CAIRNS SHIPPING DEVELOPMENT PROJECT

Revised Draft Environmental Impact Statement

APPENDIX AF: Coastal Processes Impact Assessment Technical Report (2017)

BMT WBM

Coastal Processes Impact Assessment - Technical Report

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Synopsis: **This report assesses the coastal process impacts of the Cairns Shipping Development Project.**

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1 Introduction

The Cairns Shipping Development Project (the Project) is a capital dredging project in Trinity Inlet and Trinity Bay to increase the capacity of the Port of Cairns for tourism and shipping. Up to 1 M m^3 of material is proposed to be dredged and placed onshore, with the bulk of the dredge material to be placed at the Northern Sands Dredge Material Placement Area (DMPA) on the Barron Delta and stiff clay material placed at the Tingira Street Dredge Material Placement Area (DMPA) at the Port.

The project has the potential to influence coastal processes within Trinity Inlet and Trinity Bay resulting from capital dredging of the existing shipping channel into Cairns Port, the channel bend, swing basins and inner port. Potential coastal processes impacts relate to changed tidal hydrodynamics, waves and sediment transport due to the widened channel and inner port swing basins.

The coastal processes as described herein include the hydrodynamic factors, particularly waves and currents, sediment transport forced by those factors and the resulting seabed and coastal morphology within the littoral and marine zone of Trinity Bay and Inlet, at and adjacent to the project area.

Chemical properties of the marine sediments and water quality aspects are addressed separately in the EIS. Baseline coastal processes relevant to the project have been separately reported in Chapter B3 of the draft EIS. Additional Metocean datasets collected during 2016/17 are reported in the updated Numerical Model Development and Calibration Technical Appendix (BMT WBM, 2017).

2 Assessment of Potential Impacts

2.1 Overview

This section outlines the potential impacts the project may have on the coastal processes. This section describes:

- An assessment of the impacts on these coastal processes that may result from the project. This specifically takes in account the construction and operation of the proposed channel widening/deepening and new port infrastructure.
- Any required measures proposed to manage and mitigate potential impacts to coastal processes.

A risk-based approach has been used to assess coastal process impacts, and is based on the consideration of the following:

- Consequence of Impact – made up of assessment of the intensity, scale (geographic extent), duration of s impacts to coastal processes. Table 2-1 is a summary of the categories used to define impact significance
- Duration of Impact - the duration of identified impacts is classified as per Table 2-2.
- Likelihood of Impact – which assesses the probability of the impact occurring. Table 2-3 is a summary of the categories used to define impact likelihood
- Risk rating – which assesses the level of risk for key impacting processes. The risk table (Table 2-4) adopted is generated from the Consequence and Likelihood scores, based on the overall matrix presented in Part A.

Table 2-1 Categories Used to Define Consequence of Impact (Coastal Processes)

Impact Consequence	Description for Coastal Processes (includes magnitude, duration, and sensitivity of receiving values)
Very High	The impact is considered critical to the decision-making process as it would represent a major change to the coastal processes of Trinity Bay and Inlet. This level of impact would be indicated by: • Very large changes to the natural physical processes in Trinity Bay and Inlet, such as major shoreline erosion or major changes to tidal currents and/or sediment transport patterns
High	The impact is considered important to the decision-making process as it would a detectable change to the coastal processes of Trinity Bay and Inlet. This level of impact would be indicated by: • Large changes to the natural physical processes in Trinity Bay and Inlet, such as shoreline erosion or large changes to tidal currents and sediment transport patterns
Moderate	While important at a state or regional or local scale, these impacts are not likely to be critical decision making issues. This would be indicated by: • Moderate changes to the natural physical processes in Trinity Bay and Inlet, such as significant shoreline realignment or moderate changes to tidal currents and/or sediment transport patterns
Minor	Impacts are recognisable/detectable but acceptable. These impacts are unlikely to be of

Impact Consequence	Description for Coastal Processes (includes magnitude, duration, and sensitivity of receiving values)
	importance in the decision making process. Nevertheless, they are relevant in the consideration of standard mitigation measures. This would be indicated by: • Minor changes to the natural physical processes in Trinity Bay and Inlet, such as subtle shoreline realignment or minor changes to tidal currents and/or sediment transport patterns
Negligible	Minimal change to the existing situation. This could include, for example, impacts that are below levels of detection, impacts that are within the normal bounds of variation or impacts that are within the margin of forecasting error.
Beneficial	Any beneficial impacts as a result of the project such as for example, a reduced need for maintenance dredging.

