HYDRODYNAMIC MODELLING

EXECUTIVE SUMMARY

The marine environment is influenced by tides, currents, waves, winds, river flows and the natural movement of sediment. Hydrodynamic modelling is a computer-based technique that simulates these interacting processes and predicts how water, sediment and dredge plumes move through the marine environment.

Hydrodynamic models can replicate tidal currents, water circulation and flushing processes, wave conditions, sediment transport, sedimentation and dredge plume dispersion. They are commonly used to assess potential changes to water quality and to evaluate possible effects on sensitive marine habitats such as coral reefs and seagrass meadows.

By combining environmental monitoring data with advanced numerical modelling, potential impacts can be assessed across a range of operating and environmental conditions before activities occur.

PORT OF TOWNSVILLE HYDRODYNAMIC MODEL

The Port has used hydrodynamic modelling for over 30 years to support environmental assessments and management decisions.

The current modelling framework was originally developed by specialist consultants BMT between 2012 and 2014 as part of the Port Expansion Environmental Impact Statement (EIS). The model underwent independent peer review as part of the development of the model and was also reviewed by specialists from the Australian Institute of Marine Science (AIMS) as part of the EIS assessment. It was calibrated and validated using field measurements of tides, currents and water levels collected within Cleveland Bay.

This model was subsequently updated in 2020-2021 for the Channel Upgrade Project, with additional validation undertaken using project monitoring data.

In 2026, the model was further refined to support the new 10-year Sea Dumping Permit application. This update incorporated the latest scientific information, field data, industry guidance and modelling best practice.

MODEL SOFTWARE AND CONFIGURATION

The model is built using TUFLOW FV, an industry-standard three-dimensional hydrodynamic modelling platform used internationally to simulate tides, currents, waves and sediment transport.

The model also accounts for variations in water temperature and salinity, which influence how water moves and mixes throughout the Great Barrier Reef lagoon. This allows the model to simulate both surface and deeper water processes.

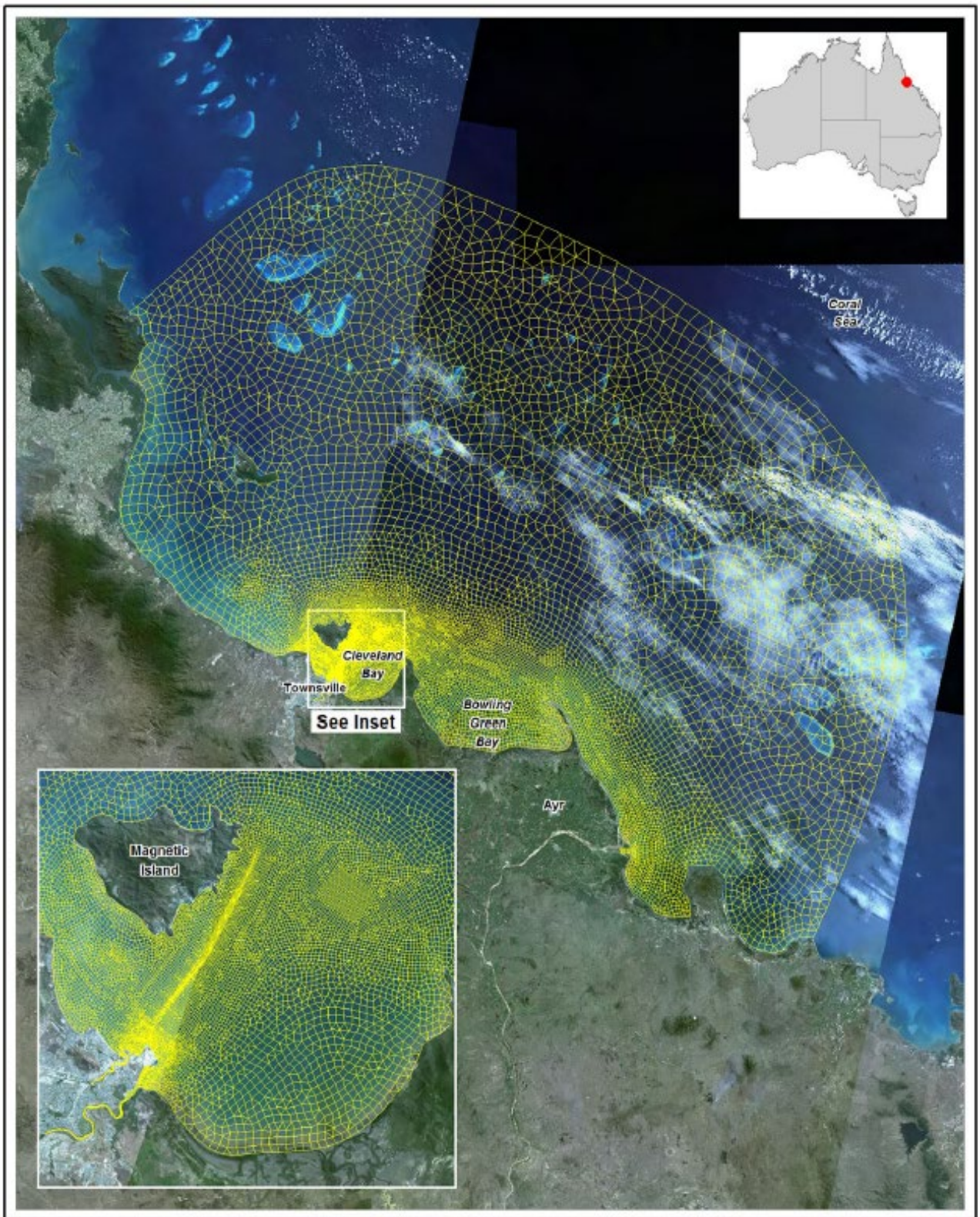
A separate wave model (SWAN) is linked to the hydrodynamic model to represent the influence of waves on currents, sediment movement and dredge plume behaviour.

