table 6-6 for the Unmitigated Seabed Footprint Impact Area (without considering substrate type, coral or seagrass cover, or coral translocation mitigation) and the Residual Impact (considering coral and seagrass cover and assuming coral translocation is implemented).

The modelled plume footprint associated with the new outfall is substantially larger than that presented in the Disclosed 2025 ESIA when assessed using the 2% salinity threshold, increasing from 9,076 m² to 69,027 m². However, the increase in plume area does not translate into a proportional increase in ecological impact because the revised assessment is based on new habitat mapping and coral cover data collected within the plume area. The drop-down video survey demonstrates that much of the expanded plume footprint is located over deep sandy habitats and deep sediment-dominated areas that support very little coral. In particular, 51,444 m² of the 69,027 m² 2% plume footprint, representing approximately 75% of the total plume area, occurs within deep sand habitat where average coral cover is only 0.05%.

As a result, although the unmitigated footprint is approximately 7.6 times larger than that assessed in the Disclosed 2025 ESIA, the residual impact is substantially lower, decreasing from 1,362 m² to 396 m². This reduction reflects the significantly lower coral cover values recorded within the new plume area compared with the assumptions applied in the Disclosed 2025 ESIA, particularly in deeper water habitats. The largest component of the new plume footprint is associated with habitats characterised by either very low coral cover (0.05% in sand habitats and 0.07% in deep sand/sediment and isolated reef outcrops) or by habitats located beyond diver-accessible depths where coral abundance is limited.

Application of the 5% salinity threshold, which is considered more appropriate than the 2% salinity threshold used in the Disclosed ESIA, further reduces the plume footprint to 20,108 m² and the residual impact to only 66 m².

Overall, the updated habitat surveys indicate that the revised outfall design directs the plume predominantly into deeper, sediment-dominated areas with very limited coral presence, meaning that the increase in plume area is not accompanied by equivalent increases in coral habitat impact.

Figure 6-5: Brine Plume Area Exceeding 2% and 5% Salinity Above Ambient and Habitat Map

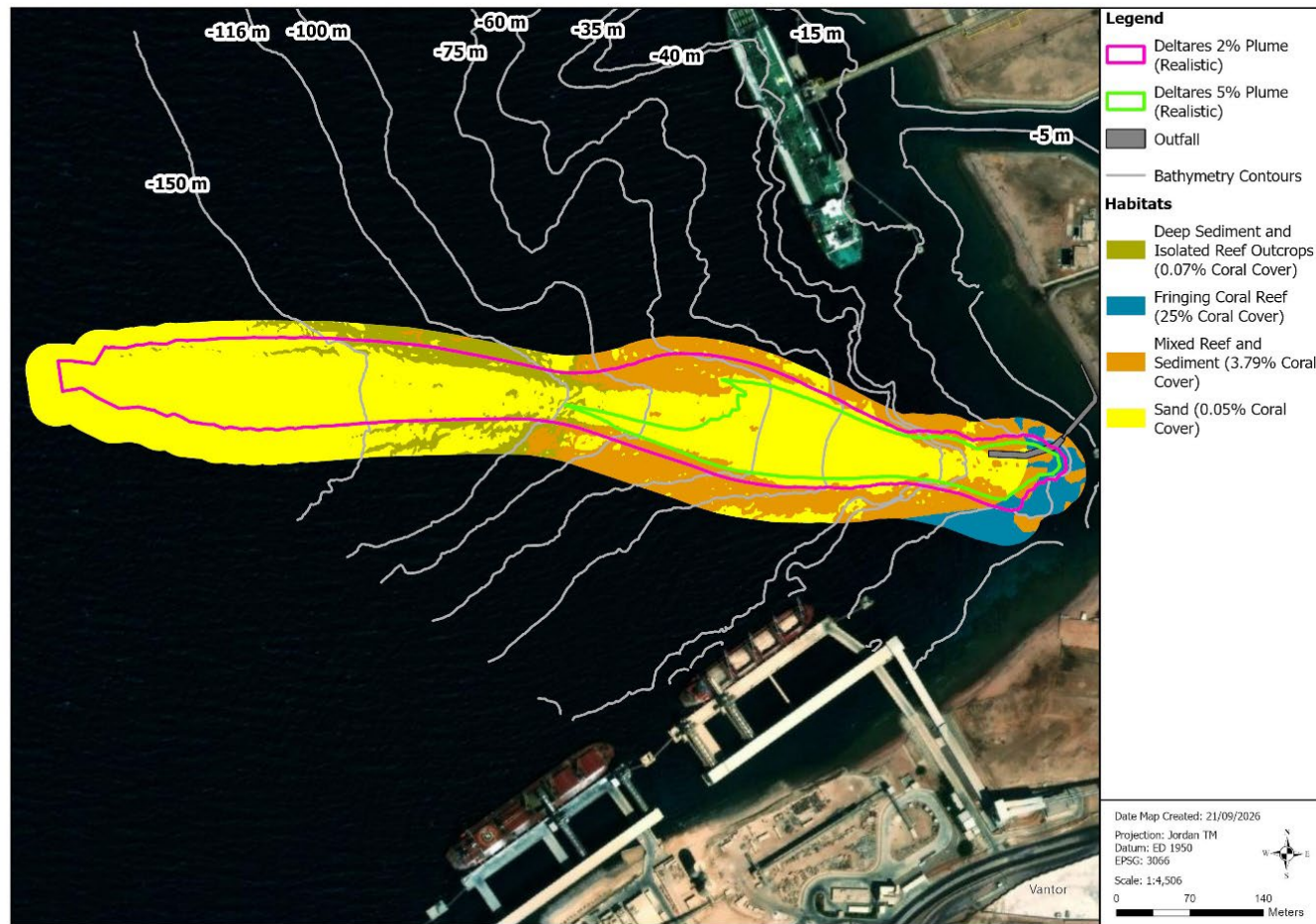


Table 6-6: Brine Plume Impact Summary Table, Including 2% and 5% Salinity Plumes

		Disclosed 2025 ESIA 2% Plume Impacts		New Outfall 2% Plume Impacts		New Outfall 5% Plume Impacts	
Habitat Type	Coral Cover %	Unmitigated Seabed Footprint Impact Area (m ²)	Residual Impact Area (m ²)	Unmitigated Seabed Footprint Impact Area (m ²)	Residual Impact Area (m ²)	Unmitigated Seabed Footprint Impact Area (m ²)	Residual Impact Area (m ²)
Fringing Coral Reef (<35m Depth)	New Outfall = 25%	0	0	1,038	52	314	16
Mixed Reef and Sediment (<35m depth)	New Outfall = 3.79%	0	0	2,989	23	1,842	14
Mixed Reef and Sediment (>35m depth)	ESIA Case = 15% New Outfall = 3.79%	305	46	7,702	292	730	28
Deep Sand/Sediment and Isolated Reef Outcrops (>35m depth)	ESIA Case = 15% New Outfall = 0.07%	8,771	1,316	4,105	3	6	0.004
Sand (<35m depth)	New Outfall = 0.05%	0	0	1,749	0.2	1,690	0.2
Sand (>35m depth)	New Outfall = 0.05%	0	0	51,444	26	15,526	8
Total Areas (m²)		9,076	1,362	69,027	396	20,108	66

6.5 Iron

The desalination plant discharge brine may contain dissolved iron because of treatment chemicals and the management of treatment residuals. Ferric-based coagulants may be applied in the pre-treatment process to enhance the removal of suspended solids and organic matter and to protect downstream treatment processes, including reverse osmosis systems. During operation, most iron associated with treatment chemicals is expected to be captured in treatment residuals such as sludge, filter backwash water, and other solids management streams. However, low residual concentrations of iron may remain in water streams routed to discharge. Consequently, trace quantities of iron in the discharge are anticipated and are recognised within the plant monitoring programme, which includes routine monitoring of total iron in discharge water. The AAWDCP Owner's Engineer has reviewed the current design information to define the anticipated iron concentrations in the brine discharge under routine and non-routine operating conditions.

The routine plant operation brine effluent iron concentration of 0.23 mg/L is derived from the EPC design case representing the maximum realistic foreseeable seawater Total suspended solids (TSS) condition under normal operation. This scenario assumes a seawater TSS concentration of 10 mg/L, aged reverse osmosis membranes, and the corresponding ferric chloride dosing requirement upstream of the dual media pressure filters. The resulting calculated iron concentration in the combined discharge stream is 0.23 mg/L. This value is therefore considered an appropriate technical basis for routine operation, as it reflects a conservative operating condition within the normal design envelope, rather than an exceptional or transient event.

The higher iron concentration of 0.37 mg/L is derived from the EPC extreme design case, which assumes a seawater TSS concentration of 50 mg/L. This condition is not considered representative of routine plant operation and is understood to be limited in duration. It should therefore be characterised as a high case for non-routine operation. The value also carries greater uncertainty, as the ferric chloride dose-to-TSS relationship is less well constrained at elevated TSS concentrations.

Other nutrient inputs to the brine discharge will be minimised through optimised chemical dosing, careful selection of treatment chemicals, and effective management of process residuals. The desalination plant design requires continuous discharge-water monitoring, including daily analysis of Total Nitrogen and Total Phosphorus.

Iron is an essential micronutrient for photosynthesis and cellular metabolism, but corals are generally not strongly iron-limited. The Gulf of Aqaba and northern Red Sea are naturally oligotrophic and often iron-poor. The ambient dissolved iron concentrations in the Gulf of Aqaba approximate to 0.00194 mg/L with a typical range from 0.00056–0.00444 mg/L (Chase et al., 2006; Al-Taani et al., 2020).

Iron is best viewed as a potential growth enhancer rather than the sole cause of eutrophication. Moderate iron enrichment may have some fertilisation effect on plankton, algae, or microbes, but available Red Sea coral studies indicate that iron does not appear to be a strongly limiting factor for coral productivity itself.

For long-term dissolved iron enrichment below 0.05 mg/L (50 µg/L) in coral reef environments, the evidence suggests that direct toxicity to corals (direct mortality, calcification impacts or coral bleaching attributable solely to iron) is unlikely, but some indirect ecological effects may exist at an ecosystem level rather than organism-level toxicity (Kelly et al., 2012; da Silva Fonseca et al., 2025; Fukushima et al., 2025).

The Deltares brine plume modelling was used to assess the potential impacts of iron by determining the dilution required to reduce iron concentrations to 0.050 mg/L, the lower threshold where potential toxic stress may occur:

- Routine operation: a minimum five-fold dilution is required
- Non-routine operation: a minimum eight-fold dilution is required

The modelling indicates that an eight-fold dilution is achieved at the boundary between the near-field and far-field models, approximately 15 to 25 m from the diffuser ports. Beyond this distance, iron concentrations are expected to fall below the lower threshold, so potential toxic stress and iron-related impacts are considered negligible. Nutrient enrichment from other non-iron-based sources is not envisaged based on the current plant design and standards. Iron concentrations are predicted to be lower than ambient levels at the border between Saudi Arabia and Jordan.

The planned laboratory-based coral exposure studies will validate this assessment. The final adaptive management plan will include specific monitoring, controls and response measures for iron and the prevention of other sources of nutrients in the brine.

6.6 Summary of Impact Quantification

The impact quantification demonstrates that the revised intake and outfall design results in a substantial reduction in residual environmental impacts compared with those presented in the Disclosed 2025 ESIA, despite some increases in the total unmitigated footprint area. The assessment reflects the benefit of the revised intake location, the updated outfall design, improved baseline survey data, including the incorporation of habitat-specific coral and seagrass cover information.

The most significant reduction in impact relates to the seawater intake system. In the Disclosed 2025 ESIA, the intake system was associated with an Unmitigated Seabed Footprint Impact Area of 35,946 m² and a residual impact area of 21,447 m². The revised intake arrangement and a revised approach to impact assessment, using more detailed and quantitative baseline survey data, reduce the unmitigated footprint by approximately 72% to 9,915 m², while the residual impact decreases by approximately 98% to only 500 m². This reduction reflects the use of the existing lagoon and intake pumping station, avoiding the need to construct a new intake lagoon and associated impacts.

The Unmitigated Seabed Footprint Impact Area associated with the new outfall construction increases from 2,646 m² to 6,441 m² because the revised construction methodology includes a new, more conservative approach to defining the construction area (the new approach considers the whole area within the silt curtain). However, despite the larger construction footprint, the residual impact decreases slightly from 207 m² to 176 m². This outcome reflects the new outfall's location within the sandy canyon and the ability to translocate corals from all affected areas, as the construction footprint is now entirely within diver-accessible depths.

The largest difference between the Disclosed 2025 ESIA and the new intake and outfall relates to the operational brine plume and the associated impacts of elevated salinity above the ambient seawater salinity of 40.7 psu. Using the 2% above-ambient salinity threshold (equivalent to approximately 41.5 psu), the Unmitigated Seabed Footprint Impact Area of the plume increases from 9,076 m² in the Disclosed 2025 ESIA to 69,027 m² for the new outfall. However, the residual impact decreases from 1,362 m² to 396 m². This decrease is explained by the updated habitat mapping, which shows that about 75% of the new plume footprint occurs over sand habitat with an average coral cover of only 0.05%. Consequently, although the area exposed to salinity increases exceeding the 2% above-ambient

threshold is substantially larger, the majority of the plume is located within habitats that support very little coral, resulting in a significantly lower ecological impact than estimated in the Disclosed 2025 ESIA.

Table 6-7 provides a consolidated comparison of the total Unmitigated Seabed Footprint Impact Area and Residual Impacts associated with the Disclosed 2025 ESIA intake and outfall design and the new intake and outfall design assessed in this report. The definition of the terms Unmitigated Seabed Footprint Impact Area and Residual Impacts is provided in Section 6.1 and is summarised here:

- **Unmitigated Seabed Footprint Impact Area:** The total area potentially affected by Project activities, without accounting for habitat type, coral or seagrass cover, or the benefits of coral translocation and other mitigation measures
- **Residual Impact:** The estimated ecological impact remaining after accounting for habitat-specific coral and seagrass cover and the application of coral translocation mitigation, assuming an 80% survival rate for translocated corals and a resulting 20% net loss of affected coral cover

Overall, considering all of the AAWDCP components and associated impacts:

- The total unmitigated footprint increases from 47,668 m² in the Disclosed 2025 ESIA to 85,383 m² when the 2% plume and 36,464 m² when the 5% plume threshold is applied using the new outfall and intake design
- Using the 2% plume, the total residual impact decreases from 23,016 m² in the Disclosed 2025 ESIA to 1,072 m², comprising 603 m² of coral and 469 m² of seagrass. This represents an approximate 95% reduction
- Using the 5% plume, the total residual impact is 742 m², comprising 273 m² of coral and 469 m² of seagrass. This is 330 m² lower than the 2% plume assessment and represents an approximate 97% reduction compared with the Disclosed 2025 ESIA residual impact
- These results indicate that the revised intake and outfall design substantially reduces impacts to coral reef habitats, despite larger modelled plume areas, because the majority of the plume is directed into deeper sediment-dominated habitats with very low coral cover.

Table 6-7: Impact Summary Table, Including 2% and 5% Salinity Plumes

Project component	Disclosed 2025 ESIA Intake and Outfall Impacts		New Intake and Outfall Impacts	
	Unmitigated Seabed Footprint Impact Area (m ²)	Residual Impact Area (m ²)	Unmitigated Seabed Footprint Impact Area (m ²)	Residual Impact Area (m ²)
Seawater intake system	35,946	21,447	9,915	500 (Seagrass 469, Hard Coral 31)
Construction	2,646	207	6,441	176
Brine plume 2% plume (5% plume in brackets)	9,076	1,362	69,027 (20,108)	396 (66)
Total Areas (m²) 2% plume (5% plume in brackets)	47,668	23,016	85,383 (36,464)	See below

Project component	Disclosed 2025 ESIA Intake and Outfall Impacts	New Intake and Outfall Impacts
Residual Impact 2% Plume		- Total seagrass = 469 - Total with coral = 603
Residual Impact 5% Plume		- Total with seagrass = 469 - Total with coral = 273

6.7 Translocation Assessment

A summary of the total area where translocation of hard corals is provided below in Table 6-8 and Table 6-9 for the 2% and 5% salinity plumes. The estimated range in translocation area of 10,287 to 12,217 m² presented in the tables excludes the seawater intake impact area. Existing coral colonies within the intake area will remain in situ because intake operation is not expected to have a direct material effect on the established coral population. Retaining these colonies will help maintain existing coral habitat, while coral settlement and benthic habitat monitoring will verify that abstraction does not adversely affect recruitment or the condition of the existing reef community. The potential intake-related effect is associated primarily with the deflection and entrainment of coral larvae rather than the physical loss of established colonies; consequently, translocation of existing corals is neither required nor considered appropriate.

The estimated translocation requirement is readily accommodated within the potential capacity of the candidate recipient areas described in Section 8.6.2. The Corniche Site provides approximately 8,000 to 10,000 m², while the Royal Yacht Club provides approximately 15,000 m², with a further 3,000 to 5,000 m² potentially available at Berenice. Together, these sites provide substantially more capacity than the translocation requirement and sufficient additional area to accommodate translocation or other habitat restoration measures needed to offset residual coral impacts.

Table 6-8: Summary of Translocation Area (2% Plume)

Habitat Type	Coral Cover	Unmitigated Seabed Footprint Impact Area (m ²)
Construction		
Shallow Intertidal Areas (<35 m depth)	10%	3,125
Patch Reef and Shallow Seagrass (<35m Depth)	10%	954
Fringing Coral Reef (< 35 m depth)	25%	1,185
Mixed Reef and Sediment (< 35 m depth)	15%	1,177
2% Plume		
Fringing Coral Reef (<35 m depth)	25%	1,038
Mixed Reef and Sediment (<35 m depth)	3.79%	2,989
Sand (<35m depth)	0.05%	1,749

Habitat Type	Coral Cover	Unmitigated Seabed Footprint Impact Area (m ²)
Area-weighted average cover	10.3%	
Total 2% Plume and Construction Area (m ²)		12,217

Table 6-9: Summary of Translocation Area (5% Plume)

Habitat Type	Coral Cover	Unmitigated Seabed Footprint Impact Area (m ²)
Construction		
Shallow Intertidal Areas (<35 m depth)	10%	3,125
Patch Reef and Shallow Seagrass (<35m Depth)	10%	954
Fringing Coral Reef (< 35 m depth)	25%	1,185
Mixed Reef and Sediment (< 35 m depth)	15%	1,177
5% Plume		
Fringing Coral Reef (<35 m depth)	25%	314
Mixed Reef and Sediment (<35 m depth)	3.79%	1,842
Sand (<35m depth)	0.05%	1,690
Area-weighted average cover	10%	
Total 5% Plume and Construction Area (m ²)		10,287

6.8 Offset Quantification

The offset quantification in this section is preliminary. It provides an initial estimate of potential offset requirements based on the current understanding of residual impacts to support early offset planning and site screening rather than define the final biodiversity offset obligation.

The assessment incorporates several assumptions and limitations. Additional survey work and studies identified in Section 3.1 remain in progress, including further habitat mapping, ROV survey of the brine plume area, coral exposure studies and coral settlement monitoring.

The offset site selection process has commenced. Candidate recipient sites have been identified and subject to preliminary evaluation; however, further investigations, suitability assessments and stakeholder engagement are required before preferred offset locations are confirmed. Section 8.6 describes the proposed approach to offset development, site selection, and implementation, with the next steps outlined in Section 8.6.3.

The final Biodiversity Action Plan will provide an updated residual impact quantification incorporating the results of the additional surveys and studies, refined impact assessment assumptions and a biodiversity accounting methodology based on a quality hectare approach.

Sections 6.8.2 and 6.8.3 present the estimated coral offset area requirements for the construction footprint combined with the 2% and 5% plume impact scenarios, respectively. The offset requirements have been calculated using both the 80% and 60% coral translocation survival scenarios described above. Section 6.8.4 presents the estimated seagrass offsetting requirement.

6.8.1 Approach To Coral Offset Quantification

The initial offsetting requirements for coral reef habitat were estimated based on the total residual hard coral loss remaining after application of mitigation. This includes:

- Residual impacts within areas deeper than 35 m water depth, where coral translocation is not considered feasible
- Residual impacts remaining following implementation of the proposed coral translocation programme. To account for uncertainty in translocation performance, two post-translocation survival scenarios have been considered: 80% survival and 60% survival.