Table 2-2 Classifications of the duration of identified impacts

Relative duration of impacts	
Temporary	Days to months
Short Term	Up to one year
Medium Term	From one to five years
Long Term	From five to 50 years
Permanent / Irreversible	In excess of 50 years

Table 2-3 Categories Used to Define Likelihood of Impact (Coastal Processes)

Likelihood	Categories
Highly Unlikely/Rare	Highly unlikely to occur but theoretically possible
Unlikely	May occur during construction/life of the project but probability well <50%; unlikely but not negligible
Possible	Less likely than not but still appreciable; probability of about 50%
Likely	Likely to occur during construction or during a 12 month timeframe; probability >50%
Almost Certain	Very likely to occur as a result of the proposed project construction and/or operations; could occur multiple times during relevant impacting period

Table 2-4 Risk Matrix for Coastal Processes

Likelihood	Impact Consequence				
	Negligible	Minor	Moderate	High	Very High
Highly Unlikely/ Rare	Negligible	Negligible	Low	Medium	High
Unlikely	Negligible	Low	Low	Medium	High
Possible	Negligible	Low	Medium	Medium	High
Likely	Negligible	Medium	Medium	High	Extreme
Almost Certain	Low	Medium	High	Extreme	Extreme

Table 2-5 Risk Rating Legend

Extreme Risk	An issue requiring change in project scope; almost certain to result in a 'significant' impact on a Matter of National or State Environmental Significance
High Risk	An issue requiring further detailed investigation and planning to manage and reduce risk; likely to result in a 'significant' impact on a Matter of National or State Environmental Significance
Medium Risk	An issue requiring project specific controls and procedures to manage
Low Risk	Manageable by standard mitigation and similar operating procedures
Negligible Risk	No additional management required

2.2 Methodology

The TOR and EIS guidelines have been followed in assessing the impacts on coastal processes by:

- Determining the nature and behaviour of the existing conditions and processes occurring
- Assessing the potential changes to processes affecting the existing conditions that may be caused by the proposed project.

A review of available relevant literature and existing data was undertaken in order to:

- Characterise existing coastal processes that affect the stability and integrity of the physical marine and coastal environment (coastal landforms) in and around the study area
- Identify potential issues that are of key relevance to the impact assessment process
- Identify gaps in existing knowledge to be investigated in this study.

Key sources utilised during the review of existing literature are set out in the Reference section of this chapter. Review of available existing information as published in reports and other sources has been augmented by additional investigations undertaken as part of the EIS preparation.

Coastal processes have been considered in two broad categories, based on their morphological nature and the predominant sediment transport mechanisms, namely:

- Trinity Bay and Inlet marine hydrodynamic and sedimentation processes, including siltation in dredged areas and effects of dredged material placement
- Cairns littoral and beach system processes.

Each of these systems has been investigated and assessed using a combination of historical records, continuous datasets obtained specifically for this EIS and numerical modelling tools.

The construction phase of the project will involve dredging of between 0.78M and 1.0M m^3 of material from the channel. Dredge material quantities include soft clays (estimated between 710,00 and 900,000 m^3), and stiff clays (estimated between 80,000 and 100,000 m^3).

Soft clay dredge material is to be transported to a shore based Dredge Material Placement Area (DMPA) at the Northern Sands sand extraction operation on the Barron Delta. Stiff clay dredge material is to be transported to previously reclaimed Ports North land at Tingira Street, Portsmith.

The soft clays are to be dredged via a 5,600 m^3 capacity Trailer Suction Hopper Dredge (TSHD) discharging to a temporary floating pump out facility between approximately 2.7 and 3.7 km NE of Yorkeys Knob.

Dredge material will be pumped from the pump out facility via a submerged steel pipeline, which will make landfall near the Richters Creek mouth, thence to the Northern Sands DMPA via cane farm headlands and Captain Cook Highway culverts (Figure 2-2). Due to the pipeline distance (approximately between 8.1 km and 9.1 km) from pump out to the NS DMPA, up to three pipeline booster pumps will be required, depending on TSHD pumping capacity. The duration of TSHD dredging would be approximately 12 weeks (not including mobilisation and demobilisation) while the BHD component would be around 5-6 weeks, with the two activities potentially occurring concurrently.

Construction phase impacts related to the Project dredging works are predominantly assessed in the Marine Water Quality and Marine Ecology chapters of the revised draft EIS using outputs from the hydrodynamic and water quality modelling. These impacting processes include dredge plume turbidity and sedimentation impacts as well as impacts from the reclamation tailwater discharge.

In the context of coastal processes, the impact of the submerged temporary dredge material pipeline is assessed in this document. However, the performance of the Northern Sands reclamation under fluvial and storm tide inundation flooding scenarios is assessed in the EIS.

The operational phase impacts associated with the Project are generally related to the effects on coastal processes following the completion of the proposed dredging works. The channel design to be assessed in the Revised Draft EIS will involve the following elements (Figure 2-1):

- -8.8m LAT target declared depth (plus overdredge allowances).
- Expanded Crystal Swing Basin to 380m
- Expanded Smith's Creek Swing Basin to 310m
- Outer Channel width 90 -100m

- Inner Channel width generally to 110m (outer bend to 180m)
- Total volume of sediment to be dredged is estimated to be between 0.78M and 1.0M m^3.

The difference in bed elevation between the “Base Case” (existing approved channel dimensions) and “Developed Case” channel scenarios is shown in Figure 2-3. These two bathymetric scenarios form the basis for the coastal processes impact assessment. Numerical model simulations were completed for each bathymetric scenario (all other model inputs and settings are identical) and the outputs compared. Differences between the model results are deemed to be impacts associated with the Project.

The subsequent report sections present the impact assessment of the Project for the key coastal processes issues identified in the baseline section which are:

- Construction impacts related to submerged dredge material pipeline
- Operational impacts related to hydrodynamics
- Operational impacts related to waves
- Operational impacts related to morphology and sedimentation

Key assumptions and limitations of the impact assessment are outlined and discussed where relevant.