MODEL AREA

The model covers approximately 28,400 km^2 and includes:

- Port of Townsville;
- Cleveland Bay;
- Halifax Bay;
- Bowling Green Bay; and
- Surrounding areas of the Great Barrier Reef lagoon.

The large model area ensures that regional influences such as tides, waves, river flows and ocean circulation are appropriately represented.



Title:
Port of Townsville TUFLOW FV Model Mesh

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MODEL SCENARIOS AND ASSUMPTIONS

To support the proposed 10-year permit application, maintenance dredging and sea placement activities were modelled under a range of realistic operating and environmental conditions.

Two dredging scenarios were assessed:

EXPECTED CASE

- 400,000 m^3 dredged over approximately 35 days.

UPPER CASE

- 600,000 m^3 dredged over approximately 50 days.

The Upper Case scenario represents a situation where additional maintenance dredging may be required following major events such as cyclones that increase sedimentation within port channels. While not expected to occur routinely, it provides a conservative assessment of potential impacts.

Each dredging scenario was modelled under three different climate conditions:

- El Niño (dry conditions);
- La Niña (wet conditions); and
- Transitional (neutral) conditions.

Assessing multiple climate conditions provides confidence that the model captures the range of environmental conditions likely to occur during the permit period.

Model assumptions were based on current maintenance dredging practices and operational records from previous dredging campaigns. The assessment assumed that maintenance dredging would primarily be undertaken using the TSHD Brisbane, with dredged material placed at the existing offshore Dredge Material Placement Area (DMPA). Dredging productivity, cycle times and operating patterns were based on actual dredge logs from previous campaigns to ensure the modelling reflected realistic operating conditions.

The model also incorporated dredging activities across all key maintenance dredging areas, including the Inner Harbour, Outer Harbour, Platypus Channel, Ross River and associated port infrastructure, based on expected dredging volumes over the permit period.

Approximately 85% of the modelled maintenance dredging occurs within the Inner Harbour, Outer Harbour and Platypus Channel, with relatively small volumes in the Sea Channel and other port infrastructure. This reflects current maintenance dredging requirements across the Port.

HOW POTENTIAL IMPACTS WERE ASSESSED

The modelling assessed changes caused by dredging relative to normal environmental conditions.
Specifically, modelling outputs were used to assess:

- Increases in suspended sediment concentrations (turbidity);
- Increases in sediment deposition on the seabed; and
- Whether those increases could exceed locally derived environmental thresholds.