The 80% survival scenario represents the primary assessment case and is considered a realistic outcome for the Project based on the favourable environmental conditions within the Gulf of Aqaba, the availability of suitable recipient sites, and the successful implementation of established coral translocation techniques, including appropriate collection, handling, transport, attachment and post-translocation monitoring. Previous coral translocation initiatives undertaken in Jordan have frequently reported survival rates exceeding 85% (Kotb et al., 2015; Kotb, 2016), reflecting the high environmental quality of recipient sites and the relative resilience of Gulf of Aqaba corals.

The 60% survival scenario is more conservative and accounts for uncertainty in translocation performance. This assumption is consistent with the global coral restoration literature, which reports average survival rates of approximately 64% across international coral restoration projects (Boström-Einarsson et al.) and 60.9% across marine ecosystem restoration projects involving corals (Bayraktarov et al.). The 60% survival rate therefore provides a precautionary benchmark that reflects globally observed restoration outcomes and allows the offsetting strategy's robustness to be tested against a lower translocation success rate.

For each survival scenario, residual coral loss was calculated as the proportion of impacted coral cover that was not successfully established within recipient sites following translocation. The resulting residual coral loss area was then used to estimate offset requirements based on a target recipient habitat with an average coral cover of 25%. Under this assumption, each square metre of recipient habitat contains approximately 0.25 m² of live coral. Consequently, the area required for offsetting is equivalent to approximately four times the residual coral loss area, ensuring that an equivalent quantity of live coral is restored within the offset site.

6.8.2 Coral Residual Impact Abstraction, Construction and 2% Plume

Table 6-10 presents the estimated offset area requirements for the abstraction zone, construction footprint and 2% plume scenario, based on assumed coral translocation survival rates of 80% and 60%.

Table 6-10: Coral Offset Area Requirement (m²) for Abstraction, Construction, and 2% Plume

Translocation Survival Assumption	Total Residual Impact (m ²)	Target Coral Cover %	Total Area Required for Offset (m ²)
80%	603	25%	2,412

Translocation Survival Assumption	Total Residual Impact (m ²)	Target Coral Cover %	Total Area Required for Offset (m ²)
60%	884	25%	3,536

6.8.3 Coral Residual Impact Abstraction, Construction and 5% Plume

Table 6-11 presents the estimated offset area requirements for the abstraction zone, construction footprint and 5% plume scenario, based on assumed coral translocation survival rates of 80% and 60%.

Table 6-11: Coral Offset Area Requirement (m²) for Abstraction, Construction, and 5% Plume

Translocation Survival Assumption	Total Residual Impact (m ²)	Target Coral Cover %	Total Area Required for Offset (m ²)
80%	273	25%	1,092
60%	509	25%	2,036

6.8.4 Seagrass (Abstraction Area)

The current seagrass offsetting requirement is based on the predicted loss of seagrass habitat within the seawater abstraction area only. Based on the extent of affected habitat identified to date, approximately 469 m² of seagrass restoration or offset habitat would be required to compensate for the residual loss.

This estimate is preliminary and does not currently include any potential seagrass impacts associated with the marine construction or plume footprint. The offsetting requirement will therefore be reviewed and updated once the final construction-related impact areas have been confirmed and incorporated into the assessment.

6.8.5 Other offset initiatives

With regard to other critical habitat qualifying features associated with or dependent on coral and seagrass habitats, these will be addressed through the proposed offset actions to support living reef substrate together with the coral colonies. Living substrate provides a range of microhabitats that support associated organisms and ecological functions, including nursery, feeding, shelter, and refuge functions for other species. Accordingly, the offset actions will not be limited to the target coral colonies in isolation but will, as far as practicable, retain the associated biological communities inhabiting or utilising the living substrate.

Offsetting actions to support and promote living rocks will therefore be considered an integral component of the offsetting measures. Maintaining these living substrates and their associated communities will help retain the ecological functions and habitat features supported by the reef structure. The condition and survival of living rocks, corals, and associated organisms will also be incorporated into the monitoring program for the offsetting measures.

In addition, the planned introduction of artificial reef structures as part of the offsetting activities is expected to provide additional habitat for reef-associated species and communities, with the habitat developing and becoming increasingly colonised over time. This approach is supported by the experience of previous artificial reef deployments within the Marine Reserve. For example, the artificial reef structures known as “Reef Arabisc” located in front of the Marine Science Station, have developed into established habitat for a range of reef-associated organisms, including newly recruited corals and other

reef fauna. The incorporation of artificial reef structures into the Project's offsetting program therefore provides an additional component that can contribute to the development of new reef-associated habitat and enhance the overall ecological value of the proposed offsetting measures.

In addition to coral reef habitat, the AAWDCP recognises that seagrass represents an important ecological receptor and contributes to the overall residual biodiversity impact identified by the assessment. Accordingly, the Project's Biodiversity Action Plan will address residual impacts on both coral reefs and seagrass. The Project will develop dedicated seagrass restoration and offset initiatives to compensate for residual seagrass losses. Potential measures may include restoring degraded seagrass habitats, enhancing existing seagrass meadows, and other conservation actions designed to achieve long-term ecological benefits.

The need to support Giant Clam populations as part of an offset initiative will be determined in the final Biodiversity Action Plan, noting that only 3 individuals have been identified in the diver transect survey data analysed at the time of preparing this report, following the analysis of more than 1,000 quadrats.

6.9 Residual Impact in the Context of Jordan's Total Reef Extent

Table 6-7 shows the estimated impact footprint for individual components of project activity and a cumulative total impact footprint for a 2% and 5% plume. For critical habitat assessment procedures, significance is generally evaluated against the ecological receptor of concern, in this case loss of coral cover that is actually affected, rather than the total unmitigated area, and this is provided by the residual impact area.

6.9.1 Contextual Assessment using the Allen Coral Atlas

To determine the significance of coral loss as an ecological resource to Jordan's reef environment, it must be considered as a proportion of the total ecological resource available. The Allen Coral Atlas (<https://allencoralatlas.org>) utilises high-resolution satellite imagery and advanced analytics to map the world's coral reefs⁴. The atlas covers shallow tropical coral reefs up to a maximum depth of 15 m and maps the extent of reef habitat. The Atlas reef class has been used to provide an estimate of total reef extent for Jordan:

- Area in m²: 2,630,834
- Area in hectares: 263.08

Limitations associated with the Allen Coral Atlas introduce several important caveats when interpreting the estimated extent of Jordan's coral reef resource. The Atlas relies on optical satellite imagery and is therefore generally limited to mapping habitats visible from the surface, restricting coverage to about 15 m of water depth. As a result, the Atlas does not capture deeper reef systems below the effective depth penetration of satellite imagery and may also overestimate coral coverage in limited locations where human/engineered substrate occurs in industrial areas.

The Atlas also provides two distinct but complementary datasets, both of which should be regarded as conservative estimates. The first is Shallow Coral Reefs (Reef Extent), which defines the broader geomorphic reef structure and, in Jordan, captures the continuous fringing reef system that extends along much of the coastline. This dataset incorporates the shallow reef platform from the intertidal zone

⁴ The Atlas defines reef extent as shallow coral reef features generally visible from satellites, and deliberately makes this layer more inclusive than its detailed habitat maps. It can include reef slope, reef flat, coral habitat, rubble, sand patches, algae, seagrass and other substrates associated with the reef system.

to the outer reef slope. The second is Coral Habitat (Benthic Cover), which maps only areas identified as live coral and coral-algae habitat within the broader reef structure. Because the Atlas operates at a spatial resolution of approximately 5 m, smaller coral colonies, patch reefs and narrow reef features may not be detected, while sandy areas, seagrass meadows and rubble zones are excluded from the mapped coral habitat layer.

For Jordan specifically, the Atlas is also likely to underestimate total reef extent because steep and near-vertical reef walls are compressed or omitted in top-down satellite imagery. In addition, coral communities occurring below approximately 15 m water depth are not represented within the Atlas datasets, these are an important component of Gulf of Aqaba reef systems and likely represent a substantial proportion of the total reef area. Consequently, the reef extent and coral habitat estimates derived from the Allen Coral Atlas should be considered conservative baselines, and the actual extent of Jordan's coral reef resource is expected to be significantly greater than what the Atlas represents.

To determine the quantum of coral loss from project activity to reef extent in Jordan, the residual impact can be compared to the total reef extent of Jordan and the amount of Coral/Algae habitat class estimated by the Allen Coral Atlas; the below approach has been adopted:

- 2% plume:
 - Reef extent: $(\text{AAWDCP Project Residual impact 2\% plume} / \text{Total reef extent}) \times 100 = \% \text{ Loss}$
 - $(603 / 2,630,834) \times 100 = 0.023\%$
- 5% plume:
 - Reef extent: $(\text{AAWDCP Project Residual impact 5\% plume} / \text{Total reef extent}) \times 100 = \% \text{ Loss}$
 - $(273 / 2,630,834) \times 100 = 0.010\%$

Although the AAWDCP residual impact would result in localised reductions in reef habitat that might have a local effect upon structural complexity and associated nursery functions within the impact footprint, the affected area represents ~ 0.023% for the 2% plume and ~0.010% for the 5% plume of Jordan's mapped coral reef resource.

Consequently, the impact is unlikely to measurably reduce reef connectivity, larval dispersal, nursery habitat availability, or ecological functioning at the scale of the Jordanian coastline. Unless the affected habitat is demonstrated to support unique ecological functions, rare habitat types, or disproportionately important source populations, the residual effect on connectivity and nursery habitat would generally be considered negligible to minor at the national scale and minor at the regional Gulf of Aqaba scale.

This conclusion is justified in the context of IUCN and other international conservation bodies, which identify habitat loss and degradation of areas important for biodiversity as the relevant consideration when assessing impacts on ecosystem integrity, rather than the size of an impact footprint itself. The coral loss from the impact area will contribute locally to reef ecological functions, including provision of shelter, feeding grounds, and nursery habitat for reef-associated species; however, the impact constitutes a very small proportion of the national reef resource. International guidance on ecological connectivity indicates that significant connectivity effects are generally associated with habitat fragmentation, loss of ecological corridors, or disruption of movement pathways, none of which are anticipated from the loss of this relatively small and isolated area.

6.9.2 Contextual Assessment using the Aqaba Marine Reserve Nomination Records

The Aqaba Marine Reserve nomination records estimate that the Jordanian sector of the Gulf of Aqaba contains approximately 350 km² of marine and seabed habitat, of which approximately 4 km² (4,000,000 m²) comprises coral reef habitat. These figures provide an additional regional-scale benchmark against which the significance of the Project's residual impacts can be considered. Unlike the Allen Coral Atlas assessment, which is derived from satellite-based habitat mapping and is limited by water depth and image resolution, the Aqaba Marine Reserve figures represent a broader estimate of the reef resource within Jordanian waters and provide a useful contextual reference for evaluating the scale of habitat loss relative to the overall reef ecosystem.

Using the residual coral impact values presented in Table 6-7, the Project's coral-related residual impact can be expressed as a proportion of the total coral reef area recognised within the Aqaba Marine Reserve nomination records. For the 2% plume scenario, the residual coral impact of 603 m² represents approximately 0.015% of the estimated 4,000,000 m² coral reef resource. For the 5% plume scenario, the residual coral impact of 273 m² represents approximately 0.007% of the estimated coral reef resource.

These percentages indicate that the residual coral habitat loss associated with the Project represents a very small proportion of the total coral reef habitat present within Jordanian waters of the Gulf of Aqaba. The assessment therefore supports the conclusion that, although localised impacts to coral habitat will occur, the affected area is unlikely to result in a measurable reduction in reef extent, ecological connectivity, nursery habitat availability, larval dispersal processes, or ecosystem functioning at either the Jordanian coastline scale or the wider Gulf of Aqaba scale.

Overall, the contextual assessment using the Aqaba Marine Reserve nomination records leads to a similar conclusion to that derived from the Allen Coral Atlas assessment: the residual coral habitat loss represents a very small proportion of Jordan's overall coral reef resource and is therefore unlikely to result in significant effects on the integrity or functioning of the wider reef ecosystem.

7 Overview of ESMS and Adaptive Management Plan

7.1 Overview of ESMS

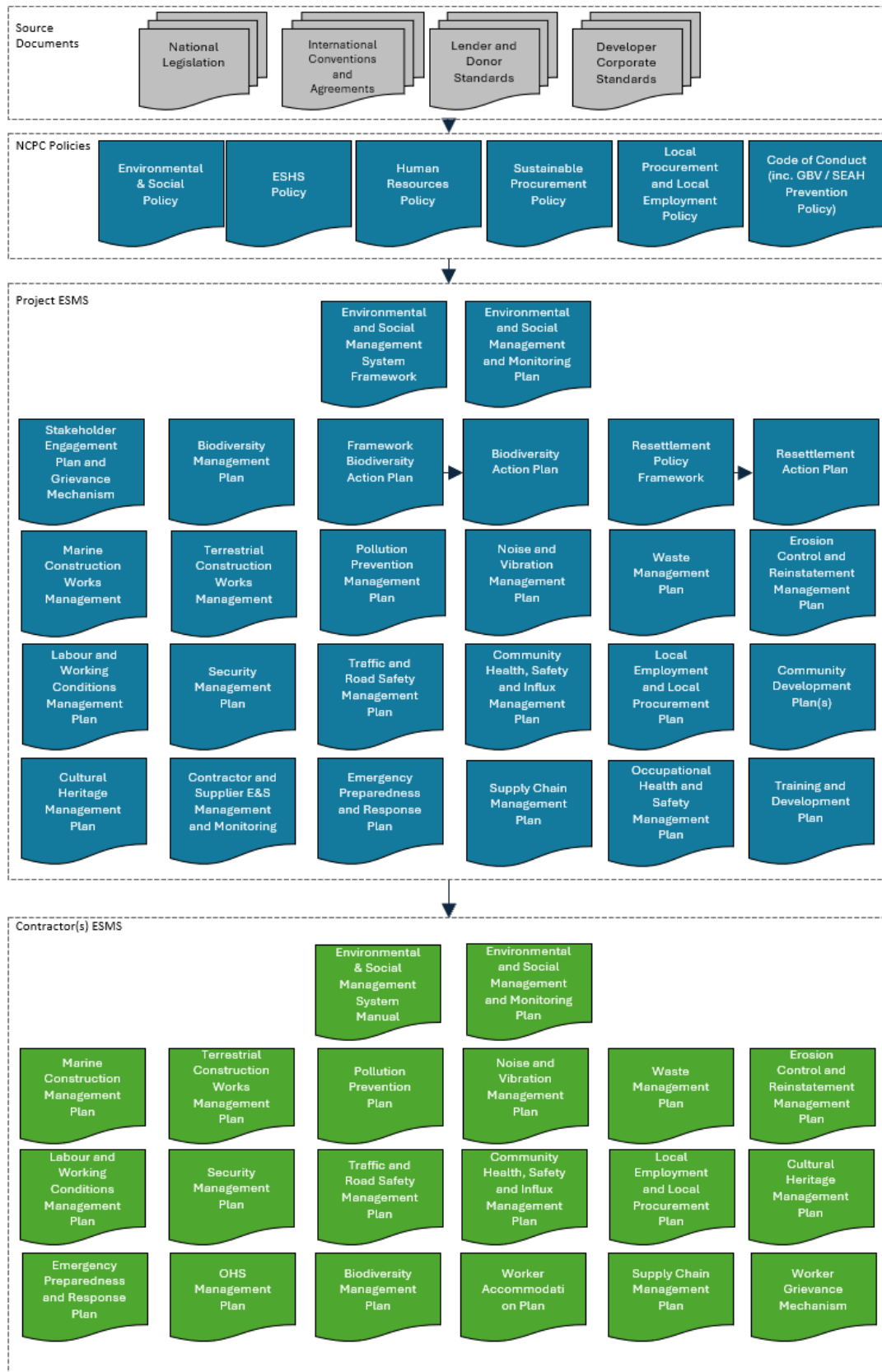
The AAWDCP has developed an Environmental and Social Management System (ESMS), see Figure 7-1, to identify, assess, mitigate, and monitor environmental and social risks throughout the full Project lifecycle, covering the construction and operations phases. This ESMS will guide all parties (NCPC, EPC contractors, and operations and maintenance contractors) in managing Environmental & Social (E&S) risks during design, procurement, through construction and into long-term operation of the desalination plant and conveyance system.

Key purposes of an ESMS to support the marine scope of the project include:

- Identify and assess marine environmental risks and impacts associated with the seawater intake system, marine construction activities, brine discharge, and other Project activities throughout the design, procurement, construction, commissioning, and operational phases
- Apply the mitigation hierarchy by embedding avoidance measures into project design, implementing impact minimisation and restoration measures during construction, and providing offset and compensation measures where residual impacts remain
- Establish clear management controls, monitoring programmes, performance standards, and adaptive management processes to protect coral reefs, seagrass habitats, water quality, and other marine biodiversity features
- Define responsibilities, procedures, and assurance mechanisms to verify that environmental commitments and mitigation measures are effectively implemented throughout the Project lifecycle. Engage regulators, lenders, marine specialists, project execution organisations and other stakeholders in the planning, implementation, monitoring, and review of marine environmental management measures
- Ensure compliance with applicable regulatory requirements, lender standards, Project commitments, and biodiversity objectives
- Monitor environmental performance, evaluate the effectiveness of mitigation measures, and implement adaptive management responses where monitoring indicates that impacts differ from those predicted
- Provide the framework for the design avoidance measures, pre-construction surveys and translocation activities, construction controls, operational monitoring, and adaptive management

To maintain the effectiveness of the management measures and their relevance to the changing E&S risks and impacts, the Project will adopt a management approach aligned with the International Organisation for Standardisation (ISO 14001:2015) standard's Plan-Do-Check-Act cycle.

Figure 7-1: ESMS Structure



7.2 Adaptive Management

This section sets out the framework for developing the adaptive management plan that NCPC will use to manage the marine environmental performance of the AAWDCP Desalination Plant during operations. It explains how NCPC will identify, assess, monitor and respond to marine environmental issues, and provides an action plan linked to detailed design, procurement, operating procedures, commissioning, and the additional environmental baseline surveys and studies required to finalise the Plan.

At the time of writing, the Project is at the pre-Project Commencement date; detailed design has not started, and this plan will mature as the Project proceeds. The approach will follow the Plan-Do-Check-Act cycle required by International Finance Corporation (IFC) Performance Standard 1 (and other applicable lenders' policies) for an environmental and social management system, and the adaptive management practice required by IFC Performance Standard 6 (and other applicable lenders' policies) to support long-term biodiversity outcome management. This plan will support the mitigation hierarchy, which incorporates a feedback optimisation process.

7.2.1 Architecture

Adaptive management will address uncertainty and change by setting clear environmental thresholds to achieve defined objectives in the final Biodiversity Action Plan. These thresholds will be used to assess monitoring outcomes and subsequently determine required mitigations (e.g. adjusting operational processes and offset programmes where effects differ from predictions) by iterating the Plan-Do-Check-Act cycle described above. This approach will distinguish between different types of deviation from the defined threshold and allow the required response option to be determined appropriately. The adaptive management plan has four components:

- A set of measurable parameters and thresholds describing the environmental marine habitat quality, including reef, sediment, seagrass, and water column condition and health, agreed against the Project's environmental objectives
- An operational monitoring process that will define measurable parameters and thresholds to establish acceptable process performance
- An intervention process setting out responsive actions where a threshold is exceeded, and who is responsible for the actions
- An evaluation and learning procedure to compare monitored conditions against desired conditions, and deciding whether to adjust the plant operation, the thresholds or the monitoring
- The sections below describe how the adaptive management framework will be developed and implemented to manage uncertainty associated with marine biodiversity impacts from the seawater intake system, outfall construction, and brine discharge and conformance with the project standards. The framework is founded on additional baseline surveys, coral exposure and settlement studies, engineering assurance activities, environmental and operational monitoring, and clearly defined response mechanisms. Together, these elements provide the evidence base needed to establish impact thresholds, verify assessment assumptions, detect unforeseen impacts, and implement corrective actions where necessary, ensuring marine biodiversity objectives and Project commitments are achieved throughout the Project's operational life.

7.2.2 Additional Pre-Construction Biodiversity Survey and Studies

Deltares has completed the brine plume modelling, which established the exposure concentration boundaries by mapping the brine plume. The remaining work is to complete the 2026 additional marine biodiversity survey and studies. These are needed to convert the modelling exposure concentrations into biological thresholds, and then numeric thresholds can be established for the biological and ambient physicochemical parameters. The 2026 marine biodiversity survey and study work has three components, their status is provided in Table 7-1:

- Additional marine baseline surveys and the establishment of long-term monitoring stations
- A coral exposure study to confirm the iron and salinity tolerance ranges of endemic corals, running for at least 3 months and up to 12 months
- A coral settlement study to confirm natural settlement patterns and variability over a 12-month period, with initial results available within the first 3 months

Once these are complete, a finalised residual impact assessment will be undertaken, and thresholds developed utilising the completed modelling results together with the further developed project design. The key milestones are provided in Table 7-1 below.