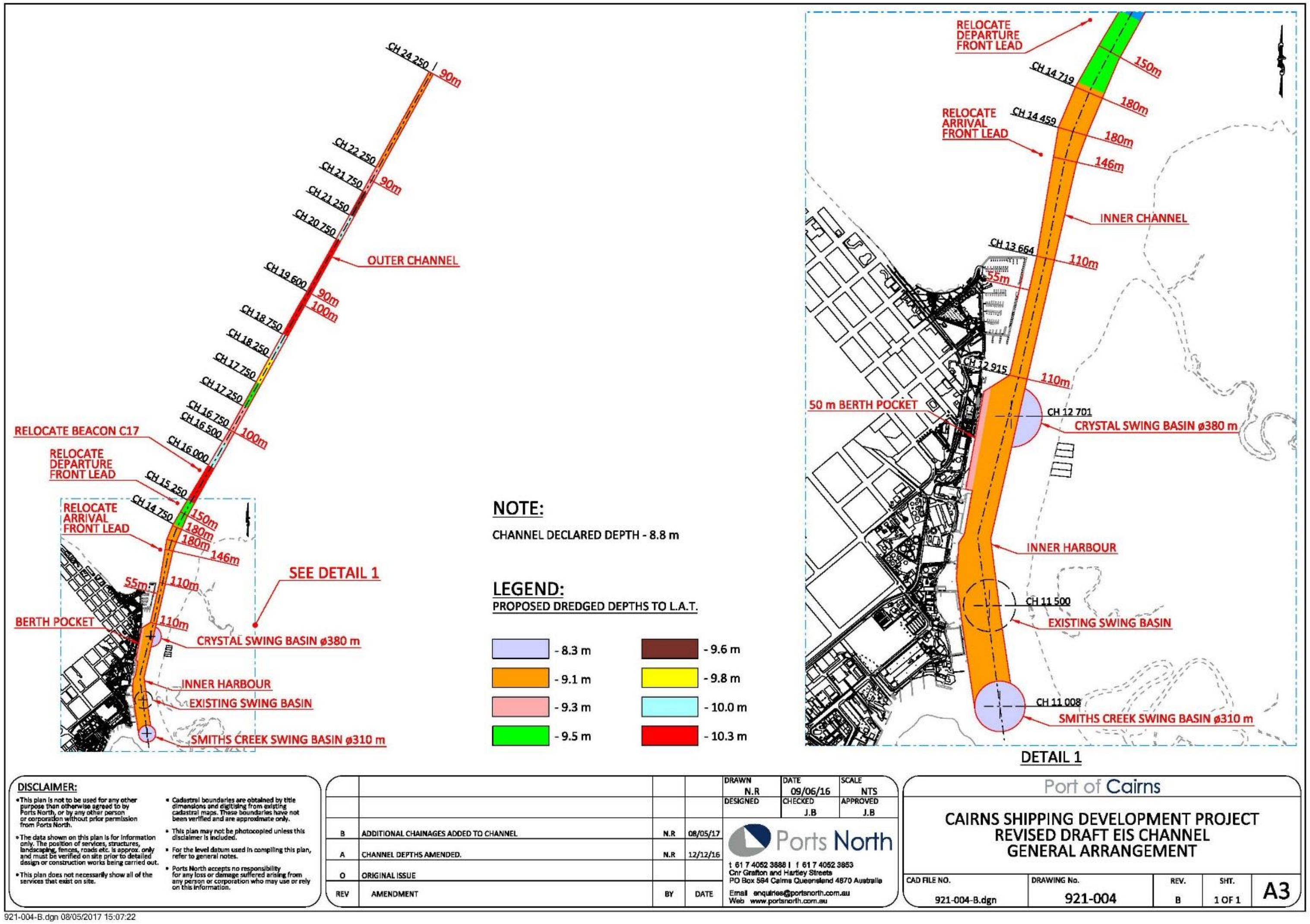
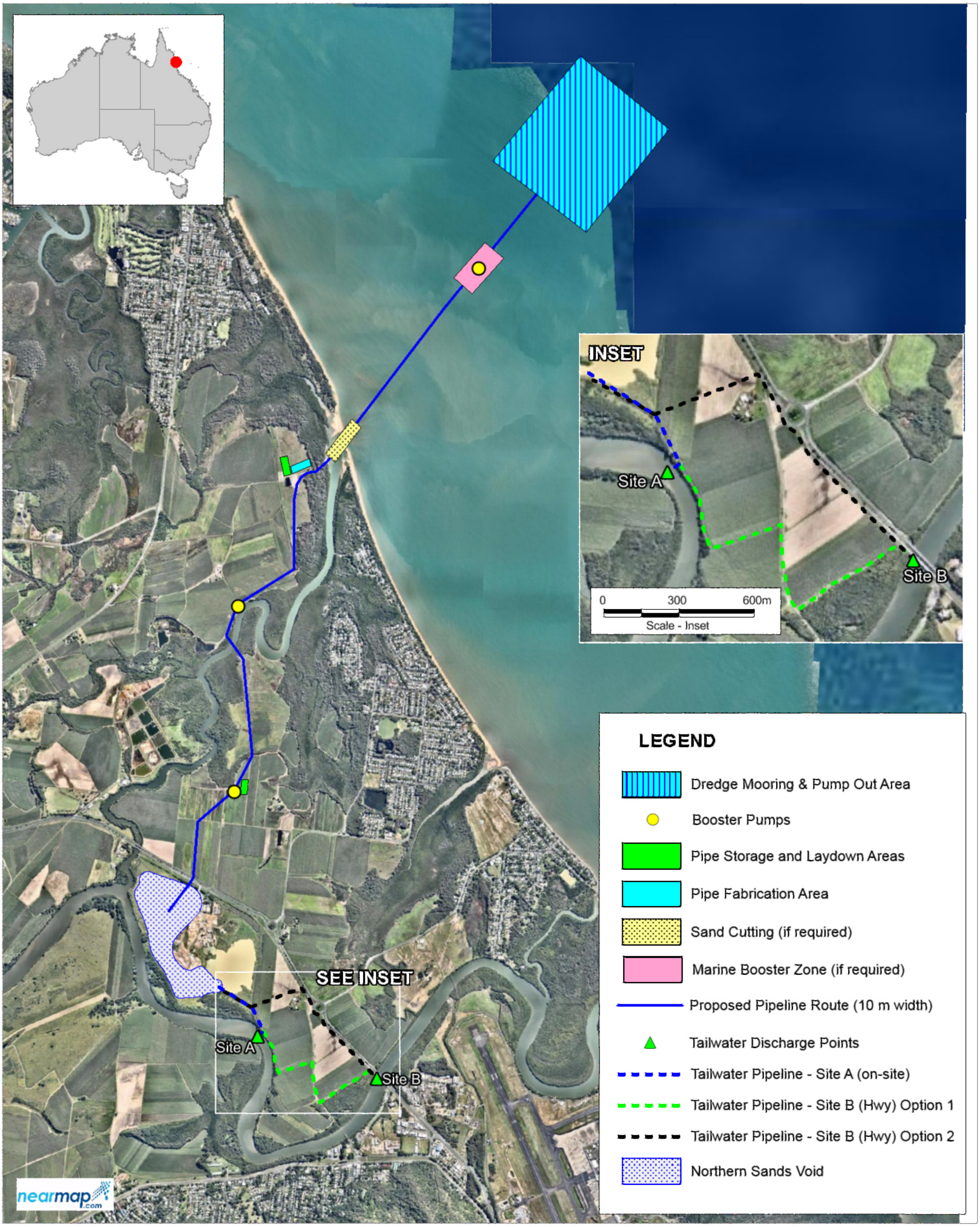