Model results were assessed across different timescales to identify both short-term and longer-term changes associated with dredging.

Modelled turbidity and sediment deposition were then compared against impact thresholds developed to protect sensitive habitats such as coral reefs and seagrass meadows in Cleveland Bay.

UNDERSTANDING THE ZONES OF IMPACT

Four impact zones are used to describe modelled outcomes:

ZONE	DESCRIPTION
Zone of Influence	Detectable dredge plume, but no ecological impacts are predicted.
Zone of Low impact	Water quality or sediment deposition may exceed natural variability, potentially resulting in minor, temporary ecological effects with recovery expected within approximately six months.
Zone of Moderate impact	Conditions are likely to exceed natural variability and may result in ecological impacts requiring up to two years for recovery.
Zone of High impact	Conditions are most likely to exceed natural variability and may result in significant ecological impacts with recovery greater than two years.

These impact zones are based on established assessment methods and locally derived environmental thresholds developed using Cleveland Bay monitoring data.

NATURAL VARIABILITY IN CLEVELAND BAY

Cleveland Bay naturally experiences substantial fluctuations in turbidity due to tides, winds, waves, river flows and seasonal weather patterns.

The modelling assessed dredging-related increases relative to these existing conditions and found that predicted increases were generally small compared with the natural variations already experienced across the bay.

This context is important when assessing whether dredging-related changes are likely to result in ecological impacts.

MODELLED OUTCOMES – WATER QUALITY

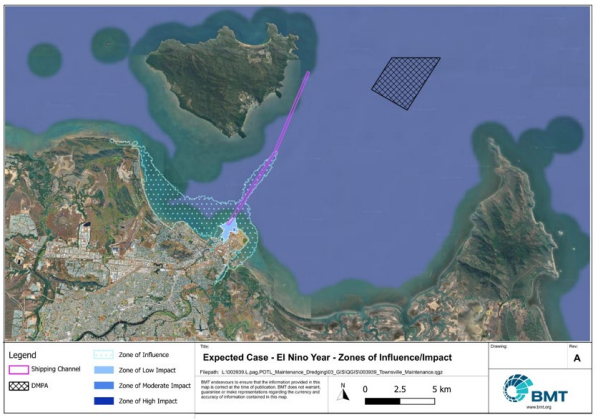
Across all dredging scenarios and climate conditions, the results show:

- A small, localised Zone of Low Impact within and immediately adjacent to the Port's Inner and Outer Harbour areas;
- Zones of Moderate and High impact are restricted to areas where dredging and placement activities occur;
- A broader Zone of Influence extending along parts of the mainland coastline towards the Ross River mouth and Cape Pallarenda; and
- No predicted adverse impacts to mapped coral habitats or mapped seagrass habitats from modelled water quality changes associated with maintenance dredging and placement activities.

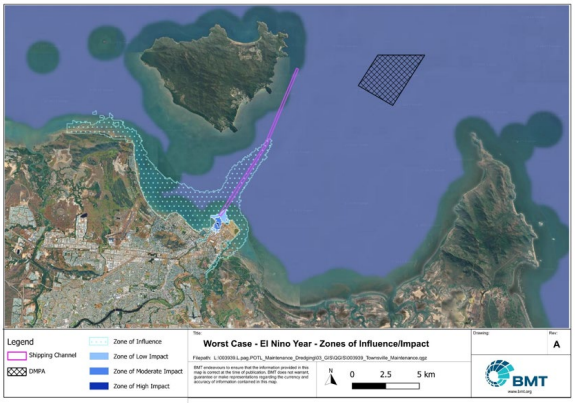
Although dredging-related increases in turbidity may be detectable in some areas outside the Port, these increases are predicted to remain within the range of natural variability.