Table 7-1: Key Biodiversity Milestones

Key milestones	What it provides	Status
Deltares brine and near-field modelling	Exposure concentrations for the laboratory arrays; plume footprint confirmation to support selection of long-term monitoring station locations; mixing zone definition	Completed
Additional marine baseline survey	Habitat maps, long-term monitoring stations, water and sediment baseline, BACI control sites	To confirm the assumptions used in the current quantification of the plume in water depths greater than 60-70 m additional drop down and then ROV surveys are in progress, sediment and water sampling, and final data analysis. Planned completion in Q3, potentially Q4
Coral exposure study (salinity and iron)	Indicators and thresholds at which local corals begin to show measurable stress	To be start in Q3, initial results Q4 2026
Coral settlement study	Determines whether reproduction and recruitment are maintained, and spawning seasonality	To be start in Q3, initial results Q4 2026
Biodiversity Action Plan and offset planning	Provides quantified residual impact, offset options and criteria, selected offset measures, monitoring indicators, engagement actions, budgets, schedules and supporting biodiversity management plans.	In progress, to be issued in 4Q 2026

7.2.3 Biodiversity Monitoring

The biodiversity monitoring programme is being developed. It will be structured as a Before-After Control-Impact (BACI) design, which provides the framework for distinguishing Project-related change from natural variation. The design is based on four core components:

- Before: Collect baseline data across both impact and control sites prior to any intervention
- After: Continue monitoring data collection after the management action or disturbance occurs
- Control: Maintain unmanipulated reference sites to account for broad, natural environmental trends over time
- Impact: Monitor the specific site subject to the management intervention or human activity

Within the adaptive management cycle, the BACI design performs three roles:

- Hypothesis testing: Explicitly to check whether the predicted outcomes of a management strategy match ecological responses within the habitats impacted
- Uncertainty reduction: Use of control-versus-impact comparisons to provide a basis for comparison between project impacts, background environmental variation and change
- Operational adjustment: Feed monitoring insights directly back into decision-making to alter, halt, or scale up management actions if trigger threshold(s) are exceeded

The first version of the monitoring program will be prepared to support the final Biodiversity Action Plan in 4Q 2026.

7.2.4 Engineering, Procurement and Construction Assurance

The priority at this stage is to confirm that engineering and procurement can deliver consistent discharge performance within the agreed project standards and supporting monitoring capabilities. Table 7-2 provides the assurance gates used at the planning stage.

To ensure that the design complies with applicable standards and 2025 AAWDCP ESIA commitments, a Design Verification Register will be developed to guide verification of engineering controls related to brine quality and pollution prevention. The Design Verification Register will remain a 'live' document, updated regularly prior to operations. The register will focus on systems and engineering packages across all aspects of the plant, including outfall, diffuser, water treatment, cleaning in place, dechlorination, and water monitoring instrumentation. The register provides the basis for a verification scheme that confirms critical elements are suitable before the design is complete, rather than after commissioning.

Table 7-2: Planning Stage Assurance Gates

Assurance gate	Environmental purpose	Key output
Hazard Identification (HAZID)	Identify environmental hazards and the elements that control them; identify critical environmental equipment	Critical environmental equipment register and confirm performance standard, maintenance schedule, sparring philosophy
Design Hazard and Operability (HAZOP) on the	Test the discharge, dosing, neutralisation and pollution pathways against deviations; confirm alarm	HAZOP actions closed

Assurance gate	Environmental purpose	Key output
Piping and instrumentation diagram (P&IDs)	and trip settings to protect the receiving environment, not only the Plant	
Vendor package reviews	Confirm analyser range, accuracy, drift and calibration requirements for the outfall panel; confirm the antiscalant achieves the phosphorus and nitrogen standards, confirm Cleaning in place (CIP) and biocide specifications	Technical queries; approved vendor data, maintenance and calibration requirements, sparing philosophy
3D model reviews at 30, 60 and 90%	Confirm sampling access, analyser panel siting, and calibration and maintenance access at the equalisation tank and outfall	Model review actions
Factory acceptance testing	Confirm dosing skids, analyser panels and the equalisation and energy dissipation control loop against their performance standards	Factory acceptance testing (FAT) records against Environmental critical equipment (ECE) performance standards
Site acceptance testing and pre-commissioning	Confirm that installed instrumentation, interlocks and the alarm threshold hierarchy behave as designed on site	Loop checks; alarm rationalisation record
Commissioning and performance testing	Establish the actual discharge signature for salinity, residual oxidant, nutrients, iron and turbidity across the production steps	Commissioning environmental dataset; provisional operating envelope
Operations and maintenance (O&M) readiness and handover	Integrate the final version of this plan into operating procedures, monitoring schedules, competencies and reporting lines	O&M procedures; adaptive management manual

7.2.5 Environmental and Operational Monitoring Thresholds

7.2.5.1 Environmental Monitoring Thresholds

The Project will develop a two-tier environmental threshold structure in which relatively simple, readily measured Tier 1 thresholds will be developed at the lower (pressure) end of an environmental pressure/response pathway to provide an early warning. Tier 2 thresholds will be developed at the higher (response) end of the pressure/response pathway and, if exceeded, signify an unacceptable risk to the environment and require a management response.

These criteria are not fixed at this stage; they will be derived, tested and refined progressively through the studies currently underway, and finalised before commissioning of the Desalination Plant.

The additional marine baseline surveys will extend the existing dataset across further seasons and reference locations, characterising ambient conditions and natural variability for the indicators of concern. These indicators include turbidity and light attenuation, salinity, temperature, nutrients and trace metals, including iron. They also include chlorophyll A, coral cover, community composition and condition at impacted and unimpacted reference sites. The resulting dataset will provide the statistical basis and guidelines for the Tier 1 and 2 thresholds, and for distinguishing Project-related change from natural and non-Project influences.

The coral exposure study using controlled exposure of local coral species to the discharge constituents of concern, principally iron and elevated salinity individually and in combination, will identify the concentration at which no measurable effect occurs and the concentration at which an adverse response is demonstrated. The coral settlement study addresses the most sensitive coral life stage. Larval settlement and early recruitment success provide a sub-lethal, ecologically meaningful endpoint, ensuring the Tier 1 and 2 thresholds protect reef recovery and recruitment, not just adult colony survival.

These outputs will be integrated with the near-field and far-field dilution modelling to confirm that each criterion is achievable at the boundary of the defined mixing zone and, if applicable, criteria can be measured at control sites. The final criteria, monitoring design, and escalation logic will be embedded into the final adaptive management plan and agreed with the applicable stakeholders before commissioning.

For coral reef assessments, biological indicators are often more important than chemical indicators because they show whether the reef ecosystem is actually being affected by stressors such as nutrients, sedimentation, temperature, salinity, or contaminants. Metrics that could be selected to be recorded as part of the monitoring strategy are:

- Macroalgal cover (%) - Often the first indicator of nutrient enrichment
- Turf algae abundance - Can increase before changes in coral cover become detectable
- Coral recruitment density - Sensitive to chronic algal competition
- Coral health observations – Bleaching, Disease, Partial mortality
- Chlorophyll-a concentration - Although a water quality parameter, it is frequently used as a biological productivity indicator and an early warning of eutrophication

All parameters will be compared to the baseline condition and control sites to eliminate background variability and area-wide change to establish the 2-tier structure and environmental thresholds:

- Tier 1: Early warning. Changes detected in monitoring parameters but do not exceed changes and/or ranges noted from baseline/reference sites, and there are no detectable adverse effects on ecological structure and function.
- Tier 2: Response required. Changes detected to monitoring parameters that exceed changes and/or ranges noted from baseline/reference sites, and there are detectable adverse effects on ecological structure and function.

An example of Tier 1 and 2 indicators is provided below in Table 7-3.

Table 7-3: Example indicators

Indicator	Tier 1	Tier 2
Salinity increase +/- 5% ambient	≤42.7psu	>42.7 psu persistent
Coral bleaching	Increased and within reference range	Statistically significant increase compared to baseline and reference range
Coral recruitment	Decreased and within reference range	Decreased and outside of baseline and reference range
Live coral cover	Decreased and within reference range	Decreased and outside of baseline and reference range
Macroalgae cover	Within reference range	Increase relative to reference

Indicator	Tier 1	Tier 2
Chlorophyll a	Within reference range	Increase relative to reference

7.2.5.2 Operational Thresholds

Desalination Plant operational monitoring indicators will be developed at the planning stage to confirm the monitoring routine, locations and data ranges that can be developed into operational thresholds. Key areas of focus during the planning stage will be on the potential pollutants listed in Table 7-4. Two tiers of operational thresholds will be developed:

Tier 1 thresholds will be developed at the lower end of an operational monitoring range to provide an early warning.

Tier 2 thresholds will be developed at the higher end of an operational monitoring range; if exceeded, they signify an unacceptable risk to the environment and require a management response

Table 7-4: Potential Pollutant

Pollutant	Current design and controls	Planning stage action
Nutrients	- The antiscalant is specified as phosphorus-free and nitrogen-free; polymer is used in thickening and dewatering - Equalisation tanks/discharge monitoring of total nitrogen and total phosphorus	- Confirm compliance with the phosphorus-free and nitrogen-free antiscalant specification through procurement - Confirm need for additional nutrient controls and sampling - Define operational thresholds
Residual chlorine and by-products	- Chlorine gas is dosed at 1.0 to 1.5 mg/L to the desalinated water, not to the intake. - A provision for future injection exists on the onshore intake pipeline, with sodium bisulfite as a back-up reducing agent at the RO feed and neutralisation tank. - Free chlorine and redox analysers, with control points ≤ 0.5 mg/L at the IPS discharge and 0.05 mg/L at the RO feed - A residual chlorine analyser on the outfall panel	- Decide whether to use intermittent shock chlorination of the intake. - The dechlorination controls and monitoring and halogenated by-product monitoring - Define operational thresholds
Iron, solids and turbidity	- Solids are removed by lamellar clarification and centrifugation, with supernatant returned to the equalisation tank - Turbidity at the equalisation tank, alarmed above 5 NTU with the control point above 10 NTU - pH control point below 7.0 or above 9.0 - Equalisation tanks/discharge monitoring planned for iron	- Iron exposure will be assessed during coral exposure study - Review results of iron study and assess control and monitoring approach - Define operational thresholds

7.2.5.3 Response Process

7.2.5.3.1 Triggering Events and Default Actions

A monitoring schedule will be established, setting out the frequency of environmental and operational monitoring, the reporting intervals, and the criteria for determining when a threshold has been exceeded. Some parameters will be monitored continuously or at higher frequency; for these, a weighting approach (time, flow, or importance) will be applied so that short-term fluctuations within acceptable limits are not treated as exceedances.

Site-based default actions will be based on the approach outlined in Table 7-5 below to investigate and take an appropriate response. The governance, roles and responsibilities will be developed to include the organisations accountable and responsible for the Desalination Plant operation as well as the regulatory aspects in subsequent revisions of this plan. Table 7-5 below omits external stakeholder, regulatory or lender reporting; Section 7.2.5.3.2 below provides more details.

Table 7-5: Triggering Events

Event level	Environmental triggering event	Operational triggering event	Site-based default action
Level 1	A Tier 1 Environmental monitoring threshold exceedance (no change at the control site)	A Tier 1 Operational monitoring threshold exceedance	Environmental triggering event: - Verify environmental (including control sites) and operational monitoring calibration Operational triggering event: - Verify the operational instrument calibration and confirm the process condition that caused the excursion - Check the corresponding environmental monitoring results, including control sites Common action: - If required, increase operational and/or environmental monitoring frequency
Level 2	Sustained Tier 1 environmental monitoring threshold exceedances within successive reporting intervals	Sustained Tier 1 operational monitoring threshold exceedances within successive reporting intervals	Common action: - Formal investigation by operations and environmental teams, corrective action plan and schedule developed - Management review and approval of investigation report, corrective action plan and schedule
Level 3	A Tier 2 environmental monitoring threshold exceedance	A Tier 2 operational monitoring threshold exceedance	Common action: - Immediate operational intervention - Formal investigation by operations and environmental teams, corrective action plan and schedule developed

Event level	Environmental triggering event	Operational triggering event	Site-based default action
			Management review and approval of investigation report, corrective action plan and schedule

7.2.5.3.2 Post-Investigation Response

This section establishes a graded hierarchy of six response options that will be selected for implementation following completion of the site based default actions and the investigation of the triggering event(s). The hierarchy provides the operations team, NCPC management, and external stakeholders with a common basis for deciding and describing action, and it converts the three triggering events in Table 7-5 into a defined and proportionate response.

Currently six response options have been identified, and the circumstances in which each is used are described in Table 7-6. The Operations and Maintenance Contractor will be responsible for implementation of the response at the desalination plant. The EPC Contractor's defects liability period or the vendor warranty and associated accountabilities for addressing defects is not included, and the approval and notification entities have not been finalised and should be considered indicative in Table 7-6.

The response options in Table 7-6 are indicative at this stage, NCPC will evaluate if additional expenditure and/or funding is required, coordinating with the appropriate stakeholders. The response options will be confirmed in conjunction with the Tier 1 and Tier 2 environmental and operational thresholds, with final governance and reporting lines in the final Adaptive Management Plan issued before commissioning will be agreed with applicable stakeholders before commissioning.

Table 7-6: Response Options

Response option	Scope and typical measures	Indicative timescale and internal governance
1. Operational adjustment and increased monitoring	Adjustment within the approved design and operating envelope, combined with additional monitoring to confirm the effect Typical measures include revised dosing rates and control setpoints for antiscalant, chlorine and sodium bisulfite; recalibration and verification of analysers; rescheduling of cleaning in place and of other intermittent discharges; an increase in environmental sampling frequency, stations or parameters	Immediate to days No capital cost and fully reversible Authorised by the Plant Operations Manager and recorded with the environmental function
2. Minor design change	Modification to installed equipment, instrumentation or the control system that does not alter Plant configuration or the discharge arrangement Typical measures include a change of chemical specification; additional or relocated analysers; dosing and neutralisation upgrades; revision of alarm, trip and control point values in the process control philosophy	Weeks to months Limited capital cost and reversible Approved by NCPC engineering and operations management Ministry of Water and Irrigation (MWI) approval

Response option	Scope and typical measures	Indicative timescale and internal governance
	Implemented under management of change and re-verified against the Design Verification Register described in Section 7.2.4	
3. Additional offsetting and compensation measures	Applied where monitoring confirms a residual effect on marine biodiversity that operational and design measures cannot prevent Typical measures include scaling up of the offset measures in the Biodiversity Action Plan; additional coral nursery; relocation or reef restoration effort; extended long term monitoring commitments; support to the management of the Aqaba Marine Reserve or other marine conservation initiatives to deliver quantifiable net gain Follows the conditional scale up approach being developed for the final Biodiversity Action Plan	Months to years Approved by NCPC senior management Requires budget approval MWI approval Approved by ASEZA and the Aqaba Marine Reserve Reported to and approved by the Lenders
4. Major design change	Modification to Plant configuration or to the discharge arrangement, where a sustained exceedance is shown to be inherent to the design Typical measures include modification of the diffuser or of the outfall ports; an additional or enhanced treatment stage, such as dedicated iron or solids removal or increased dechlorination duty; additional equalisation, blending or dilution capacity Requires detailed engineering, permitting and, where a new or changed impact arises, an addendum to the 2025 AAWDCP ESIA	Six to twenty-four months Significant capital cost Approved by NCPC senior management MWI approval Regulator and Lender approval
5. Partial Plant shutdown	Reduction in production rate, or removal from service of part of the plant such as one or more reverse osmosis trains, so that the discharge returns to within its thresholds while a response option 2, 3 or 4 is prepared and implemented May be applied for a defined period	Immediate to hours, for a duration set by the corrective action plan. Water supply and offtake implications. Approved by NCPC senior management, MWI approval Regulator and Lender approval
6. Full Plant shutdown	Cessation of production and of the discharge, reserved for a confirmed or imminent serious risk of harm to the receiving environment that no lower response option can control Executed under the Plant shutdown procedures, either automatically, where an operational trip setting is reached or by a management decision Restart requires demonstration that the cause has been corrected, and an agreement of the restart conditions	Immediate Approved by NCPC senior management, In coordination with MWI, the Regulator, ASEZA and the Lenders

7.2.5.3.3 Response Selection Principles

Selection of a response option will be governed by the following principles:

- Proportionality:
 - The response is matched to the severity, persistence and reversibility of the observed effect, and not to the fact of an exceedance alone
- Least intrusive effective response:
 - The lowest option capable of returning the monitored parameter to within its threshold is applied first, so that reversible measures are exhausted before measures that are irreversible, or that affect water supply
- Order of the mitigation hierarchy:
 - Avoidance and minimisation through response options 1, 2, 4, 5 and 6 are pursued ahead of offsetting
 - Response option 3 (additional offsetting and compensation measures) addresses the residual effects that remain once all other response options measures have been applied and does not substitute for them
- Attribution before escalation:
 - Control and reference site data from the BACI design described in Section 7.2.3 is used to confirm that an observed change is Project-related before response options 3 to 6 are invoked
 - Where attribution remains uncertain, and a Tier 2 threshold has been exceeded, the precautionary position is taken, and the response is not delayed
- Escalation where a response does not resolve the exceedance:
 - Where the environmental or operational parameter does not return to within its threshold in the period set by the corrective action plan, the response option will be escalated to the next applicable option
- Defined completion criteria
 - Every response will include defined completion criteria, monitoring evidence and the period required before completion is confirmed or, in exceptional cases, circumstances unable to be achieved, so that the Plant is not left indefinitely in a reduced or modified operating condition

7.2.5.3.4 Response Closure

Each triggering event will require a response option in Table 7-6 to be applied along with the escalation to follow if that default does not return the applicable threshold, within the period set by the corrective action plan.

A response is considered complete, and the Desalination Plant returned to its previous operating condition, only where the monitoring evidence supports it:

- For Level 1 triggering events: a monitoring result within its threshold range within the same reporting interval, together with confirmation that the operational condition is stable.

- For Level 2 and 3 triggering events, and for any response options 4, 5 or 6: the completion criteria will be defined in the corrective action plan and confirmed through the management review, with the affected indicator returned to within its Tier 1 range or lower and consistent with the control sites.

Each response, the evidence on which it was selected, and the decision to confirm its completion will be recorded so the hierarchy can be audited and the thresholds revisited, where evidence indicates they were set at the wrong value. This approach will support the Plan-Do-Check-Act cycle, and it may lead to changes to the thresholds or the monitoring programme rather than to the Desalination Plant.

7.2.5.3.5 Example Scenario: Salinity Related Triggering Event

The hypothetical example scenario presented below covers a single Level 1 triggering event from detection through to close-out:

- Salinity plume that does not behave as the modelling predicted - Tier 1 exceedance at a long-term station within the plume

Two thresholds are used throughout:

- Tier 1 threshold is the point at which a change has been detected, but there is no measurable harm to the reef; the example uses 42.7 psu.
- Tier 2 threshold is the point at which the change is outside the range seen at the baseline and reference sites and an adverse effect on the reef is detectable.