Figure 2-1 Cairns Shipping Development Project Revised General Arrangement



Title:

Northern Sands Dredge Material Placement Configuration

Figure: 2-2

Rev: A

N

0 800 1,600m

Approx. Scale

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2.3 Construction Phase Impacts

2.3.1 Dredge Material Pipeline

Dredge material will be pumped from the pump out facility via a submerged steel pipeline, which will make landfall near the Richters Creek mouth, thence to the Northern Sands DMPA via cane farm headlands and Captain Cook Highway culvert.

Below the HAT level, the potential disturbance areas are considered high energy environments (i.e. surf beach, surf zone, creek entrance and nearshore) that are comprised of highly mobile sands influenced by wind, waves and currents, and subject to regular natural physical disturbance events (e.g. storm-related wave-induced erosion). Given the dynamic nature of the area, the physical characteristics would be expected to rapidly recover (i.e. local beach morphology and sediment characteristics within range of natural variation) on completion of these beach disruption works.

While the pipeline is in place, which is expected to be greater than 3 months but less than 6 months in duration, it may produce a temporary barrier to local longshore sediment transport processes. The baseline longshore sediment transport for the Northern Beaches (refer draft EIS Section 3.4.12) indicates that the beach system around Richters Creek is very dynamic, in particular the response to the sand supply and movements of the various river and creek mouths. The upper beach alongshore sand transport regime involves a relatively modest northward net movement of sand, which varies between beach units but is estimated to be less than 20,000 m^3/year. It is noted that periods of persistent southerly sand transport may also occur from time to time.

Offshore of the subaerial beach the submerged pipeline will also have the potential to trap bedload transport of sand-sized material on its up-drift side. As for the upper beach system, net transport is also northward under prevailing conditions but may be persistently southward from time to time. The offshore submerged pipeline would not be expected to be very efficient at trapping the predominantly fine-grain offshore sediments. The effect of any temporary trapping would be alleviated following removal of the pipeline.

2.4 Operational Impacts - Hydrodynamics

The Project dredging will induce changes to flow patterns in the immediate vicinity of the development. The 3D hydrodynamic model described in BMT WBM (2017) was used to assess the magnitude and significance of the impacts. As described below, the assessment has considered impacts to current fields, water levels, bed shear stresses, tidal prism, storm tide propagation and flood plume conveyance within Trinity Inlet.

2.4.1 Tidal Current Field Impacts

The Project channel dredging will increase the conveyance (flow capacity) of the dredged channel entering Trinity Inlet and has the potential to redistribute flow patterns in the immediate vicinity of the works. Depth-averaged current speeds were extracted from the 3D hydrodynamic model Base Case and Developed Case simulations and analysed in order to understand the dredging impacts on current patterns.