MODELLED OUTCOMES - EL NINO YEAR (DRY)

400,000m^3 annual dredging volume

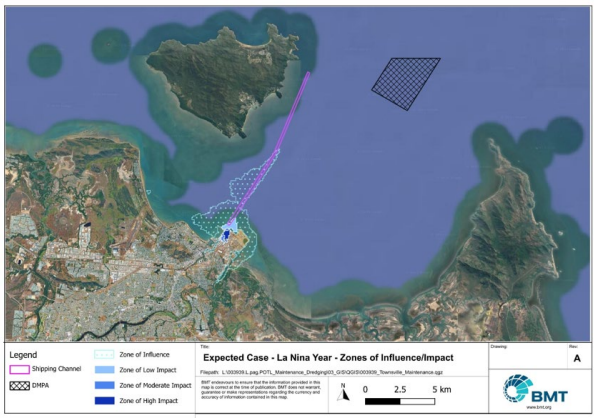


600,000m^3 annual dredging volume

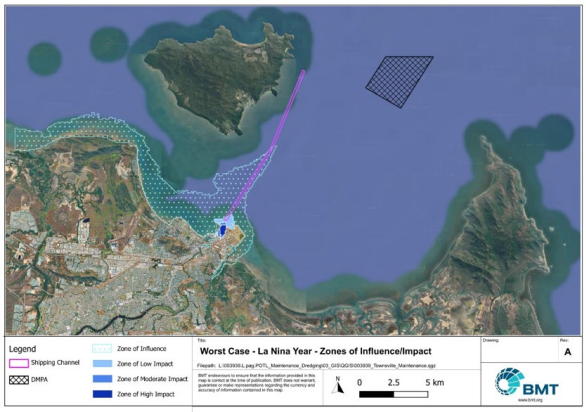


MODELLED OUTCOMES - LA NINA YEAR (WET)

400,000m^3 annual dredging volume



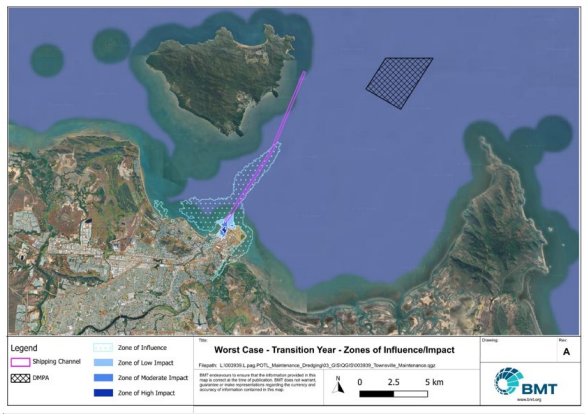
600,000m^3 annual dredging volume



MODELLED OUTCOMES - TRANSITION YEAR (NEUTRAL)

400,000m^{3}annual dredging volume

600,000m^3 annual dredging volume



It is important to recognise that these figures combine results from multiple model simulations and represent the maximum modelled impact at each location. They do not show the extent of a dredge plume at any particular moment in time.

MODELLED OUTCOMES – SEDIMENT DEPOSITION

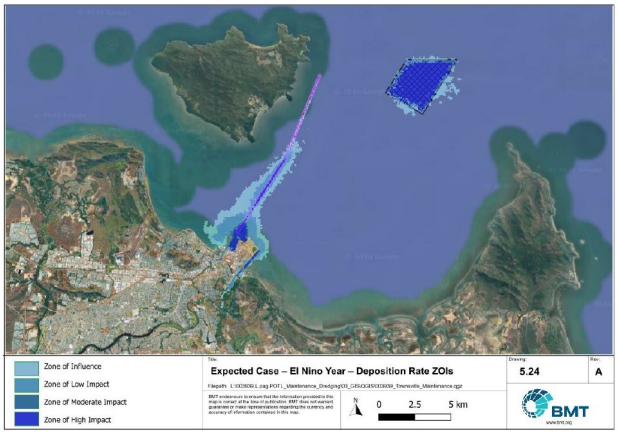
Results for sediment deposition were broadly similar across all modelled scenarios. Key findings include:

- Zones of Moderate and High Impact are largely restricted to active dredging and placement areas;
- Zones of Low Impact occur immediately adjacent to dredging and placement locations and may extend up to approximately 1.5 km from parts of the shipping channel in upper-case scenarios;
- No mapped coral habitats occur within any modelled Zones of Impact for sediment deposition; and
- The majority of mapped seagrass habitats occur outside Zones of Impact. A small area of mapped seagrass offshore from The Strand overlaps a modelled Zone of Low Impact where any impacts are predicted to be minor, temporary and recoverable.