7.2.5.3.6 The Sequence of Events

- Step 1: A single reading above Tier 1 threshold
 - Routine environmental monitoring at a long-term station within the plume records a salinity reading above the Tier 1 threshold of 42.7 psu
 - At the same time, the Desalination Plant operational monitoring reports the discharge is within the defined operational thresholds
 - As only the environmental monitoring shows an exceedance, at this point there is no evidence that the Plant is at fault
 - The exceedance is classified as a Level 1 triggering event and is communicated internally
- Step 2: Level 1 triggering event site-based default actions implemented
 - The analyser at the affected station is recalibrated and its data is verified
 - The operational monitoring results are compared against the Plant's operational record, and sampling frequency is increased
 - The environmental monitoring control and reference stations are checked to confirm the change is not part of a wider natural event
 - If the result at the affected environmental station is within its threshold range within the same reporting interval, the event closes here
- Step 3: The exceedance is sustained
 - If the Tier 1 threshold is sustained within successive reporting intervals, the event becomes a Level 2 triggering event

- A formal investigation is completed, a corrective action plan is written with a completion date, and environmental monitoring intensity is increased
- Management reviews and approves the investigation report, the plan and its schedule.
- Step 4: Based on the investigation outcome, three potential responses are presented, and the investigation's findings determine which applies, noting a combination may be applicable:
 - Response option 1: The cause is inherent to the design. The diffuser or the outfall ports do not deliver the dilution the modelling assumed. The remedy is a major design change: modifying the diffuser or outfall ports, adding or enhancing a treatment stage, or adding equalisation, blending, or dilution capacity.
 - It requires significant capital cost, is approved by NCPC senior management with MWI, Regulator and Lender approval, and requires an addendum to the 2025 AAWDCP ESIA where a new or changed impact arises.
 - Response option 2: Impacts not considered in the 2025 AAWDCP ESIA and Biodiversity Action Plan, and no operational or design measure can prevent them. Additional offsets are selected:
 - Scaling up the offset measures in the Biodiversity Action Plan, for example, additional coral nurseries, relocation or reef restoration efforts, extended long-term monitoring, and support to the Aqaba Marine Reserve.
 - This requires budget approval and the approval of MWI, ASEZA and the Aqaba Marine Reserve, and is reported to and approved by the Lenders.
 - Response option 3: The Plant is behaving as designed, and the plume is where the modelling said it would be. The evidence points to the threshold value, or the monitoring arrangement rather than the Plant, and the right outcome may be to revise the threshold values or the monitoring programme rather than change the Plant. The decision is recorded, along with the supporting evidence.
- Step 5a: Escalation where a response does not resolve the exceedance
 - If the brine discharge salinity cannot be controlled to within acceptable thresholds in the time set by the corrective action plan, the response option will be escalated to the next applicable response option, e.g. partial shutdown and additional offsets and compensation measures.
- Step 5b: Response considered completed
 - Decision to confirm its completion will be recorded so the hierarchy can be audited and the thresholds revisited, where evidence indicates they were set at the wrong value. This approach will support the Plan-Do-Check-Act cycle, and it may lead to changes to the thresholds or the monitoring programme rather than to the Desalination Plant.

7.3 Roadmap: Next Steps

This Plan will be finalised in stages as the Project moves from the pre-Project Commencement date through detailed design to commissioning. The current high-level work plan is summarised in Table 7-7. As the survey and study results are received, the biodiversity monitoring programme will be designed on the completed baseline using the BACI structure, threshold values will be set, and the residual impact assessment finalised. The offset requirement and the approach to scaling up offset will then be

determined and integrated into the final Biodiversity Action Plan, in consultation with ASEZA and the Aqaba Marine Reserve.

In parallel, the engineering and procurement assurance gates will support selection of the operational controls, monitoring program, response mechanisms and timescales. In addition, governance and reporting for internal and external stakeholders will be finalised.

Table 7-7: Roadmap of Next Steps

Ref	Action required	Schedule
1	Confirm the design review milestones, HAZOP timing, verification responsibilities and prepare a revised tiered response plan	Before the design HAZOP
2	Specify the discharge monitoring package: review nutrient and iron measurement, and confirm analyser range, drift and calibration duty	Before vendor package freeze
3	Confirm the intake shock chlorination strategy, its dechlorination duty and by-product monitoring	Before the control point set is frozen
4	Design the biodiversity monitoring programme on the completed baseline: BACI stations, control sites, parameters and an a priori power analysis	On receipt of final survey analysis and interim settlement and coral exposure results
5	Set threshold values from the exposure and settlement study results, and finalise the residual impact assessment	On receipt of final survey analysis and interim settlement and coral exposure results
6	Determine the offset requirement and the conditional scale-up approach, and integrate in the final Biodiversity Action Plan, in consultation with ASEZA and the Aqaba Marine Reserve	After the final residual impact assessment
7	Issue the final adaptive management plan for operations, consolidating the confirmed parameters, Tier 1 and Tier 2 threshold values, response mechanisms, governance and reporting lines into operating procedures, monitoring schedules and alarm rationalisation	Before commissioning, agreed with the applicable stakeholders
8	Confirm the register of operational thresholds and integrate it with the Tier 1 and Tier 2 environmental thresholds into the process control philosophy and its fault hierarchy	Before the control point set is frozen
9	Confirm the six response options, and the default response option, escalation sequence, decision authority and completion criteria set against each triggering event	In line with item 6 in this table
10	Define the governance, roles and responsibilities for the response mechanisms, including the internal, MWI, Regulator, ASEZA and Lender notification and reporting routes	Before commissioning, agreed with the applicable stakeholders
11	Test the escalation sequence against the draft operating procedures and monitoring schedules, and confirm the recording and audit arrangements for each response	At O&M readiness and handover, before the final plan is issued

8 Translocation and Offset Strategy

8.1 Introduction

The design of the AAWDCP translocation and offset strategy supports the implementation of the mitigation hierarchy. The strategy aims to achieve at least No Net Loss, and preferably a Net Gain, in coral reef biodiversity and ecosystem function. The final Biodiversity Action Plan is currently being prepared and will translate the strategy presented in this section into a detailed programme of actions, responsibilities, monitoring, and reporting requirements.

This section focuses on two principal mechanisms proposed to address Project-related impacts on coral reef habitats (Table 8-1).

- The first is coral translocation, which is a mitigation measure used where impacts are temporary and reversible. Translocation involves salvaging and temporarily relocating corals and associated marine biota from areas affected by construction activities to a suitable recipient site. Once construction is complete and environmental conditions have been restored, the translocated corals may either be returned to their original location or retained at the recipient site if this provides a better long-term ecological outcome
- The second is coral transplantation, which forms part of the Project's offset strategy and is used to compensate for unavoidable residual impacts that remain after avoidance, minimisation, restoration and translocation measures have been applied. Transplantation involves establishing corals at suitable restoration or enhancement sites to restore degraded reef habitat, generate measurable biodiversity gains, and offset residual losses of coral habitat and ecological function

Although the primary focus is coral reef habitat, the AAWDCP recognises the importance of associated ecosystems, including seagrass habitats and other reef-supporting communities, and therefore adopts a broader ecosystem-based approach. The following section explains the distinction between translocation and transplantation, their respective objectives, and the circumstances under which the Project will apply each approach.

Translocation refers to the physical relocation of existing coral colonies from one location to another, typically to avoid direct damage from project activity. Translocation is primarily applied as an avoidance, minimisation, and restoration measure, and is therefore not an offset action:

- Corals and other biota are removed from an area that will be impacted (e.g., dredging, outfall installation, intake construction) to a safe, similar marine environment
- Entire colonies or large fragments are moved
- The objective is salvage and preservation to save existing corals from imminent destruction rather than to actively build a new reef from scratch
- Usually undertaken immediately before construction
- Success is measured by survival and continued growth of relocated colonies and their survivorship when re-planted on-site post-construction

Transplantation refers to intentionally planting coral fragments or nursery-grown colonies onto a reef, often off-site, to restore, rehabilitate, or offset impacts that cannot be mitigated (e.g. brine plume). Transplantation is therefore an offset activity to compensate for unavoidable residual impact:

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- Corals may originate from donor colonies, coral nurseries, or rescued colonies
- Usually involves attaching fragments to natural reefs, artificial substrates, reef balls, or restoration structures
- The objective is reef restoration or habitat enhancement
- Often conducted as part of a longer-term offset programme
- Success is measured by survival, growth, recruitment, and reef habitat development

Table 8-1: Key differences and rationale for translocation vs. transplantation

Aspect	Coral Translocation	Coral Transplantation
Primary purpose	Salvage existing corals	Restore or enhance reef habitat
Source of corals	Existing colonies in impact area	Donor reefs, nurseries, or salvaged corals
Timing	Before disturbance	Before, during, or after disturbance
Scale	Usually limited by footprint area	Can be much larger than impact area
Outcome sought	Avoid direct mortality	Increase coral cover and ecosystem function
Common use	Impact mitigation	Compensation/offsetting and restoration

For the AAWDCP, the following mechanisms will be used:

- Translocation: To mitigate the temporary loss of an area to an activity by removing biota to a temporary location for safekeeping until such time they can be returned to their original location, and
- Transplantation: To offset and compensate residual impacts

For both translocation and transplantation, following an assessment of international literature and manuals for coral restoration, and engagement with the Project support team based in Jordan, the following method sequence is recommended:

1. Site Assessment and Mapping: Identifying, mapping, and cataloguing coral colonies, noting coral substrate and coral colony locations, including depth and aspect (location with respect to reef/location features, other coral features)
2. Selection of recipient site: identifying habitat with environmental conditions - such as depth, water temperature, light, and current flow - closely matching the original site. Sites with similar topography and substrate with existing coral (demonstrates suitability of habitat for coral growth) will be prioritised
3. Coral Collection and Transport: Safely detaching coral colonies and including base substrate, where possible, and whole bommies (substrate with multiple coral colonies) and transporting them immediately to the prepared recipient site
4. Secure Attachment Methods: Fastening corals to the substrate or artificial structures with marine cement and in a position and aspect as similar as possible to that of the donor site
5. Monitoring: Record and tag colonies for monitoring to track survival rates, tissue integrity, bleaching responses, and ecological adaptation. Monitoring will include changes to associated biota (fish, invertebrates) to demonstrate ecological functioning success

As well as actions focused on coral reefs, other actions will be considered as part of an offset plan, see Section 8.6.1:

- **Habitat Protection Offset:** This includes protection of an area of coral reef, seagrass, and reef fish habitat that is currently unprotected but is under future development pressure. Potential actions that will be considered include establishing a reef conservation zone, restricting anchoring and fishing, installing mooring buoys and/or funding long-term enforcement and monitoring
- **Other reef environment offsets:** This includes restoring seagrass areas, developing reef resilience and climate adaptation measures and/or developing further capability and capacity for environmental management in Jordan

8.2 Regulatory Environment

8.2.1 Regulatory and Approval Framework

All relocation activities will comply with applicable Jordanian regulations and the conditions of the approved ESIA/permit packages. Execution requires written approvals from the competent authority for:

- Baseline survey deliverables
- Recipient site(s)
- Method statement and equipment plan
- Monitoring plan and reporting schedule

No field works will commence without clearance from relevant authorities.

8.2.2 Governance, Roles, and Responsibilities

Key roles will be aligned to ASEZA requirements and international good practice:

- **Coral Scientific Supervisor (CSS):** authority-approved marine biology/coral specialist who supervises detachment, handling, fixation, and monitoring design
- **Specialised Marine Works Contractor:** provides professional divers, vessels (tow + escort), cages, lift bags, and Health, safety and environment (HSE) management
- **Competent Authority / Reserve Management:** approves sites and methods, provides direct oversight, and receives monitoring program handover

8.3 Intervention Option Selection

Intervention options for each impacted area depend on whether the impact is persistent or transient and/or whether the affected area is accessible for diver activity. Currently, three categories of impact areas are envisaged:

1. For areas inaccessible to divers and subject to persistent impacts, translocation is not an option, and any efforts to restore losses on-site will fail as a consequence of the persistent nature of the impact. Such sites will be compensated/offset off-site, and a component of this will be the restoration of diver accessible degraded sites through transplantation using farmed and/or donor site corals

2. For areas accessible to divers and subject to persistent impacts, transplantation is an option. Here, corals and other biota that would otherwise be permanently lost will be salvaged and used to restore an off-site degraded area
3. For areas accessible to divers and subject to non-persistent impacts, translocation is an option. Here, corals and other biota that would be otherwise destroyed or degraded by an activity will be removed to a safe haven until such time they can be returned on-site

8.3.1 Recommended Interventions

Based upon the location and nature of the impact, translocation and/or transplantation can be presented as part of a compensatory mix.

1. Seawater Intake Area: Although diver accessible (maximum depth impacted is 25 m), the persistent nature of the impact (deflection direction of current flow) and the recipient (coral larvae) suggest that on-site mitigation is not appropriate. This is because the area is not substrate-limited for larval settlement, suggesting that natural recruitment and/or survivorship are already low; therefore, any on-site intervention is unlikely to be successful. Furthermore, the impact is not expected to have any direct material impact on the existing coral population, so coral cover and larval settlement are expected to maintain the existing coral habitat. The recommendation is to monitor coral settlement before and during operations, coupled with benthic habitat monitoring, to confirm impact from seawater abstraction operations. However, because some entrainment of coral larvae is expected from a small area of reef fronting the inlet lagoon mouth, an offset can be calculated based on the affected area and the settlement success rate (i.e., the settlement potential loss) derived from settlement-rate monitoring. The calculation will provide the likely loss of new colonies per unit area per year to the affected habitat, which can be offset by adding transplantation to selected degraded coral habitat. Settlement enhancement at this site can be enhanced through the installation of artificial structures (settlement devices) designed to create microhabitats that are suitable for coral larval settlement and recruitment. These structures can incorporate small crevices and sheltered surfaces where local water flow is reduced, facilitating larval retention and settlement. Following successful settlement, the sheltered microhabitats can provide favorable conditions for the establishment and early development of new coral colonies, potentially increasing their survival during the vulnerable early life stages.
2. Construction area: This area is accessible to divers, one portion of which is subject to a non-persistent impact during construction and will not be affected by the brine plume, and a second portion may be subject to the construction impact associated with installation of the diffuser, which will overlap with the persistent impact from the brine plume; this will be confirmed prior to construction. Here, the options are to use translocation for the area affected by construction activity only, and to use corals and biota from the area that will also be subject to the brine plume as salvaged coral for transplantation to restore an off-site degraded site. Some of the corals identified for translocation could be relocated within the same site, particularly to suitable buffer areas between the construction and intake zones that are not expected to be affected by brine discharge, construction activities, or water abstraction. This approach would retain the corals within their original environmental setting while reducing the need for relocation to external sites. In addition, internal translocation could help maintain and enhance coral biodiversity within the site and support the ecological continuity of the existing reef habitat.
3. The brine plume in this area can be split into two discrete zones:

- a) Diver accessible zone: The area in water depths of 30 m to 14 m can be used as a source of salvaged coral for transplantation to restore an off-site degraded site
- b) Diver inaccessible zone: For depths deeper than 30 m, translocation or transplantation of coral and other biota is not feasible. Here, options include identifying donor sites and/or establishing coral farming capacity to restore an equivalent area of degraded reef to the loss of coral habitat affected by the brine plume.

8.4 Implementation Plan

Translocation and transplantation require a suite of supporting activities and background information.

8.4.1 Translocation Areas

Translocation mitigates the temporary loss of an area to an activity by moving biota to a temporary location for safekeeping a “safe haven” until they can be returned to their original location. Translocation will involve separate activities in the ‘donor’ area in this case the Construction area and the ‘Safe haven’ area:

- Construction Area where impacts are temporary: Here, precise spatial surveys to produce a site map are required to identify corals and substrate suitable for translocation, specifically recording:
 - Depth and orientation of individual corals and substrate
 - Photo/video catalogue (fixed-angle per colony where feasible) to provide a colony-level inventory (unique ID, taxa/morphotype, size class, health score, substrate type)

A plan will be made for the transport of colonies/substrate from the Construction Area to the Safe Haven Area with the primary aim to minimise exposure to air and time out of water; this will include:

- Detachment and underwater packing: Divers will detach colonies using the least destructive tools suited to substrate and growth form. Colonies will remain submerged at all times and will be placed immediately into underwater metal cages. Separators will be used where required to prevent abrasion
- Lift-bag suspension and towing: After cages are filled, lift bags will be used to raise and suspend cages for transport. Suspended cages will be connected to a large tow vessel (tug) and escorted by a small boat carrying divers. Tow speed will be minimised to prevent oscillation and contact damage; routes will avoid reef contact
- Safe Haven Area: This will harbour corals and other biota during the construction phase until conditions allow corals and other biota to be returned and re-established. Relocation to the safe haven will be for individual coral colonies that require substrate (either natural or man-made) for placement, or for whole pieces of substrate with attached coral and other biota that need to be stably established on the seabed. Here, site selection will aim to replicate as closely as possible the physical and hydrological conditions of the construction area. The area will be:
 - A degraded site where the cause/source of degradation has been removed and the site previously hosted healthy coral, other biota and reef, or
 - An area with healthy coral and substrate where there is space to host the translocated material without disturbing the resident biota

Prior to translocation, the precise positioning of translocated colonies and substrate will be identified, and man-made substrate will be pre-positioned to receive individual colonies that will be attached with marine cement. A plan will be made for the sequence of colony/substrate movement and will include the unloading and fixation procedure and post-fixation recording/photography referenced to the colony/substrate ID.

Once construction activity has ceased, colonies and substrate will be returned to the Construction Area by the reverse process, ensuring that they are re-established at their original locations and aspect. If the original location no longer exists, those colonies/substrate will be relocated on-site and/or considered as a contribution to transplantation options. The success of returning colonies, other biota and substrate to their original footprint is only viable if the construction activities do not fundamentally alter the site's environmental profile and the original substrate remains in its original state.

It should be noted that there is both spatial and temporal separation between the construction area and the intake (water abstraction) area. Construction and dredging activities are scheduled to commence at the beginning of the project, whereas operation of the intake is expected to begin approximately four years after project commencement. This time interval provides a potentially valuable opportunity for the temporary translocation of corals from areas that will be affected by construction activities to suitable areas within the future intake zone.

Following completion of the construction and dredging activities, the translocated corals could be returned to suitable locations within their original habitat, subject to site conditions and the condition of the colonies at that time. This approach would allow the corals to remain within the same broader environmental settings, with only a relatively limited spatial displacement during the construction period.

Such a temporary translocation strategy could reduce the distance over which corals need to be moved, potentially minimizing handling and acclimation stress. It may also reduce logistical requirements, time, and costs associated with permanent translocation to external sites, while potentially improving translocation success by maintaining the corals within their original environmental conditions. Excess corals can be used for offsetting activities in other sites.

8.4.2 Transplantation Areas

Transplantation areas consist of two discrete locations, namely:

- off-site degraded area(s) to be restored, and
- nursery location(s) for the farming of coral (and possibly other biota) to be transplanted out onto degraded sites for offset/compensatory habitat restoration

Key features that will be considered when planning a transplantation activity are:

- Colony size: Larger colonies generally survive handling and transport stress better than small fragments
- Growth forms: Massive and encrusting corals feature thick skeletons that resist physical trauma and yield higher survival rates. Conversely, branching corals grow rapidly but suffer high post-transplant mortality due to fragility and vulnerability to environmental shock
- Handling and transport stress: Physical shock, air exposure, and temperature changes during transit lead to stress and reduce survival rates
- Attachment method: Seabed cementation generally provides better long-term structural stability against heavy wave action than temporary artificial frames

- Ecosystem mismatch: Recipient areas must feature matching water quality, light penetration, and wave energy, ideally situated safely away from the construction sediment plume. Moving corals to a recipient site does not transfer the complex 3D reef framework or associated biodiversity, making it an incomplete ecological offset

8.4.2.1 Selection of Restoration Offset Sites

Off-site offset sites are required because the impact cannot be mitigated (made less intense or less damaging), and the on-site area therefore requires offsetting. Off-site area selection depends on the size of the area requiring offsetting and the suitability of an off-site area to provide a high probability of successful restoration. The following steps will be completed during the offset site selection process:

1. Calculating area to be offset: The biota of concern is coral. The quantity of coral potentially lost will be calculated as: $\text{Area impacted} \times \% \text{ hard substrate} \times \% \text{ coral cover} = \text{square metres of coral to be restored off-site}$
2. Determining the area to be restored: Determination of the area required
3. Based on the off-site area required, degraded sites will be screened for their suitability as candidate restoration sites. The intention is to gather enough information at each candidate site to judge whether it is suitable for coral restoration or enhancement work, and to allow sites to be compared consistently. Surveyors will record findings against each criterion below, along with supporting photographs or video where practical. The criteria to be assessed are:
 - a) Overall Area: The approximate area of the site under consideration will be recorded in square metres. Where the boundary is not clearly defined by natural features, the basis for estimation of the extent will be noted (for example, from a swim transect, drop camera survey, or existing chart data) so that the figure can be checked or refined later
 - b) Depth Range: The minimum and maximum depth across the site will be recorded. Where depth varies significantly across the area, the locations where shallow and deep extremes occur will be noted, as this will affect light penetration, wave energy, and the range of coral species likely to be suitable
 - c) Three-Dimensional Topography: Notes will be made on whether the site has structural relief, such as ridges, overhangs, bommies, or crevices, or whether it is predominantly flat. Structural complexity generally supports higher biodiversity and can influence how restoration structures are sited and anchored, so this will be described rather than simply marked present or absent
 - d) Ratio of Hard to Soft Substrate: An approximate percentage split between hard substrate (rock, reef pavement, rubble) and soft substrate (sand, silt, mud) will be provided. This will be estimated visually along transects rather than measured precisely, but the basis for the estimate will be recorded
 - e) Stability of Hard Substrate: An assessment will be made of whether the hard substrate present is stable or prone to movement, for example, loose rubble that shifts under wave or current action. Unstable substrate is generally unsuitable for coral attachment or fixing of restoration structures, so this point will be addressed directly rather than assumed from the substrate ratio alone
 - f) Cause of Degradation: The cause of past damage or decline will be recorded. This will include storm damage, anchor damage, sedimentation, thermal stress, disease, or physical removal

of structure (for example, from a wreck or other impact). Where the cause is uncertain, the working assumption and the evidence it is based on will be noted

- g) **Whether the Source of Degradation Has Been Removed:** Whether the original cause of degradation is still active at the site or has ceased will be recorded. A site where the pressure is ongoing, such as continued sedimentation or repeated physical disturbance, is a poor candidate for restoration until that pressure is addressed, regardless of how favourable the other criteria are
- h) **Presence of Coral:** Presence of any live coral will be recorded, and, where present, an approximate indication of cover, the dominant genera or growth forms observed, and their apparent condition will be noted. This will establish the baseline against which any offset or restoration work will be measured and will indicate preferred coral types for transplantation
- i) **Macroalgae Cover on Hard Substrate:** Whether macroalgae is present on hard substrate will be recorded, and, if so, notes will be made on whether it appears to be overgrowing or smothering the substrate to a degree that would compete with coral settlement or survival. Heavy macroalgal cover is a useful indicator of nutrient or grazing pressure and will be flagged as a potential constraint on site suitability
- j) **Evidence of Coral Settlement:** Signs of natural recruitment, such as juvenile coral colonies or recent settlement on hard or stable substrate, will be sought. This is a useful indicator that conditions at the site remain broadly favourable for coral, even where existing cover is low, and will be recorded separately from the presence of established coral colonies

Each criterion will be recorded per site using a consistent template, supported by georeferenced photographs and, where possible, video transects. A short summary judgement on overall suitability will be added once all criteria have been assessed, but this will be kept separate from the raw observations so that the underlying data remains usable if the assessment criteria are revisited later.