Changes to current patterns in the vicinity of the Port were assessed for a flooding tide and an ebbing tide during a period of spring tides. Spatial plots of the changes in velocity magnitudes between the Base Case and Developed Case are shown in Figure 2-5 and Figure 2-6 (zoomed view) for the flooding tide. Figure 2-7 and Figure 2-8 (zoomed view) show the equivalent model predictions for the ebbing tide. Reductions in velocity magnitude are in blue, and increases in yellow. The vectors (arrows) on these plots represent both the direction and magnitude of the depth-averaged currents. The developed case vectors are overlain on the impact plots in order to aid interpretation.

BMT WBM (2017) provides a detailed discussion of the spatial current pattern impacts. In summary, the velocity impact plots show that the changes in velocity magnitudes associated with the Project are confined to the Project Area and the immediate surroundings. The highest magnitude changes are not large (generally up to ±0.1 m/s during spring ebb tide flows). The velocities in the deepened and widened channel are generally reduced, with some localised areas of both increased and decreased velocities immediately adjacent to the dredging footprint. The minor changes to current patterns are not expected to be of significance to seagrass or other benthos (potential project related impacts to marine ecology are considered separately elsewhere in the EIS.

Time series of depth-averaged velocity were extracted at the seven analysis sites shown in Figure 2-4. The time series plots are shown in Figure 2-9 through to Figure 2-12 and correspond to the one-week period from 14 September 2013, which was selected as it includes some relatively large spring tide conditions. Tidal hydrodynamic impacts due to the channel dredging are most pronounced during spring large spring tide conditions. The timeseries presentation of results confirm that it is generally difficult to discern any significant difference between the base and developed case currents and is indicative of negligible impact from the channel works.

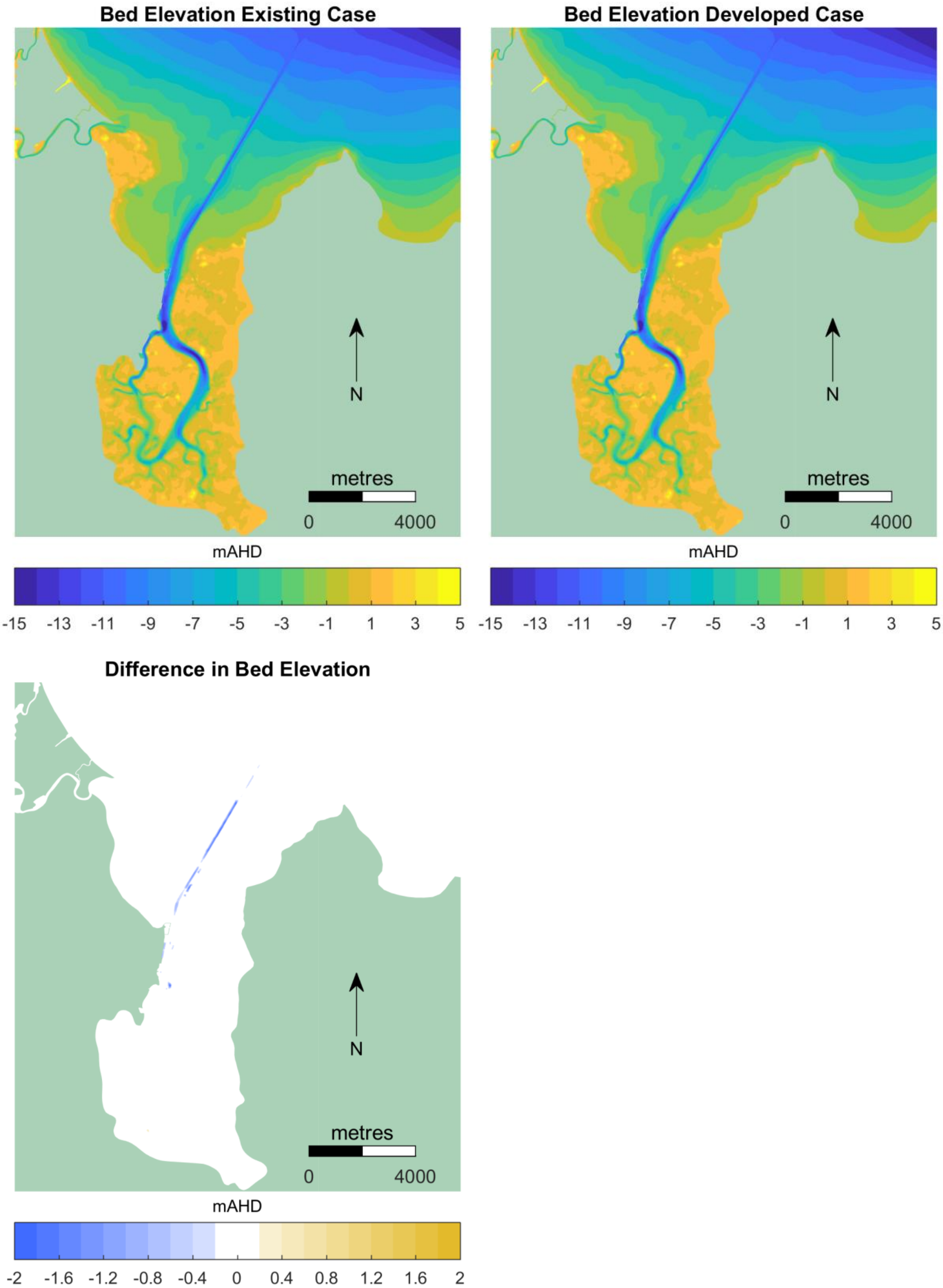

Figure 2-3 Cairns Shipping Channel and Surrounds Bed Elevation: Base Case (*top left*); Developed Case (*top right*) and Difference (*bottom*)