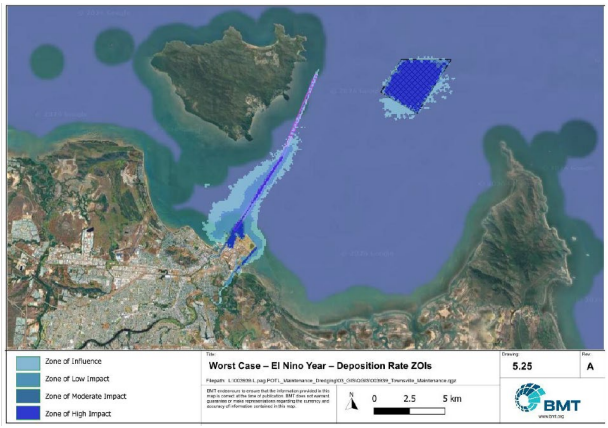
Overall, sediment deposition impacts are predicted to be localised and largely confined to dredging and placement areas, with no predicted impacts to mapped coral habitats and only a small area of seagrass predicted to experience minor, temporary and recoverable effects.

MODELLED OUTCOMES - EL NINO YEAR (DRY)

400,000m^3 annual dredging volume

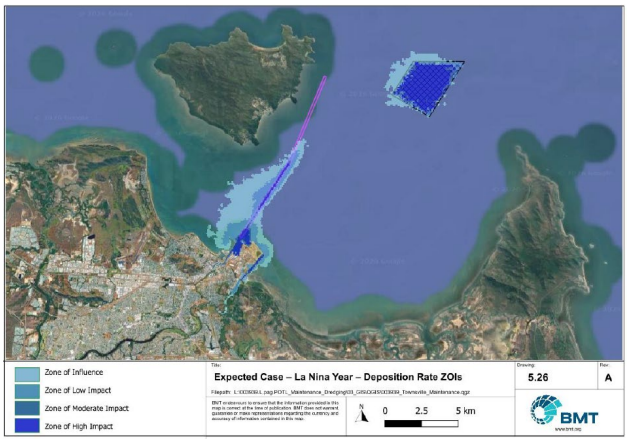


600,000m^3 annual dredging volume

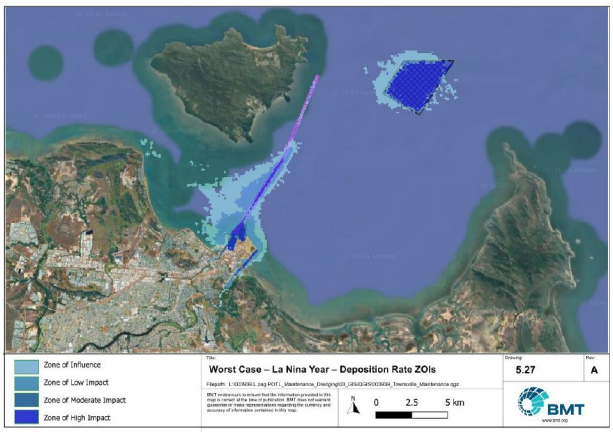


MODELLED OUTCOMES - LA NINA YEAR (WET)