8.4.2.2 Establishing Coral Farm Nursery

The primary objective of a coral nursery is to cultivate healthy coral fragments under controlled field conditions until they reach a suitable size for transplantation to restoration sites. Successful nursery programmes require careful planning, appropriate site selection, effective husbandry practices, and long-term monitoring to ensure high survival and growth rates. The following aspects will be considered:

- **Nursery location:** The nursery will be established in an area that mirrors, as closely as possible, selected restoration sites for biophysical and hydrological conditions
- **Collection and maintenance of donor coral:** Some donor corals will be available from the construction site area, but the majority will need to be collected from the local reef ecosystem. Particular attention will be given to matching donor and recipient habitats and maintaining nursery conditions that reflect local reef environments. Donor colony selection will represent a mix of growth forms and taxa that mimics healthy reef environments, such as those surveyed in the Project baseline survey. Donor colonies will be spatially separated, and only a small proportion of each colony will be removed to minimise impacts on the natural reef. The programme will maintain detailed records of donor locations, colony condition, and species. Fragments will only be taken from healthy donor colonies showing no evidence of disease, predation, or bleaching. Fragment sizes typically range from 5 to 15 cm for branching corals and 3 to 6 cm for massive species. Collection will use sterilised equipment to minimise the risk of disease transmission. Following collection, fragments will be attached to nursery structures using

appropriate mounting methods and allowed to recover and grow under natural environmental conditions

- Nursery design: Nursery structures will be appropriate for the environment in which they are installed and cognizant of depth, stability and coral type. Rope and tree nurseries are commonly used for branching corals. Table nurseries are often used for massive coral species that require greater stability. Structures will be securely anchored and will not be installed directly on living coral habitat. Each coral fragment will be labelled and tracked within a nursery database to allow monitoring of provenance, growth, and survival
- Assessment of nursery success: Key indicators, including survival rates, growth rates, colony size, bleaching incidence, disease prevalence, and overall coral condition, will be assessed to evaluate the viability of corals in the nursery. Monthly assessment will take place during the first six months of operation, followed by quarterly assessments thereafter
- Harvesting and outplanting: Corals will be harvested once they have reached a suitable size for transplantation. Nursery residence times commonly range from 6 to 12 months for fast-growing branching corals and up to 24 months for slower-growing massive species. Outplanting will occur during periods of low thermal stress and calm weather conditions. During transport to degraded sites, corals will be kept in seawater and any aerial exposure minimised. Corals will be attached to restoration sites using marine cements.
- It should be noted that there is considerable cumulative experience in coral nursery and coral husbandry practices among local experts in Aqaba. For example, the Marine Science Station (MSS) has extensive experience in coral nursing, both *in situ* and in land-based raceway systems within its laboratory facilities. These coral nurseries have been used for scientific research as well as for the restoration of damaged coral reefs.
- In addition, ASEZA operates coral nurseries that have been used to culture coral fragments collected from areas affected by previous construction activities. This established local expertise and existing infrastructure provide a strong practical basis for incorporating coral nurseries into the project's offsetting strategy. The availability of experienced personnel and locally established nursery techniques should facilitate the implementation and management of nursery-based coral restoration activities.

8.4.2.3 Restoration Site Preparation

Before out-planting from a coral nursery, the substrate will be checked for stability, and structures will be installed to replace any lost 3-dimensional topography. Structures will be installed sufficiently ahead of receiving donor colonies so that surfaces are conditioned. Based on the nursery database, a clear out-planting schedule will be established to minimise disturbance and the time between the nursery and the out-planting location.

8.5 Monitoring

For both translocation and transplantation activities, monitoring is required to demonstrate restoration success. Monitoring will be undertaken at one, three, six, and twelve months post-transplantation, followed by annual assessments. Indicators will include survival, colony growth, coral cover, structural complexity, juvenile coral recruitment, and evidence of reproductive activity. The monitoring criteria will be designed to maintain the integrity of a Quality Hectare designation over time that evaluates activities against goal-based metrics, see Table 8-2.

Table 8-2: Monitoring Metrics

Metric	Short-Term Focus (1–2 Years)	Long-Term Focus (5–10+ Years)
Survival & Growth	Fragment attachment success, initial skeletal growth	Self-sustaining colony growth, structural rugosity
Ecosystem Function	Low macroalgae competition at out-plant points	Natural larval recruitment, return of grazing fish biomass
Resilience	Minimal bleaching during minor thermal anomalies	Adaptation and survival through severe marine heatwaves

8.5.1 Determining Success

Determining success requires monitoring features to be assessed against targets and/or standards that allow metric to be measured against survivorship and quality indices.

8.5.1.1 Survival

A global synthesis of coral restoration projects noted that typical short-to-medium-term coral survival stabilises between 60% and 77% and is highly dependent on coral type and local substrate and environmental conditions. Survival rates in highly regulated and managed projects can achieve higher survival rates, and notably a project at the Aqaba Marine Park achieved 88% over a 2 year period. For a translocation project, where background environmental conditions are generally favourable for coral health and corals would be returned to their original reef after construction, a reasonable planning assumption for success is provided in Table 8-3 (Kotb et al., 2015; Kotb, 2016)

Table 8-3: Coral Translocation Survival Rate Assumptions for Typical Favourable Environmental Conditions

Outcome	Survival Rate
Excellent implementation	90-95%
Typical well-managed project	80-90%
Challenging conditions	60-80%

For environmental impact assessment and offset calculations, regulators often consider anything above 80% post-return survival as evidence of a successful translocation program, with additional replacement or restoration measures triggered if survival falls below this threshold.

For a coral transplantation project (where corals are permanently moved to a new recipient site rather than returned to their original location), success rates are typically lower and more variable than for temporary translocation because corals must adapt to a different environment and substrate. A reasonable planning assumption for success is provided in Table 8-4.

Table 8-4: Coral Transplantation Survival Rate Assumptions for Recipient Site Relocation

Performance Category	1-2 Year Survival Rate
Excellent project	80-95%
Typical well-managed project	70-85%

Performance Category	1-2 Year Survival Rate
Moderate success	50-70%
Poor site selection or high environmental stress	<50%

These ranges align with findings that transplanted colonies can achieve high survival when recipient sites closely match donor-site conditions, while survival declines when environmental conditions are suboptimal.

For both translocation and transplantation, a reasonable planning assumption for success based on the growth form of coral is provided in Table 8-5.

Table 8-5: Assumed Coral Translocation and Transplantation Success Rates by Coral Growth Form

Coral Type	Expected Survival
Massive corals (Porites, Favia, Favites)	80-95%
Encrusting corals	75-90%
Branching corals (Acropora, Pocillopora)	60-85%
Delicate branching species	50-80%

Larger colonies often have better long-term survival than small fragments, although handling becomes more complex.

8.5.1.2 Quality Indices

Metrics to determine quality indices beyond just survivorship will be based on four core operational and ecological layers:

1. Coral Indicators (health) to assess individual coral performance and structural integrity:
 - a) Attachment Success Rate: Percentage of colonies remaining securely fixed to the receiver reef substrate
 - b) Bleaching and Tissue Mortality Index: Percent surface area of translocated coral displaying bleaching, tissue loss, or disease
 - c) Linear/Skeletal Growth Rate: Average change in colony size (length, width, or volume) over time to confirm adaptation to new environment
2. Population and Community Indicators to measure whether the translocated corals are scaling up to form a functioning ecosystem:
 - a) Live Coral Cover Change: The absolute percentage increase in hard coral coverage across the receiver reef
 - b) Macroalgae to Hard Coral Ratio: The ratio of benthic space occupied by fleshy algae versus live coral to demonstrate environmental quality
 - c) Spawning and Fecundity: Presence of gamete release during annual synchronous spawning events to indicate transition from a managed project to a self-sustaining wild population
3. Ecosystem Function Indicators to indicate restoration of broader ecosystem services:
 - a) Structural Complexity (3D Rugosity): The physical three-dimensional habitat architecture generated by the translocated corals

- b) Fish Abundance and Biomass: To confirm that the coral is providing critical habitat and nursery grounds
- c) Invertebrate and Cryptobenthic Biodiversity: Recruitment of associated reef fauna like sea urchins, crabs, and bivalves indicates a healthy and functioning reef structure
- 4. Adaptive management to provide husbandry of coral relocation to include:
 - a) Monitoring attachment success and re-attaching as necessary
 - b) Algal sweeps to manually remove algae if algal canopy exceeds 20% around outplants

8.6 Offset Selection

The selection of off-site areas suitable to offset/compensate for residual impacts will be evaluated according to a hierarchy of options, from those ecologically closest to the impacted habitat to those that provide broader ecosystem gains.

8.6.1 Determining Preferred Approach

The hierarchy will prioritise measures that maximise ecological equivalence, likelihood of success, and long-term conservation outcomes:

- Adjacent reef environments: Where residual losses remain after restoration of the impact site, enhancement is undertaken on nearby reefs within the same ecological unit. Examples include:
 - Coral transplantation to adjacent degraded reef
 - Coral nursery production and out-planting
 - Rubble stabilisation
 - Enhancement of reef structural complexity
 - Removal of local stressors
 - Advantages of the approach include similar water quality and hydrodynamic conditions, maintenance of local genetic diversity and preservation of local ecological function
- Habitat Creation and Reef Rehabilitation: Where sufficient restoration opportunities do not exist nearby, new habitat may be created or severely degraded habitat rehabilitated. Examples include:
 - Artificial reef deployment
 - Restoration of historic reef areas
 - Creation of substrate suitable for coral recruitment
 - Coral gardening and large-scale out-planting
 - Advantages of the approach include potential to generate substantial habitat gains and support of long-term reef expansion. Challenges of the approach include a long time lag before ecological equivalence is achieved and greater uncertainty
- Supporting Habitat Restoration - Restore habitats that directly support coral reef ecological function. Examples include:
 - Seagrass restoration

- Fish nursery habitat enhancement
- Water quality improvement measures
- The approach can benefit reef fish communities, support nutrient cycling and sediment trapping, and enhance overall ecosystem resilience. However, the approach does not directly replace coral habitat and requires demonstration of functional linkage
- Landscape or Seascape Scale Conservation Actions - Protection or enhancement of larger reef systems to produce measurable conservation outcomes. Examples include:
 - Establishment of no-anchor zones
 - Expansion of marine protected areas
 - Crown-of-thorns control programs
 - Mooring buoy installation
 - Fisheries management programs
 - The approach often provides durable conservation benefits and may generate significant biodiversity gains. Limitations of the approach include demonstration of additionality and difficulty in quantification of benefits.
- Out-of-Kind Marine Biodiversity Offsets - Used only when direct coral reef offsets are demonstrably unfeasible. Examples include:
 - Protection of other marine habitats
 - Large-scale biodiversity conservation programs
 - Regional ecosystem resilience initiatives
 - Challenges with this approach include the need to provide equivalent biodiversity value, strong scientific justification, and usually high offset ratios.
- An additional offsetting measure that could be considered is investment in local capacity building and scientific research related to coral conservation and restoration. This could include supporting postgraduate training in coral ecology, monitoring, restoration, and rehabilitation techniques, as well as sponsoring targeted scientific research to improve coral restoration practices and better understand the factors affecting coral health and recovery.
- Such initiatives would provide longer-term benefits by strengthening local scientific capacity, developing a new generation of coral conservation specialists, and supporting the continued development and application of effective coral restoration and rehabilitation approaches in the Gulf of Aqaba.

To assess options across multiple hierarchy levels, a weighted scoring matrix will be used to compare alternatives.

8.6.2 Site Selection

The AAWDCP includes a range of impact areas that encompass shallow and deep-water environments. Preliminary surveys of the deep brine plume area indicate that it may be heavily sedimented with low-relief rock and limited biotic cover. This is likely to constrain any direct restorative actions in like-for-like sites and deliver little biological and/or habitat gain. Although like-for-like is a preferred option, for deep-water locations, direct deep-water restoration has not been elected as the preferred offset option due

to significant technical constraints, lower implementation certainty, limited demonstrated restoration success at depths exceeding 30 m, and reduced monitoring feasibility. Instead, sites have been sought where degraded sites effectively provide potential gaps to ecologically connected shallow reef habitats within the Jordanian reef system. Site selection was based on habitat similarity, larval connectivity, biodiversity value, climate resilience, and the capacity to achieve quantifiable biodiversity gains exceeding the predicted residual loss within the deep-water plume area.

Effectively pooling the requirement for deep water offsetting/compensation within assessment and evaluation for shallow reef requirements provides ecological equivalence through replacement of reef biodiversity function and ecosystem service value to Jordanian reef systems rather than strict depth-for-depth habitat replacement.

Surveys have been made of six candidate sites suitable for receipt of coral transplants provided by the Aqaba Special Economic Zone Authority (ASEZA).

8.6.2.1 The Cornishe Site

This site was subject to the construction of a commercial tourist facility directly located on the shoreline (Figure 8-1). It was reported that the owners have used rocks to reclaim part of the seafront during the construction process. Dumping of rocks into the sea caused complete damage to all reef structures located within the site.

Figure 8-1: The Cornishe Site Tourist Facility



Underwater, the site is characterised by extensive rock material dumped along the seabed, with the rock structures extending from the shallow coastal zone to approximately 30 m water depth (Figure 8-2). The diving inspection confirmed that a substantial proportion of the exposed rock surfaces provide stable hard substrate suitable for coral transplantation. The relatively complex structure of the rocks provides attachment surfaces and vertical and inclined faces that could potentially accommodate transplanted coral colonies.

Figure 8-2: Large Area of the Seabed was Completely Covered by the Dumped Rocks



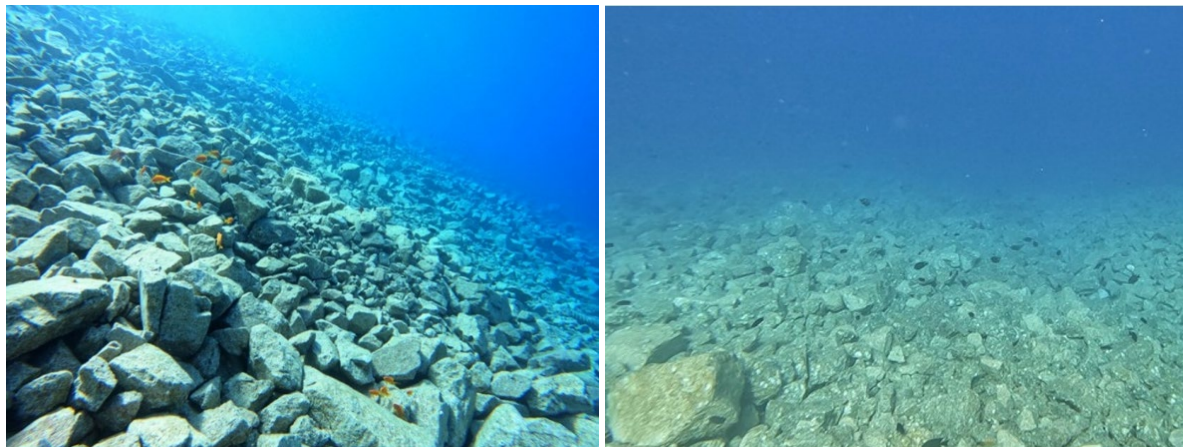
A preliminary estimate indicates that approximately 8,000–10,000 m² of area may be available for the proposed transplantation and offsetting activities. However, the exact available area and detailed seabed topography require further verification through additional field surveys and mapping. The site provides a broad depth gradient extending from the shoreline to approximately 30 m depth. This is particularly advantageous for the proposed coral transplantation program, as it allows transplanting donor colonies into recipient areas at depths comparable to those from which they are collected. Maintaining similar depth conditions between donor and recipient locations can reduce environmental differences and facilitate the acclimatisation and establishment of transplanted colonies.

During the Self-contained underwater breathing apparatus (SCUBA) inspection, several coral colonies were observed in close proximity to the rock areas, including colonies that are naturally growing there or had been transported to the site. These colonies exhibited generally healthy morphological characteristics and tissue condition (Figure 8-3). Fish communities were also observed occupying the site, apparently using the rocky structures as refuge and potential nursery habitat, while some species are known to feed on algae growing on the rock surfaces (Figure 8-4). These observations indicate that the existing rocky substrate is already providing ecological functions and is being utilised by marine organisms.

Figure 8-3: Coral Colonies are Growing within the Site, Indicating a Healthy Environment that Supports Coral Life



Figure 8-4: Fish Communities Inhabiting the Rocky Area



An important observation during the inspection was the presence of new coral recruits naturally established on the surfaces of the dumped rocks (Figure 8-5). The occurrence of naturally settled coral recruits is a positive ecological indicator, showing that corals are colonising the available hard substrate under the prevailing environmental conditions. Natural recruitment also suggests that the site may provide suitable conditions for coral settlement and, potentially, for the establishment and long-term survival of newly transplanted coral colonies.

Figure 8-5: New Coral Recruits on the Rocks' Surfaces were Recorded During the Inspection



From a coral transplantation perspective, the combination of stable hard substrate, evidence of natural coral recruitment, existing coral colonies and fish utilisation, and a broad depth gradient makes the Corniche Site a potentially suitable recipient location for transplantation and offsetting activities. Nevertheless, before final selection, further quantitative assessment is recommended, including evaluation of substrate stability, coral recruit density, existing benthic community composition and cover, sediment accumulation, water movement, turbidity, and other relevant environmental parameters. These assessments will support the final suitability evaluation and prioritisation of the site relative to the other candidate locations.

8.6.2.2 Berenice Site

The second inspected site is within the marine reserve and close to a resort called Berenice. SCUBA diving observations indicated that the area contains a heterogeneous benthic environment comprising established coral reef habitats, well-developed seagrass meadows, and sandy-bottom areas (Figure 8-6 and Figure 8-7).