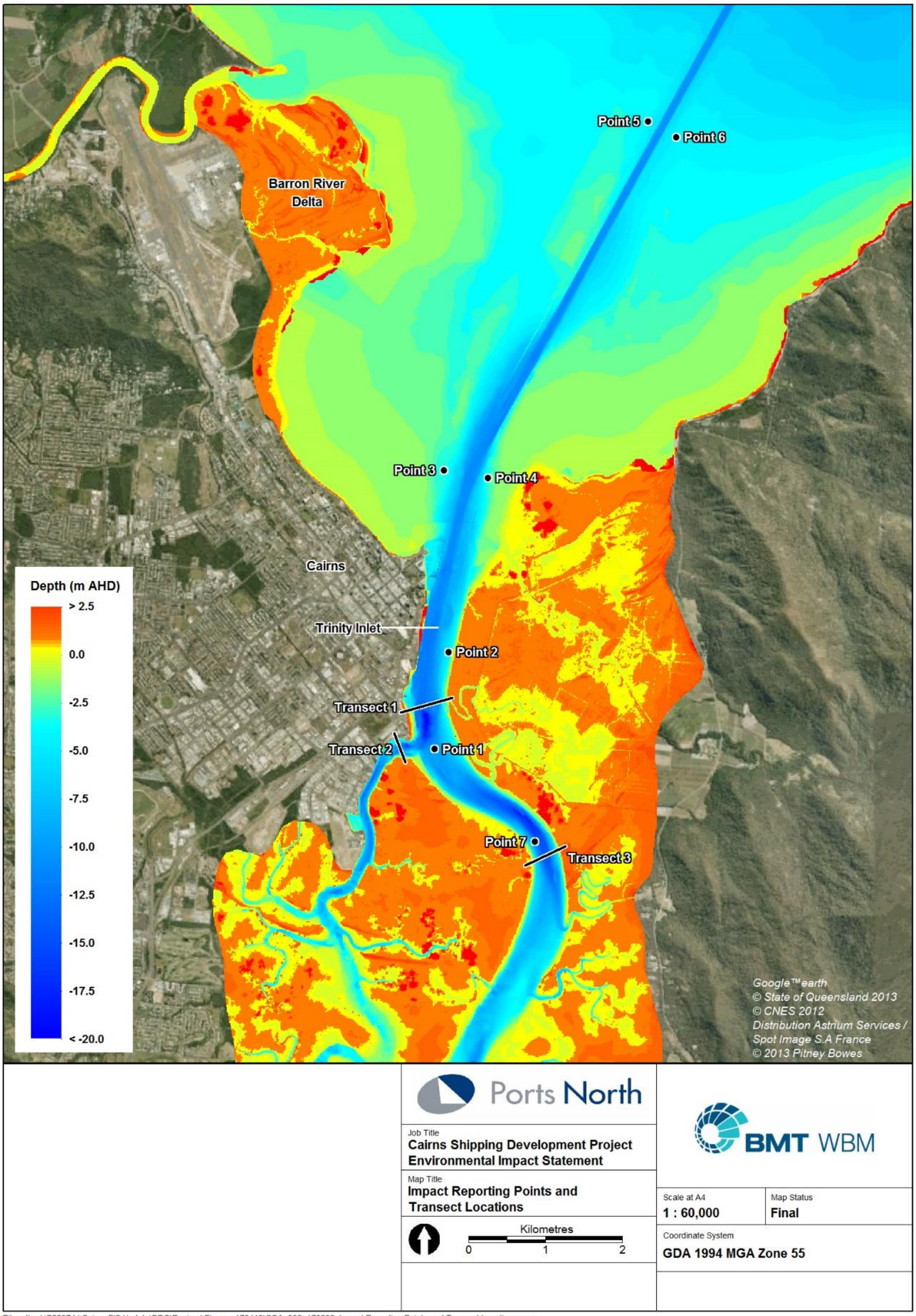

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Figure 2-4 Impact Reporting Points and Transect Locations