400,000m^3 annual dredging volume

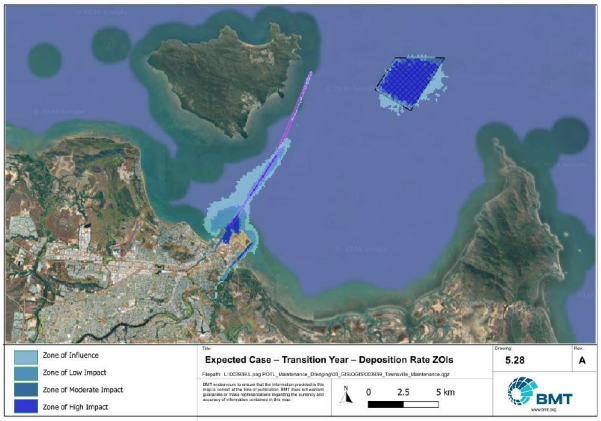


600,000m^3 annual dredging volume

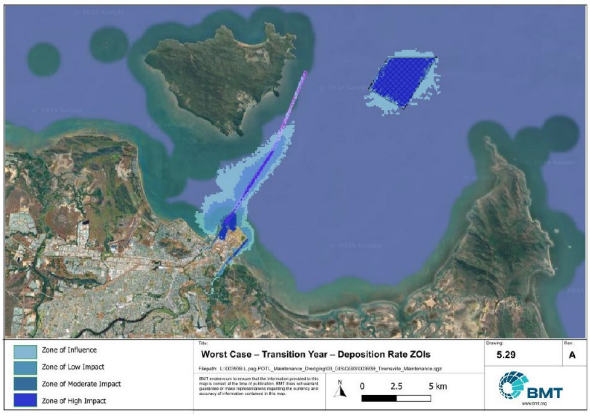


MODELLED OUTCOMES - TRANSITION YEAR (NEUTRAL)

400,000m3 annual dredging volume



600,000m3 annual dredging volume



As outlined above - It is important to recognise that these figures combine results from multiple model simulations and represent the maximum modelled impact at each location. They do not show the extent of a dredge plume at any particular moment in time.

ASSESSMENT CONFIDENCE

Confidence in the modelling results is supported by:

- A hydrodynamic modelling framework that has been developed, calibrated and refined over more than a decade;
- Independent peer review and specialist review during previous environmental assessment processes;
- Validation against measured water levels, currents, waves and turbidity data collected within Cleveland Bay;
- Assessment of both expected and upper-case dredging scenarios;
- Assessment under El Niño, La Niña and neutral climate conditions; and
- Application of current industry guidance and best-practice modelling methods.

The consistency of results across all dredging volumes and climate conditions provides confidence that the model adequately represents the range of conditions that may occur during the proposed 10-year permit period. The 2026 assessment reached broadly similar conclusions to the previous 2014 maintenance dredging assessment, providing additional confidence in the predicted environmental outcomes despite model updates, refinement of assumptions and incorporation of additional data.

SUMMARY OF FINDINGS

Overall, the modelling indicates that the environmental effects of maintenance dredging are localised, temporary and unlikely to result in measurable long-term impacts to sensitive marine habitats in Cleveland Bay. Key findings include:

- Modelled impacts are highly localised and generally confined to areas immediately surrounding dredging and placement activities. Zones of Moderate and High Impact are largely confined to areas where dredging and placement activities occur.
- A Zone of Influence is predicted to extend along parts of the mainland coastline towards the Ross River mouth and Cape Pallarenda. Within this zone, dredging-related increases in turbidity may be detectable, however water quality is predicted to remain within the range of natural variability.
- No predicted adverse impacts to mapped coral habitats, and no predicted adverse impacts to the majority of mapped seagrass habitats, are expected from maintenance dredging and placement activities.
- A small area of mapped seagrass offshore from The Strand overlaps a modelled Zone of Low Impact for sediment deposition. In this area, any effects are predicted to be minor, temporary and recoverable.

- The model indicates that maintenance dredging impacts are temporary and largely limited to the immediate vicinity of dredging and placement activities. Because these impacts are short-term and localised, they are not expected to accumulate from one maintenance dredging campaign to the next. Consequently, cumulative impacts to water quality, coral reefs and seagrass habitats are not predicted over the proposed 10-year permit period.
- Given the short duration of maintenance dredging campaigns, the short-term nature of dredge plumes and the natural variability that characterises water quality in Cleveland Bay, annual maintenance dredging is not expected to result in measurable long-term impacts to sensitive marine environments
- The 2026 assessment reached broadly similar conclusions to the previous 2014 maintenance dredging assessment. While the modelling framework has been updated using new data, contemporary industry guidance and refined dredging assumptions, the results continue to indicate that impacts are localised, temporary and unlikely to result in measurable long-term effects on sensitive marine habitats.