Figure 8-6: Huge Healthy Reef Structures with Massive Colony Sizes are Seen in the Site

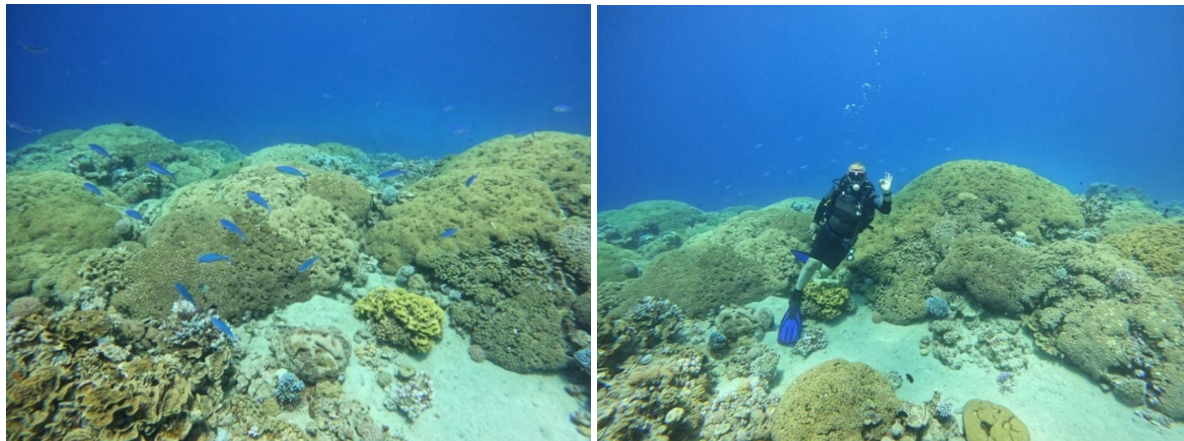


Figure 8-7: Sandy Seabed and Seagrass Meadows are Found in the Site

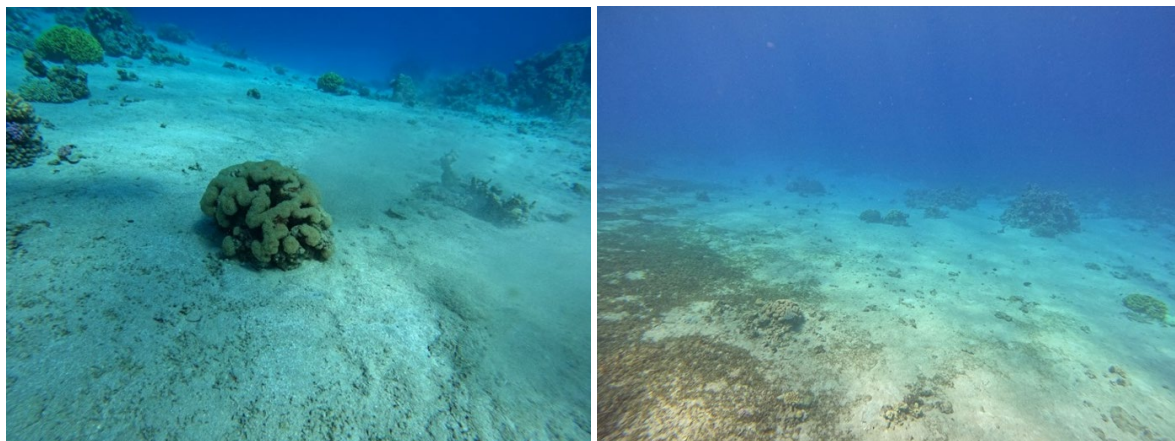
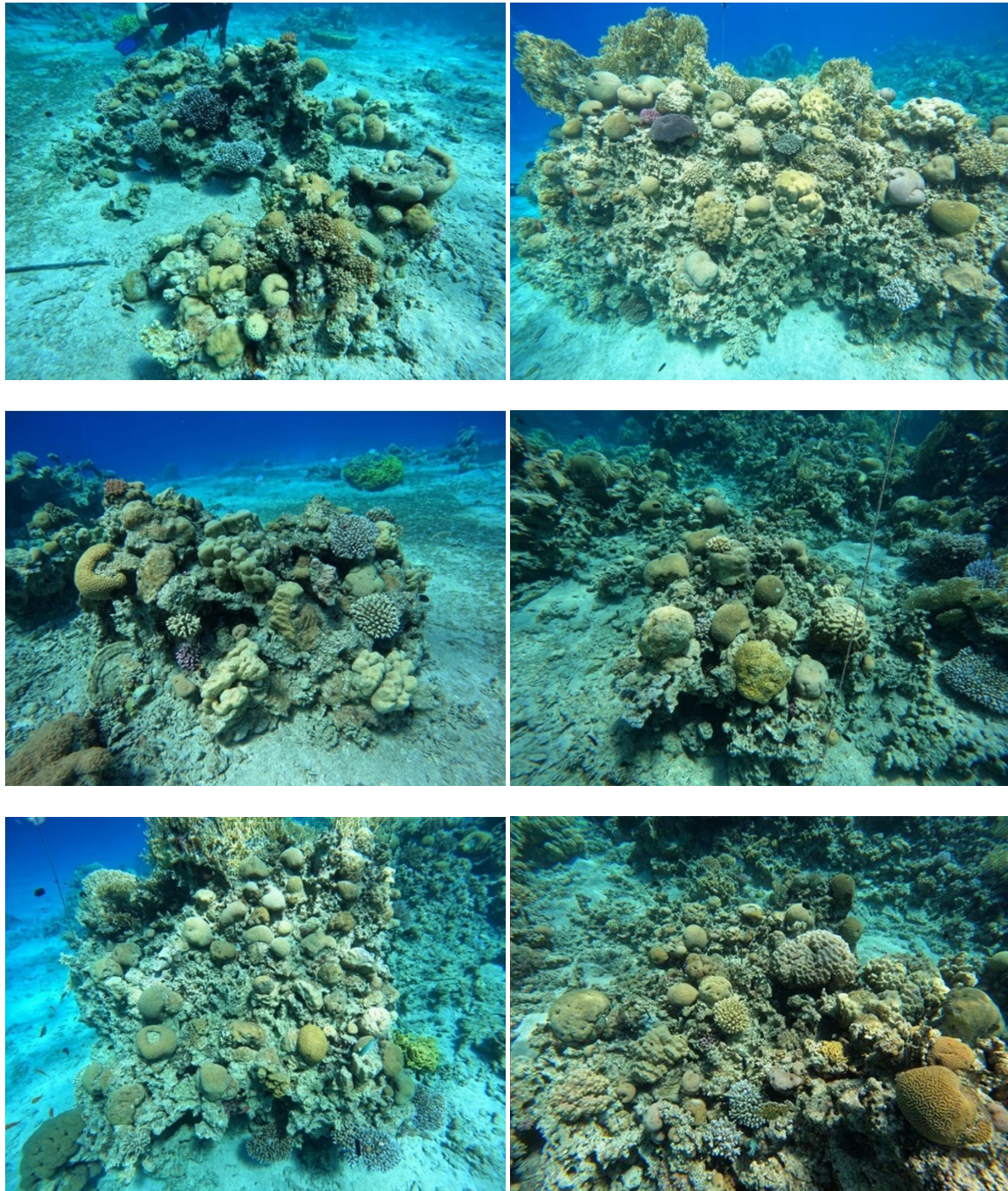


Figure 8-8: Transplanted Corals in the Site are Looking Healthy after 9 months of Translocation



The existing coral reef areas indicate that the site supports established coral communities under the prevailing environmental conditions. Healthy seagrass meadows are also an important ecological feature and will be considered when determining transplantation locations to ensure restoration structures are not placed within, or do not unnecessarily disturb, existing seagrass habitat.

The site also contains sandy-bottom areas that may be suitable for installing dedicated coral transplantation structures. These areas could provide an opportunity to establish transplantation units without directly modifying existing coral colonies or seagrass meadows. Using these areas would allow

the restoration activity to increase coral habitat while maintaining the integrity of existing natural habitats.

Another significant feature of this location is the presence of areas where coral transplantation has previously been conducted (Figure 8-8). These areas provide an opportunity to evaluate the performance of earlier transplantation activities, including colony survival, attachment and growth, and the development of associated benthic communities. The previous transplantation areas could therefore provide valuable baseline information for designing and optimising future offsetting interventions.

A comparison was made between the coral colonies transplanted approximately nine months ago, in January 2026, and the same colonies observed during the current inspection conducted in September 2026. The field observations indicate that the transplanted colonies have maintained generally good condition, with an estimated survival rate of more than 90 % (Figure 8-9). This preliminary assessment suggests high survival and successful establishment of the transplanted colonies during the first nine months following transplantation.

Figure 8-9: Coral Colonies Transplanted During January 2026 (Left) and the Same Colonies During September 2026 (Right)



8.6.2.3 Royal Yacht Club (RYC)

The seafront boundary of the RYC is primarily formed by a rock-armoured breakwater wall, extending along the seafront face of the RYC (Figure 8-10). The marine area associated with the site is estimated to cover approximately 15,000 m², with water depths ranging from approximately 2 m near the shoreline to 20 m offshore.

Figure 8-10: Breakwater Wall at the Royal Yacht Club Site



The seabed within the inspected area comprises a combination of different seabed structures including: (Figure 8-11 to Figure 8-13)

- Sandy-bottom habitats
- Seagrass meadows
- Scattered patches of hard corals
- Artificial structures in the form of concrete blocks

The concrete blocks have previously been deployed within the site to function as artificial reef structures. They are currently distributed relatively sparsely across the seabed, providing additional hard substrate within an otherwise mixed soft-bottom habitat.

The rock surfaces forming the breakwater also exhibit existing biological colonisation, including coral growth and evidence of new coral recruits (Figure 8-14). This indicates that the available rock substrate can support coral settlement and growth under the prevailing environmental conditions.

Figure 8-11: Sandy Bottom (Top) and Seagrass Meadows (Bottom) are Found in the RYC Seabed Habitat

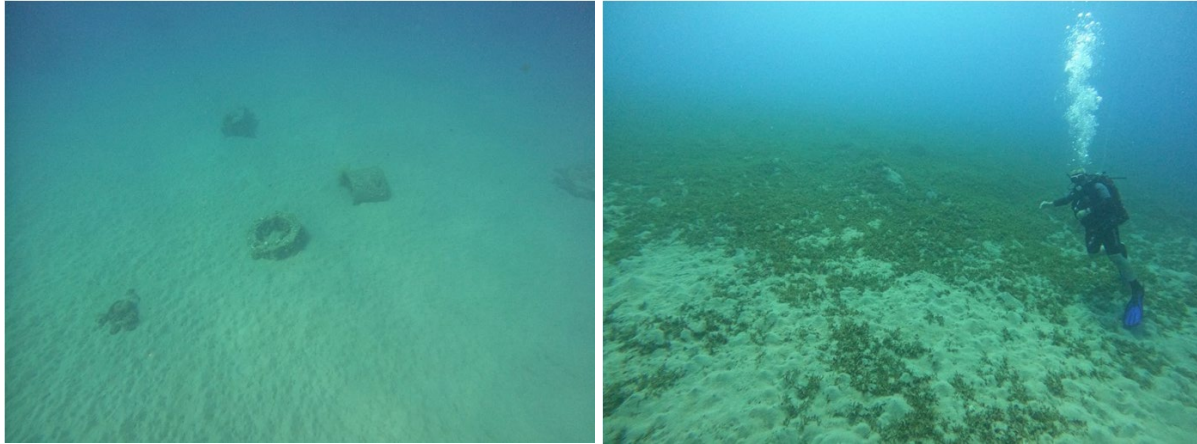


Figure 8-12: Colonisation of the Hard Surfaces with Corals and Other Reef Organisms



Figure 8-13: Colonisation of the Hard Surfaces with Corals and Other Reef Organisms

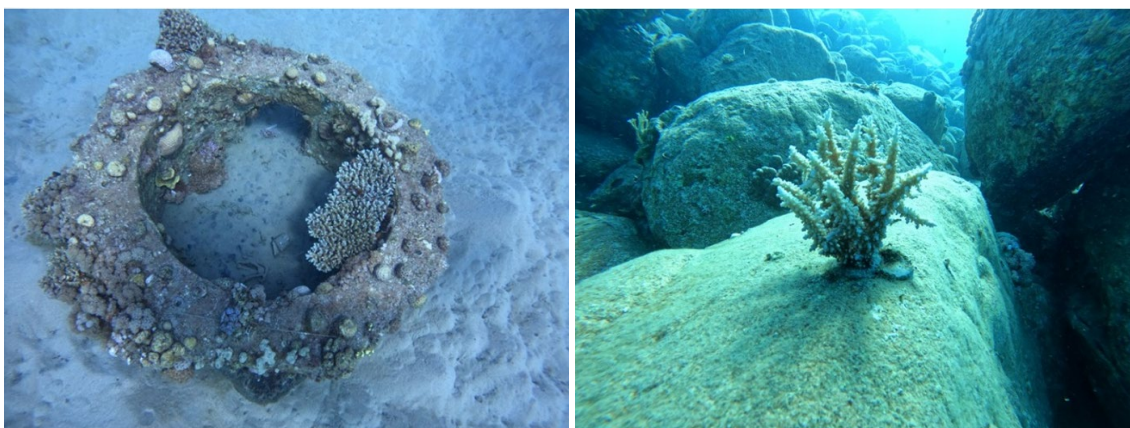


Figure 8-14: New Coral Recruits' Presence Indicate Healthy Environment in the Site



The rocky breakwater represents a potentially valuable substrate for coral transplantation activities. Its extensive hard surfaces provide naturally stable attachment points, while observed coral growth and recruitment suggest the substrate can support coral establishment.

The combination of existing natural habitats, artificial reef structures, and suitable hard substrates provides an opportunity to further develop the site as a managed reef-enhancement and ecological offsetting area. ASEZA is also planning to deploy additional substrates within the site to function as artificial reefs. These planned structures could be strategically positioned to complement the existing concrete blocks and breakwater, increasing the overall availability of suitable hard substrate and creating a more extensive reef habitat.

The RYC site could be developed beyond its current condition by adding purpose-designed artificial reef and coral transplantation structures. Such development could increase coral habitat, enhance biodiversity, and provide additional ecological value within a highly modified coastal environment.

Given the site's accessible location, range of depths, existing coral development, and planned deployment of additional artificial reef structures, it could also potentially be developed as a new recreational diving site. Establishing an attractive artificial reef area at the RYC could help divert some diving activities away from natural coral reef areas. This may provide an indirect conservation benefit by reducing physical disturbance and diving pressure on sensitive natural reefs.

8.6.2.4 Preliminary Comparison of the Sites

Based on the SCUBA diving inspections, the three locations exhibited characteristics that could support coral transplantation and offsetting activities; however, their ecological conditions and restoration potential differ considerably. The sites were evaluated and compared based on their current ecological status and suitability for restoration interventions, as summarised in the Table below.

Criterion	Cornish Site	Berenice (Marine Reserve Site)	Royal Yacht Club
Hard substrate	Extensive rock substrate	Existing reef; sandy areas available	Rocky breakwater, Artificial concrete structures
Potential for coral attachment	High on stable rock surfaces	High on reef and transplantation structures	High on stable rock surfaces

Criterion	Cornish Site	Berenice (Marine Reserve Site)	Royal Yacht Club
Evidence of natural recruitment	Coral recruits observed on rocks	Established coral communities observed	Coral recruits observed on rocks
Depth range	Shoreline to ~30 m	Multiple habitats/depths	2-20 m
Seagrass habitat	Not a dominant feature observed during inspection	Well-developed seagrass meadows	Well-developed seagrass meadows
Sandy substrate	Limited/variable	Extensive areas available	available
Previous transplantation	Not specifically identified	Previous transplantation areas present	None
Priority of conducting offsetting and transplantation activities	High Potential capacity: 8,000–10,000 m ²	Low Potential capacity: 3,000–5,000 m ²	High Potential capacity: 15,000 m ²

Based on the field assessment findings, the Corniche Site is a high-priority candidate for coral transplantation and environmental offsetting activities. The site provides suitable hard substrate, evidence of natural coral recruitment, existing coral colonies, and a broad depth gradient, indicating good potential to support the establishment and persistence of transplanted colonies.

In contrast, although the Berenice Site is technically suitable for coral transplantation and offsetting activities, its existing ecological condition is relatively good, with established coral communities and functioning reef habitat. Consequently, there is currently less justification for implementing active restoration or offsetting interventions at this location. Therefore, in terms of restoration priority, the Berenice Site is classified as a low-priority candidate, while the Corniche Site is recommended as the top-priority site among the two assessed locations.

Based on the site inspection, the RYC site has good potential for coral transplantation and ecological offsetting activities. The existing rocky breakwater provides substantial, stable hard substrate, while observed coral growth and recruitment show the substrate can support coral colonisation.

The planned deployment of additional artificial reef substrates provides an opportunity to further enhance the site's ecological function. With appropriate design, placement, coral transplantation, and subsequent monitoring, the RYC could potentially be developed as a dedicated reef-enhancement and diving site, contributing to coral habitat creation and protecting natural reefs by redistributing recreational diving pressure.

Other candidate sites are currently under investigation to evaluate their suitability for the implementation of coral transplantation and/or offsetting activities.

8.6.3 Next Steps

The approach and preliminary actions described above are initial steps to identify, plan and implement activities to action offsets and Additional Conservation Actions that will compensate significant residual impacts on biodiversity, particularly in natural habitat/ priority biodiversity features (requiring No Net Loss) or Critical Habitat (requiring a Net Gain), that remain after all feasible avoidance, minimisation and restoration measures have been applied. The information will inform the final Biodiversity Action Plan, which will confirm locations, specific actions, implementing parties, the implementation programme, monitoring of gains, and costs and be integrated into the final Adaptive Management Plan.

9 Next Steps and Permitting Implications

9.1 Next Steps

This Interim ESIA Addendum represents an interim stage in the continuing development of the marine component of the AAWDCP. The assessment has benefited from a substantially improved evidence base compared with that available during preparation of the Disclosed 2025 ESIA; however, several additional activities remain underway to further strengthen understanding of marine biodiversity, confirm assessment assumptions and support implementation of the Project's mitigation hierarchy.

The immediate priority is completion of the additional baseline survey and study programme. This includes the planned ROV survey of the brine plume area, sediment and water quality sampling, laboratory-based coral exposure studies and coral settlement monitoring. Together, these activities will provide additional information on habitat distribution, coral condition, environmental variability, coral recruitment patterns and the tolerance of locally occurring coral species to salinity and iron concentrations predicted within the brine plume. The results will be used to refine habitat mapping, improve confidence in impact quantification and provide additional evidence to support long-term monitoring and adaptive management.

Further engineering development will continue during detailed design. This will include confirming marine construction methodologies, finalising anchor plans, verifying environmental performance requirements, and continuing engagement with relevant stakeholders on construction logistics, marine infrastructure interfaces, and operational requirements. In addition, the Project will further assess brine plume velocity, considering environmental and technical aspects and the need for appropriate mitigative measures.

The Project will also continue to develop the environmental monitoring systems and operational controls required to verify compliance with Project commitments and environmental objectives.

Planning for coral translocation and biodiversity offset implementation has already commenced and will continue as additional survey information becomes available. Candidate recipient sites have been identified and inspected, and sufficient capacity has been confirmed to accommodate the currently identified translocation and restoration requirements. Further site investigations, mapping and implementation planning will be undertaken to support final site selection and execution planning.

The Project will also continue development of the Biodiversity Action Plan, Environmental and Social Management System and Adaptive Management Plan to ensure that mitigation measures, monitoring programmes, response mechanisms and governance arrangements are fully integrated into detailed design, construction planning and operational management.

Overall, the remaining work is focused on reducing uncertainty, strengthening the biodiversity evidence base, confirming environmental thresholds and monitoring requirements, and ensuring that the mitigation, translocation, restoration and adaptive management measures described in this report can be effectively implemented throughout the construction and operational life of the Project.

9.2 Permitting Implications

The revised design has no implications for the environmental approvals already obtained from the Ministry of Environment and ASEZA. These approvals are final and cover the design amendments and additional work undertaken to date.

At the construction stage, the EPC Contractor will need to coordinate with the relevant authorities and municipalities to obtain the routine permits required to undertake the works and formally notify them, as applicable.