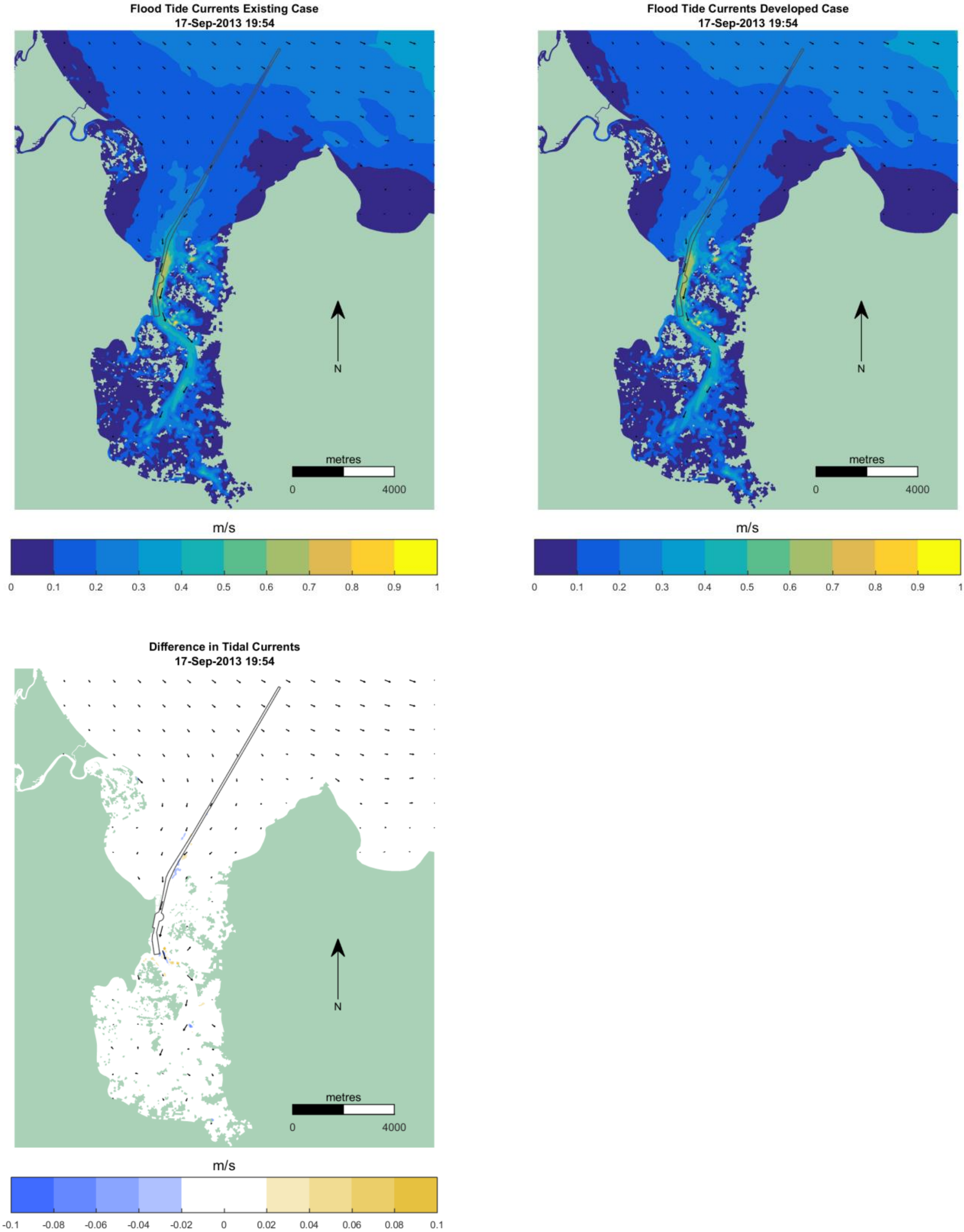


Figure 2-5 Modelled Spring Tide Flood Currents and Impacts. Base Case (*top left*); Developed Case (*top right*) and Impacts (*bottom*). Vectors indicate Direction; Contours indicate Magnitude