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Appendix 1: Review of Tolerance of Corals to Hypersalinity

Aqaba-Amman Water Desalination and Conveyance Project (AAWDGP) Review of Tolerance of Corals to Hypersalinity

Report Issue Record

Project: Aqaba-Amman Water Desalination and Conveyance Project (AAWDCP)

Title: Review of Tolerance of Corals to Hypersalinity

Date: September 2026

Version: V1

Date	Rev	Author	Checked	Approved
May 2026	0	MLT/F & FAH	FB	BB
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Abbreviations and Acronyms

AAWDC	Aqaba-Amman Water Conveyance and Desalination
AAWDCP	Aqaba-Amman Water Desalination and Conveyance Project
ALT	Alanine Aminotransferase
CAT	Catalase
CCA	Crustose Coralline Algae
CHA	Critical Habitat Assessment
ESIA	Environmental and Social Impact Assessment
GoA	Gulf of Aqaba
IFC	International Finance Corporation
LDH	Lactate Dehydrogenase
MDA	Malondialdehyde
SOD	Superoxide Dismutase

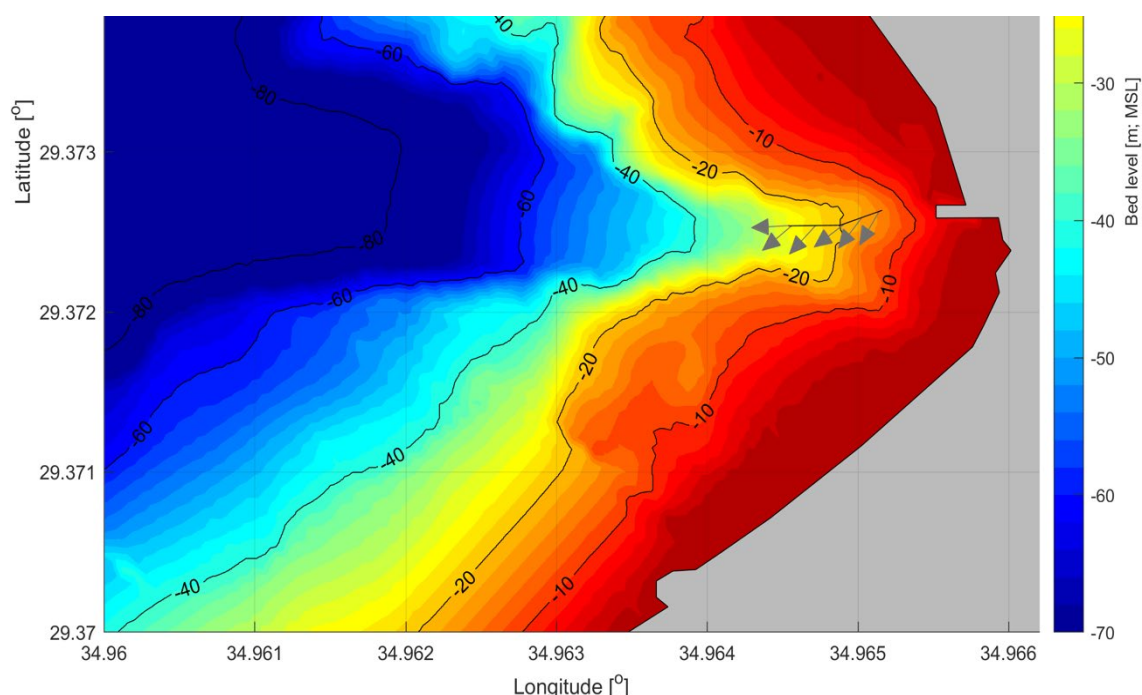
Purpose and Scope of Document

The purpose of this document is to undertake a review of salinity tolerances for coral that will be exposed to AAWDCP brine discharge and to present a salinity risk assessment with a recommended salinity tolerance. The review will provide a synthesis of peer-reviewed literature and other available reports (including environmental impact assessments, and regulatory guidance) that have addressed the tolerance of corals to hypersalinity conditions, focusing on species relevant to the discharge area. Emphasis has been placed on chronic and acute exposure effects, life-stage sensitivities, and ecosystem-level impact.

1 Background Review of Available Project Information

The current EPC design (case 5) proposes to use an outfall diffuser with 6 ports between approximately 15 and 30m water depth (Figure 1-1, Source: Deltares AAWDCP - Rapid assessment recirculation modelling - 17 March 2026). The diffuser will be placed in the centre of a sandy canyon, which is bordered by a fringing reef.

Figure 1-1: Bathymetry and Location of Outfall Pipe and Diffuser Ports



The 2024 National Monitoring Program recorded a salinity range of 40.36 psu to 40.73 psu at the Industrial Zone station, which is the closest to the study area. The report noted a slight increase in salinity over the period 2020 to 2024 in the summer months, possibly reflecting the influence of temperature (via increased evaporation) on salinity. For modelling purposes, a background salinity of 40.7 psu has been used. Characteristics of the modelled hypersaline brine plume that are relevant to a review on hypersaline tolerances for corals are shown in Table 1-1.

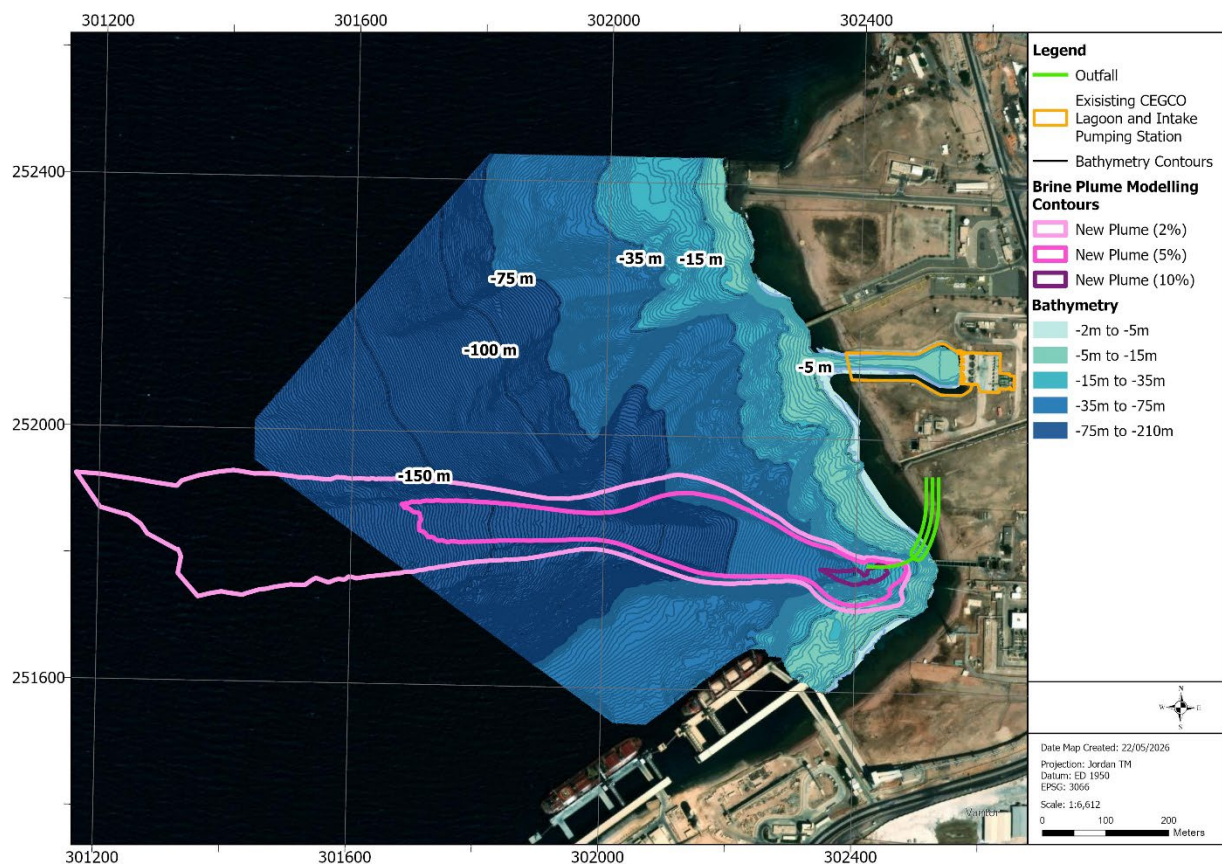
Table 1-1: Relevant Characteristics of Brine Discharge for Review of Coral Tolerance to Hypersalinity

Hypersaline Brine Discharge Characteristic	Parameter
Excess salinity	+34.8 psu
Distance to impact point (Ports 1 – 3 at ~15 – 20m)	15m
Dilution (& salinity) at impact point (Ports 1 – 3)	8.4 (44.84psu)
Distance to impact point (Ports 4 – 6 at ~20)	23m
Dilution (& salinity) at impact point (Ports 4 – 6)	9.6 (44.33 psu)
Distance to end of near field	48 – 72m
Dilution (& salinity) at end of near field	13 – 14.5 (43.38 – 43.10 psu)

Based on the assessment the boundaries where salinity will exceed 2%, 5% and 10% above ambient have been modelled (Figure 1-2).

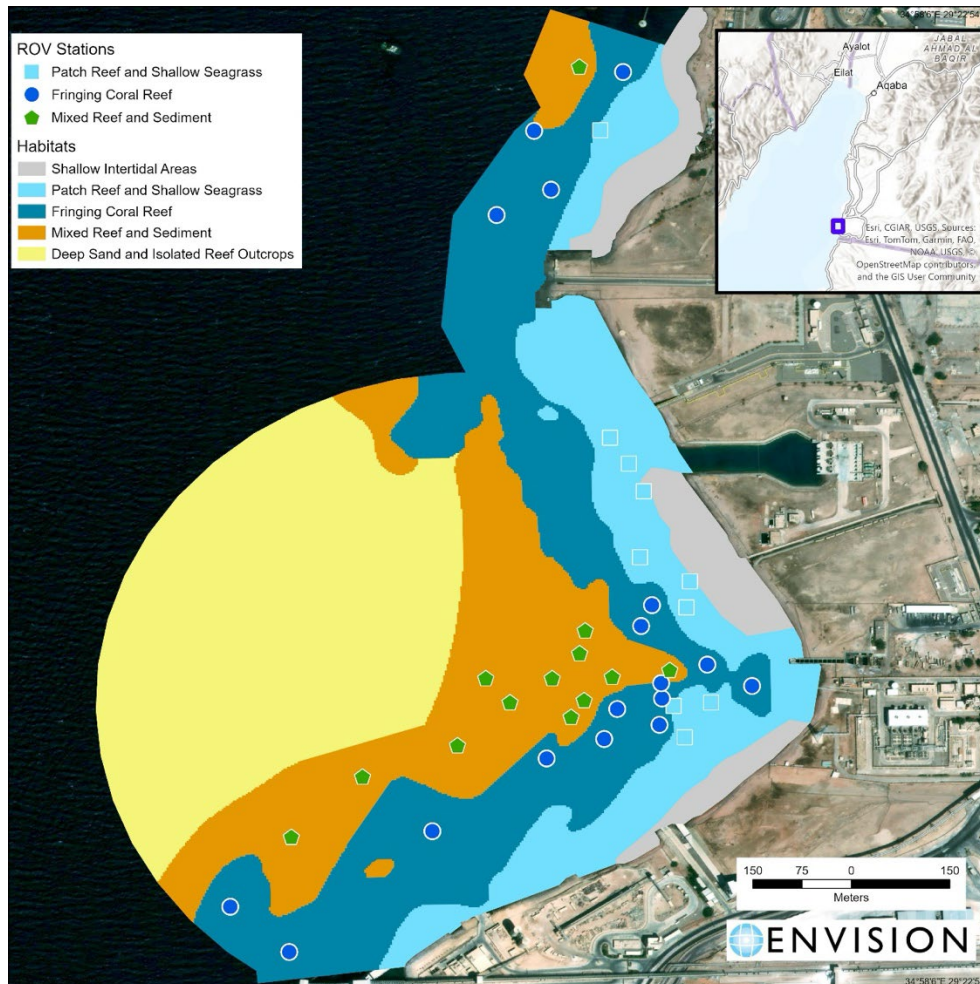
The bathymetry shown in Figure 1-2 shows that the shoreline is bounded by a narrow fringing reef in the order of 250m wide before sloping steeply to depth. Figure 1-2 presents the modelled plume boundaries for elevated salinity levels of 2%, 5%, and 10% above ambient (40.7 psu), together with bathymetry for case 5, the latest EPC design. The figure indicates that the 10% above ambient plume boundary is largely confined within the canyon and, although 5% and 2% plume orientation is predominantly within the canyon, the boundaries do overlap with the steeply sloping walls of the fringing reef to the north and south.

Figure 1-2: Modelled Plume Boundaries



The marine habitats have been broadly characterised by a baseline survey (Figure 1-3, Source: Envision Marine Habitats Baseline Report December, 2025 & Figure 1-4) that covers the nearshore embayment and adjacent deeper waters, spanning intertidal rock platforms, shallow subtidal zones, fringing reefs, mesophotic reef slopes and deeper soft sediments.

Figure 1-3: Broad Marine Habitat in the Study Area

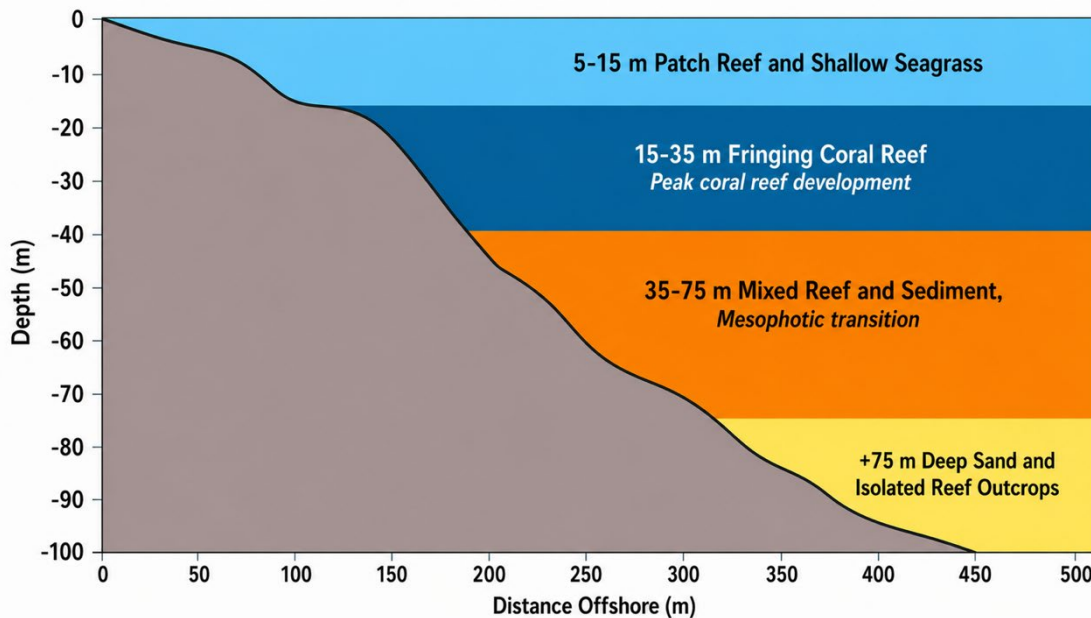


The baseline survey has identified the major coral types (to family/genus level) and other fauna and flora that characterise the habitat types. However, the features and spatial properties of the habitat types and fauna and flora of the canyon and its bordering reef/substrate are not known in detail. The baseline survey is currently being refined and detailed by further surveys, in particular the detailed habitat characteristics of the canyon floor and adjacent fringing reef walls in order to calculate the quantity and identify the types of coral that will be subject to the brine discharge.

Knowledge of the zonation of habitat types and distribution of fauna and flora, and specifically within the study area, is important because this will determine the sensitivity to the brine discharge. The baseline survey found a clear depth-related pattern. Very shallow zones support relatively low coral cover on mobile or sediment-influenced substrates. Coral cover (Table 1-2 & Figure 1-4, Source: Envision Marine Habitats Baseline Report December, 2025) increases to 30m, reaching locally high values where stable hard substrate and moderate light coincide, with a diverse assemblage of branching, massive and plating growth forms. Below approximately 35m, coral abundance declines as light levels fall, although mesophotic corals remain present into the 50 - 70m range. At depths between 30m and 60m, the baseline survey found that the diversity of corals was dominated by species that were sediment tolerant (reflecting a change from contiguous reef substrate to more patchy sand/rubble substrate) and from taxonomic families (e.g. Agariciidae, Lobophylliidae and Mirulinidae) that are known to be more tolerant

to salinity variance and increases. Below 60m, the ratio of sand to hard substrate increases with depth, and where hard substrate is available, coral cover is less than 15% and is dominated by *Leptoseris* ^[11].

Figure 1-4: Depth Profile Through the Project Area with the Broad Marine Habitats



Seagrass cover is concentrated in shallow, sheltered areas and diminishes with depth and exposure. The detailed characteristics of the canyon area and deeper reefs (below 60m) that are likely to be impacted by the brine discharge plume have not been characterised in detail, which is the subject of ongoing survey work.

Table 1-2: Depth Characteristics of Coral Reefs

Depth Zone	Coral Cover	Description (Main Characteristics)
5 – 15m	<5 – 30%	Small isolated colonies through small patch reefs to contiguous reef substrate with shallower areas with coral cover and diversity increasing with depth.
15 – 35m	30 - 84%	Fringing reef slope with increasing coral cover and diversity with depth. Coral colony forms change from branching and massive shapes to table with massive shapes as depth increases indicating adaption to lower light levels.
35 – 75m	<20 – 50 %	Substrate begins to change to patchy hard, rubble and sediment with reducing coral cover and diversity with depth and shift to plating and massive shapes.
75 – 150m	15 - <10 %	Increasingly less and more patchy hard substrate dispersed amongst sediment areas. Coral cover reported up to 15% where hard substrate is present.

Note: Descriptions for 5 - 60m are based on the Envision Baseline Habitat report and below 60m are from Reference [11, 51]. Zones to 35m are described as photic (corals rely on photosynthesis for survival), 35m to 60 -75m as upper mesophotic (corals increasingly rely on other feeding strategies as light progressively diminishes) and 75 - 150m Lower mesophotic.

In the context of coral reefs in the Gulf of Aqaba, the photic zone can extend to approximately 170m depth^[1, 9], which has a strong influence on the characteristics of reef ecosystems. This means that scleractinian (reef-building) corals that are more usually confined to 40-70m can be present to much greater depths and overlap over an extended area with deeper water reef fauna that inhabit the mesophotic zone¹ (usually 30-40m to 150m)^[10, 11, 12, 18, 19]. At these depths, reefs can be dominated by sponges, algae, and deep-water corals (including Octocorals), as well as Scleractinian coral types, which are normally found in shallower waters. The physiology of corals from deeper depths are generally adapted to a lower light and higher pressure environment through adapting their physiology, symbiosis^[31], metabolic and cellular processes^[55, 56] with the effect that:

- Coral species undergo physiological changes to host different symbiotic algae and coral morphologies adjust skeleton growth form to maximise light capture (e.g. massive to plating morphologies)^[71]
- Species richness (biodiversity and coral cover) are reduced as depth increases, as fewer coral species are able to adjust to the deeper environmental conditions
- Reproduction strategies change from large-scale spawning events at depths above 30m to lower intensity spawning (10-20% participation vs. 100%) at 150m so that deeper reefs are less able to recover from degradation compared to shallower reefs^[72]

In addition to an extended photic zone, the Gulf of Aqaba is characterised by high salinity and temperature^[4] compared to most other coral reef regions of the world; the reef fauna and flora are already acclimated² to a relatively higher salinity and temperature environment, and thus this review focuses on literature that addresses tolerance to elevated salinity from similar regions, namely; the Red Sea (including Gulf of Aqaba) and Arabian Gulf.

¹ **Photic reefs** are shallow-water coral ecosystems (0–30m) bathed in bright sunlight, relying on photosynthesis for the survival of reef-building corals. In contrast, **mesophotic reefs** exist in increasingly lower light levels with depth, forcing corals and organisms to rely on other feeding strategies.

² **Acclimation** is the reversible, physiological adjustment an organism undergoes in response to a changing environment to improve its tolerance. Acclimation shifts the tolerance curve, expanding the range of conditions an organism can handle.

Tolerance is the ability of an organism to survive or function within a certain range of environmental conditions (e.g., specific temperatures or salinities) and is the absolute limit an organism can withstand (what it can handle).

2 Literature Search: Systematic Search of Academic Databases and Reputable Online Data Sources

To begin to understand the potential impacts of the brine plume, a literature search has been conducted to review the current understanding of the effects of hypersalinity on the biology and ecology of the fauna and flora present within the identified habitats.

The review includes experimental studies, field observations, and meta-analyses reporting quantitative salinity thresholds and excludes studies lacking rigour or regional relevance. The focus for the potential effect from the hypersalinity of brine discharge is on coral reefs, and their associated fauna and flora, as they have been identified as Critical Habitat³.

2.1 Literature Limitations

The literature almost exclusively reports relatively short-term laboratory exposure experiments (less than 1 month) and coral types that are common to upper reef zones (above 35m) rather than those found in deeper zones. Because laboratory conditions cannot mimic natural ecological conditions, results from laboratory versus in situ observations often predict greater ecological risks compared to the latter ^[49, 73] (e.g. reference [6] compared to [8]).

2.2 Background

Coral reefs have a highly heterogeneous assemblage of flora and fauna characterised by organisms permanently attached to a rocky substrate that is itself often, or mostly, of biogenic origin. The health of reef organisms is important because the maintenance and growth (and resistance to erosion) of the substrate is dependent on the viability of the organisms that produce it.

This review focuses on literature available specifically addressing hypersalinity. Hypersaline conditions are typically described as salinity exceeding 35 – 40 psu or 10% above ambient levels. This is because corals are generally assumed to be stenohaline osmoconformers (organisms that do not expend energy on actively adjusting the salt concentration in their bodies (osmoconformers) and can only survive a very small fluctuation in the salinity of the water (stenohaline) and so are adapted to thrive at 32–35 psu with some capacity to withstand short-term spikes to 40 – 45 psu ^[13, 27, 54]. In Jordanian waters of the Gulf of Aqaba, ambient salinity levels have been recorded between 40.27 and 42.15 psu, with a range between 40.36 and 40.73 at a monitoring location close to the study area in 2024 ^[66]. Understanding the possible consequences of persistent long-term exposure of the fauna and flora of the coral reef ecosystems in the study area, where organisms are ‘pre-acclimated’ to hypersaline conditions, is important to define the risk for long-term alteration of the biodiversity in the study area and what the consequences of this might be.

2.3 Impacts of Hypersaline Conditions

Sensitivity to elevated salinity can vary significantly between different species through impacts to their physiology, metabolism and reproductive success, as well as shifts in community structure and reduced resistance to secondary stressors ^[3]. For coral communities’ studies have shown that impacts can arise through ^[3,4, 5, 6, 7, 69, 70].

³ Aqaba Amman Water Conveyance and Desalination (AAWDC) Project. Marine Critical Habitat Assessment (CHA). 2025.

- **Coral Bleaching and Tissue Damage:** Elevated salinity levels can lead to a break down the symbiotic relationship between corals and their photosynthetic algae (zooxanthellae). Studies indicate that salinities above 42 psu can lead to partial, severe, or total bleaching depending on species and the extent and duration of salinity increase
- **Reduced Calcification and Growth:** Corals exposed to hypersaline conditions show a 20-50% decrease in calcification rates (normal conditions $1 - 2 \text{ g CaCO}_3 \text{ cm}^{-2} \text{ yr}^{-1}$), meaning they cannot build their skeletons effectively
- **Reduced Photosynthesis and Metabolism:** High salinity restricts photosynthesis of zooxanthellae, reducing the energy available to the coral host
- **Microbiome Restructuring:** Long-term exposure to high salinity forces a significant shift in the bacterial communities (microbiome) associated with coral, which may help them adapt but often at the cost of overall fitness

The specific conditions found in the Gulf of Aqaba means that corals (and other flora and fauna) are already acclimated to the existing elevated saline conditions and show enhanced tolerance to even higher saline conditions ^[13, 14].

3 Effects of Hypersaline Conditions on Reef-building Coral

Reefs in the Gulf of Aqaba include a range of different calcifying reef-building organisms (Table 3-1) that produce skeletons that can build and contribute to reef substrate accretion ^[18,19].

Table 3-1: Main Coral Types and Their Function to Coral Reef Ecosystems

Taxonomic Group	Role
Scleractinia	Scleractinian corals (stony corals) are the foundational ecosystem engineers of coral reefs. Through the secretion of calcium carbonate skeletons, they construct the massive 3-dimensional physical framework of the reef. Most reef-building Scleractinia host symbiotic algae (family Symbiodiniaceae) within their cells. Through photosynthesis, these algae provide the coral with up to 98% of their energy requirements, including vital carbohydrates and lipids that allows stony corals to grow rapidly enough to form massive reef structures in shallow, nutrient-poor tropical waters.
Octocorals	Octocorals, including sea fans, sea whips, and soft corals, are vital ecosystem engineers but are not light dependent and can populate a greater range of habitats. Unlike stony corals, they feature flexible internal skeletons and provide critical three-dimensional habitat. They have unique microbial partnerships that allow them to survive harsh environments. Their skeletons help cement and consolidate reef substrate.
Hydrozoa	Carbonate hydrozoans (often called hydrocorals) play critical ecological roles on coral reefs by providing structural habitat, maintaining biodiversity, and contributing to reef accretion. Although symbiotic with algae and light dependent they are often more resilient to harsh environments than stony corals.
Coralline algae	Coralline algae, particularly crustose coralline algae (CCA), act key structural components and glue of coral reefs. They secrete hard calcium carbonate skeletons, which cement the reef structure together, resist intense wave energy at the reef crest, provide crucial chemical cues for coral larvae to settle, and suppress the growth of opportunistic fleshy macroalgae helping to maintain substrate that favours coral (all types) growth.

The baseline survey was not designed to identify individual fauna depth and distribution ranges and focussed on Scleractinian corals. However, all coral types would be expected to be present at all depths except Hydrozoans (Millepora) which are generally found above 30m depth.

The Gulf of Aqaba has a very high water clarity⁴, such that many coral species exhibit a depth range extending across photic and mesophotic zones far greater than other regions. As light is attenuated by depth and reefs become progressively more mesophotic, they are characterised by substrate that is antecedent (built on relic terraces from previous sea level stands) with diversity reducing and growth form (becoming more platy and encrusting). Reefs at mesophotic depths include coral types, particularly Octocorals, that exhibit high tolerance to hypersalinity and other environmental stresses ^[13, 20, 21].

In general, the ability of all types of coral to tolerate and acclimate to high salinity levels is linked to two features:

1. An accompanying restructuring of their microbiome towards beneficial bacteria (e.g., *Pseudomonas veronii*), which help to manage the salt stress ^[13]

⁴ Characterized by incredibly low turbidity (low suspended particles), the depth at which 1% of surface sunlight (photosynthetically active radiation) penetrates frequently exceeds 110 metres compared to 20 to 40 metres in other coral reef regions ^[52].

2. The upper limits of tolerance of corals' symbiotic algae, where photosynthesis during short-term exposure studies has been found to be significantly inhibited by salinity levels of 55-60 psu, whilst extreme levels (70 ppt) caused irrecoverable damage ^[8, 27, 41]

3.1 Scleractinia (Stony Reef-building Corals)

Corals in the Gulf of Aqaba tolerate ambient salinity levels of 40 to >41 psu ^[6], which is higher than the global average range of 32 – 35 psu, and supports high biodiversity reefs ^[18]. The Persian Gulf is another region where hypersalinity can be as high as 50 psu, and there are healthy viable coral reef systems albeit with reduced biodiversity compared to other reef regions ^[4, 8, 58]. This strongly suggests that some coral species have a capacity to acclimate long-term to elevated salinity levels.

Research has shown that some species in northern Red Sea regions, such as the Gulf of Aqaba, can tolerate up to 48-50 psu ^[47] over a one-week exposure experiment. Some species such *Acropora*, *Fungia*, *Platygyra* and *Stylophora pistillata* showed tolerance to even higher concentrations (45psu up to approx. 51-55 psu) over a short period of time ^[13, 15, 34], although the calcification rates (growth rates) were 8-fold decreased and showed signs of mucus release as a sign of stress over approximately one month of incubation.

The effect of salinity on coral reproduction has mainly been investigated in the context of hyposalinity. Results suggest that lower (hyposalinity) and higher (hypersalinity) salt levels can affect fertilisation success, structural and developmental deformities in the resulting embryos, lowering larval survival rates and consequential decreased settlement and recruitment onto substrate ^[53, 68, 74, 75, 76].

Cultured symbionts (*Symbiodinium*) associated with these corals have also demonstrated remarkable resilience, withstanding salt-adjusted laboratory conditions ranging from 25-55 psu through the prominent presence of the symbiont *Symbiodinium hermophilum* that shows strong local adaptation not only to high temperatures but also to the exceptionally high salinity ^[27].

While corals have been shown to exhibit extreme resilience, their capacity to handle 48-50 psu is likely at the edge of their physiological limits, and this tolerance could become overwhelmed by combined additional pressures. For instance, some species of *Acropora* and *Platygyra* bleached at around 51-51.3 psu and *Stylophora pistillata* exhibited high tolerance, with bleaching occurring closer to 55 psu ^[4, 41, 42], with the effect being associated with the decline in the symbiotic algae.

Laboratory experiments have incubated coral fragments representing three branching species (including *Stylophora pistillata*, *Acropora tenuis*, and *Pocillopora verrucosa*) in seawater with elevated salinity (about 10% above ambient) with and without antiscalant present ^[6]. Results showing a negative response were attributed to osmotic stress, and a significantly greater impact was noted for treatments that included antiscalant. However, the study was relatively short, consisting of 2-4 weeks of incubation, and other studies have shown that although there may be a significant reduction in calcification and photosynthesis in the short term, the microbiome could remain stable. Long-term exposures can result in unchanged photosynthesis levels and visually healthy coral colonies, indicating long-term acclimation to high-salinity levels, accompanied by major restructuring of the coral microbiome ^[4, 13].

It should be noted that most of the research has been conducted over relatively short periods of time ranging from a few hours to one month and includes *in vivo* and *in vitro* experiments that can make direct extrapolation to natural *in situ* conditions difficult ^[43, 44].

A longer 3 month, as yet unpublished laboratory experiment, which exposed two branching coral species, *Stylophora pistillata* and *Acropora sp.*, to different brine enrichment levels (2%, 5%, and 10% above ambient salinity) was conducted by the Jordanian Marine Science Station in 2024. A number of stress

markers, including Malondialdehyde (MDA), Lactate Dehydrogenase (LDH), Alanine Aminotransferase (ALT), and antioxidant enzymes including Superoxide Dismutase (SOD) and catalase (CAT) were measured in the incubated corals.

The two incubated coral species showed a clear dose-dependent response to increasing salinity from brine exposure. At low exposure (+2%), both *Stylophora pistillata* and *Acropora sp.* showed minimal or no significant physiological stress, with stable or slightly altered biomarkers and high survival (100% in *S. pistillata*). At moderate exposure (+5%), both species exhibited increased oxidative stress markers (MDA, LDH, ALT) and activation of antioxidant defenses (SOD and CAT), indicating the onset of physiological and metabolic stress. However, *Acropora sp.* showed stronger effects, including a noticeable drop in survival (68%). At high exposure (+10%), both species experienced severe oxidative stress, with elevated damage markers and reduced antioxidant enzyme activity (SOD and CAT), indicating overwhelmed defense systems. This resulted in clear cellular damage and a sharp decline in survival, especially in *Acropora sp.*, showing it is more sensitive to salinity stress than *Stylophora pistillata*.

3.2 Octocorals

Octocorals exhibit high tolerance to high salinity, often showing superior resilience compared to scleractinian (reef-building) corals. Many species, particularly in the Indo-Pacific and Red Sea, can withstand salinities of 48–60 psu, allowing them to dominate in disturbed or high-stress environments [13, 20, 21, 32]. Experimental studies have found that high salinity (60 psu) exposure to octocorals such as *Sinularia flexibilis*, *Paralemnalia thyrsoidea*, and *Sinularia compressa* facilitated the release of symbiotic cells without damaging their viability.

3.3 Hydrozoa

Millepora (fire corals) are important contributors to coral reefs in the Red Sea and the Gulf of Aqaba, particularly *Millepora dichotoma*. There is no specific literature available regarding their tolerance to hypersalinity and extreme temperatures; however, the genus is known for extreme physical, biochemical and behavioural plasticity, allowing it to adapt its growth form to high-energy and variable environments [28, 29, 67].

3.4 Coralline Algae

Tropical crustose coralline algae are essential for reef building and coral settlement. They exhibit resilience to high salinity conditions such as those of the Gulf of Jordan. Their tolerance is likely attributed to their ability to adjust photosynthetic efficiency and manage ionic balance under extreme environmental conditions [1, 11, 25, 26]. Coralline algae have been found to exhibit a wide depth distribution in the Gulf of Jordan to depths in excess of 150m and, in depths below 100m may become the dominant seabed cover [12]. There are no studies from the Gulf of Jordan on tolerance of coralline algae to elevated salinity levels.

3.5 Seagrass

Seagrasses in the Gulf of Aqaba have a depth distribution range of 1 to 50m [22]. The baseline survey recorded seagrass cover on sandy substrate of 10% at 15m (the upper depth boundary of the brine discharge plume). Exposure experiments conducted on *Halophila stipulacea* presented that up to 10% increase in salinity above ambient (i.e. 44-45 psu) led to stress [57]. This study showed that exposure from +5% salinity onward induced measurable stress, and +10% salinity resulted in pronounced cellular impairment, indicating a shift from adaptive responses to damage [57]. Studies from other regions have

shown that effects of hypersalinity on seagrasses were more pronounced, with long-term exposure impairing photosynthesis and altering osmotic balance, resulting in ~69% mortality at 54 psu after 6 weeks ^[23].

An incubation experiment was conducted by the Marine Science Station to examine how the seagrass *Halophila stipulacea* responds physiologically to simulated desalination brine exposure under controlled laboratory conditions. *Halophila stipulacea* represents one of three seagrass species present in the Jordanian coast of the Gulf of Aqaba. In this exposure experiment, plants with associated sediments from the Gulf of Aqaba were exposed for a short period of two months to increased salinity levels (+1%, +5%, and +10% above ambient).

Physiological stress was evaluated using antioxidant enzymes and lipid peroxidation as an indicator of cellular damage. Results presented a clear salinity-dependent stress response: antioxidant activity increased with rising salinity, while higher treatments caused significant oxidative damage. Exposure from +5% salinity onward induced measurable stress, and +10% salinity resulted in pronounced cellular impairment, indicating a shift from adaptive responses to damage.

The study concluded that sustained salinity increases associated with desalination activities can induce significant sub-lethal stress in seagrass ecosystems prior to any visible signs of degradation. However, longer-term incubation experiments are still required to confirm and better understand the effects of each level of salinity increase on seagrass communities.

3.6 Summary of Saline Tolerances

The response of reef-associated taxa to hypersaline conditions varies significantly across functional groups, exposure duration, and magnitude of salinity increase. Table 3-2 summarises quantitative salinity tolerances, exposure conditions, and observed physiological responses reported in the literature, with an emphasis on studies relevant to the Gulf of Aqaba and comparable environments. The appraisal synthesises evidence across major reef taxa groups to support the identification of salinity tolerance thresholds.

Table 3-2: Appraisal of Salinity Tolerance Thresholds and Responses for Major Reef Taxa

Group	Reported Tolerance (psu / % Above Ambient)	Evidence Type & Duration	Observed Effect	Study Quality & Limitations	Applicability to AAWDCP	Weight of Evidence	Implication for Threshold
Scleractinia (reef-building corals)	48–50 (short-term); bleaching 51–55; stress at +5–10%	Lab + short-term incubation (hours–1 month)	Reduced calcification (up to ~8×), mucus release, bleaching, mortality at +10%	Strong experimental base but short duration ; limited long-term field validation	High (dominant reef builders in plume depth range)	High (short-term), Moderate (long-term)	Chronic stress begins ≥ +5%; significant risk ≥ +10% Tolerance overlaps with predicted plume (~44 psu), but long-term exposure risk remains uncertain
Coral symbionts (Symbiodinium)	25–55	Laboratory studies	High tolerance; supports host adaptation	Lab-based; indirect ecological relevance	High (controls coral resilience)	Moderate	Adaptation of symbionts underpins coral tolerance in GoA Extends tolerance but does not remove coral stress thresholds
Octocorals	48–60	Experimental (short-term)	High resilience; viable symbionts at 60 psu	Limited quantitative thresholds for mortality; few long-term studies	Moderate–High (present in mesophotic zones)	Moderate	Likely more tolerant than reef-building corals and may dominate under Likely tolerate > modelled plume; not limiting receptor

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Group	Reported Tolerance (psu / % Above Ambient)	Evidence Type & Duration	Observed Effect	Study Quality & Limitations	Applicability to AAWDCP	Weight of Evidence	Implication for Threshold
Hydrozoa (Millepora)	No quantitative data	Observational	High plasticity inferred	Major data gap ; no salinity thresholds	Unknown	Low	Uncertainty—cannot constrain threshold
Coralline algae	Broad tolerance; algae 1–70 (optimum 10–50)	Mixed studies (lab + field)	Maintain function under high salinity	Generalised algal data; not all reef-specific	Moderate (reef stabilisation role)	Moderate	Some evidence of highly resilient; may increase dominance under disturbance
Seagrass	Stress at +5% (~42–43); strong damage at +10% (~44–45); mortality ~54 psu	Lab + medium-term (weeks)	Oxidative stress, impaired photosynthesis, mortality	Good experimental data; some duration relevance	Moderate (shallower zones mainly)	High	More sensitive than corals; shallow habitats most at risk Sensitive receptor: threshold likely $\leq +5\%$

4 Salinity Risk Assessment from Salinity Tolerance Thresholds

Based on the literature review the following conclusions can be drawn:

- Most reef-building corals tolerate short-term exposure up to ~48–50 psu, with stress and bleaching emerging above ~51 psu
- The modelled plume (~44 psu; +8%) sits within observed tolerance ranges, but:
 - Overlaps with stress thresholds in experiments (+5–10%)
 - Long-term exposure data are lacking, making this a risk of chronic sub-lethal impact rather than acute mortality

4.1 Derived Recommended Salinity Threshold

The AAWDCP ESIA used a reference of 2% increase in salinity as a benchmark. Evidence from the literature strongly supports a conclusion that reef systems will be able to tolerate and acclimate to changes in salinity. The literature also indicates that there are some corals, and especially those already acclimated to living in deeper waters (below 60-75m) that will tolerate a $\leq +5\%$ above ambient salinity increase ($\approx \leq 42\text{--}43$ psu under typical GoA baseline conditions). A scientific justification for this is that the literature indicates:

- Consistent stress onset: Multiple experimental studies show onset of physiological stress in corals and seagrasses begins at approximately +5% salinity increase
- Seagrass sensitivity: Among assessed receptors, seagrasses exhibit clear sub-lethal stress at +5% and severe damage at +10%, making them the most sensitive ecological receptor
- Coral response envelope: Reef-building corals tolerate higher salinity in short-term studies (up to ~48–50 psu), but show reduced calcification, metabolic stress, and bleaching beyond ~+5–10%

However, there is significant uncertainty regarding the consequences of persistent and constant long-term exposure to elevated salinity levels compared to short-term (< 1 month) exposure. This is because:

- Most studies are short-term (hours to weeks), and there is limited evidence for chronic exposure, increasing risk uncertainty at higher salinity levels
- Tolerance is species-specific, particularly within scleractinian corals
- Local hydrodynamic behaviour of the plume (mixing, dilution) and co-stressors (temperature, antiscleractinants) may adjust impacts
- There is an absence of quantitative thresholds for hydrozoa and some benthic taxa

5 Conclusion

Overall, reef-building corals in the Gulf of Aqaba exhibit relatively high short-term tolerance to elevated salinity; however, measurable physiological stress occurs at increases of +5-10% above ambient, and the ecological consequences of persistent long-term exposure at these levels remain uncertain.

A precautionary salinity increase limit of **≤ +5% above ambient** is recommended to protect sensitive reef-associated ecosystems in the Gulf of Aqaba, recognising that higher levels (e.g. ~+8% predicted at plume touchdown) fall within experimentally observed stress ranges and may result in chronic sub-lethal ecological impacts under prolonged exposure.

However, in the context of the AAWDCP project this review has identified critical knowledge gaps, namely:

1. The biology and ecology below 60m and in the environs of the canyon where the outfall is to be located require the collection of additional data to support decision-making.

This shortcoming is being addressed through a targeted survey programme, and once results are known, the outcomes can be contextualised in relation to those found from this literature review to identify risks associated with the brine discharge under its current configuration. A monitoring programme implemented during operations will allow impacts to be assessed against predictions and support the development of adaptive mitigation strategies.

2. The specific sensitivity of the types of corals found within the study area and that will be exposed to the brine plume at the new outfall location, and the associated elevated salinity and iron, is not known in detail. This is because the literature that is available has not assessed the long-term exposure of corals in the specific context of the coral types that will be exposed to the bio-, physicochemical conditions within the brine plume.

It is recommended to conduct exposure experiments to mimic conditions of the brine discharge and field conditions (light, water chemistry⁵) that will provide a better understanding of coral sensitivity, tolerance and acclimation potential.

⁵ N.B. Depth as an environmental parameter cannot be replicated in an experimental setting but through use of appropriate controls to compare between corals collected from depth under experimental/control conditions, this affects from this parameter can be isolated.

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Appendix 2: Brine Plume Dispersion Modelling, Sensitivity Analysis and CFD Comparison

See separate PDF document