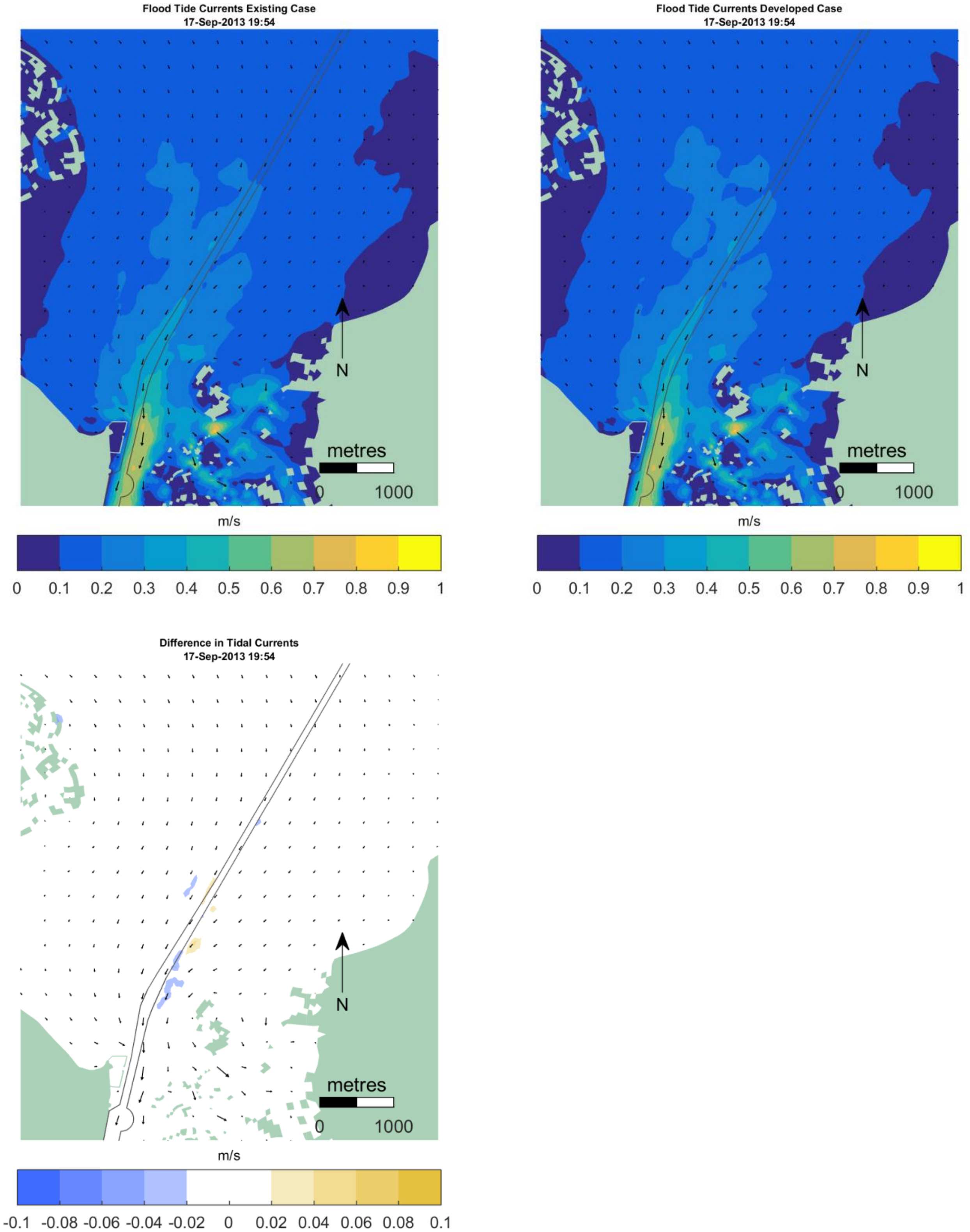


Figure 2-6 Modelled Spring Tide Flood Currents and Impacts – zoomed. Base Case (*top left*); Developed Case (top right) and Impacts (bottom). Vectors indicate Direction; Contours indicate Magnitude

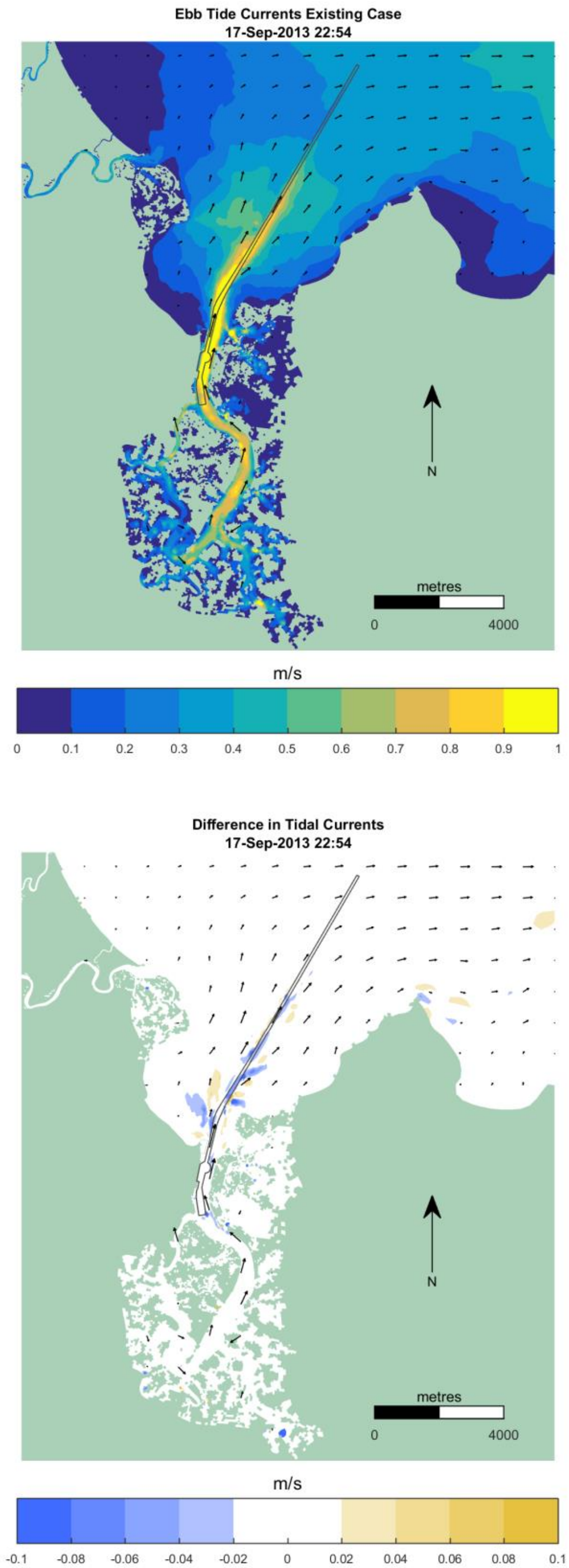


Figure 2-7 Modelled Spring Tide Ebb Currents and Impacts. Base Case (*top left*); Developed Case (*top right*) and Impacts (*bottom*). Vectors indicate Direction; Contours indicate Magnitude

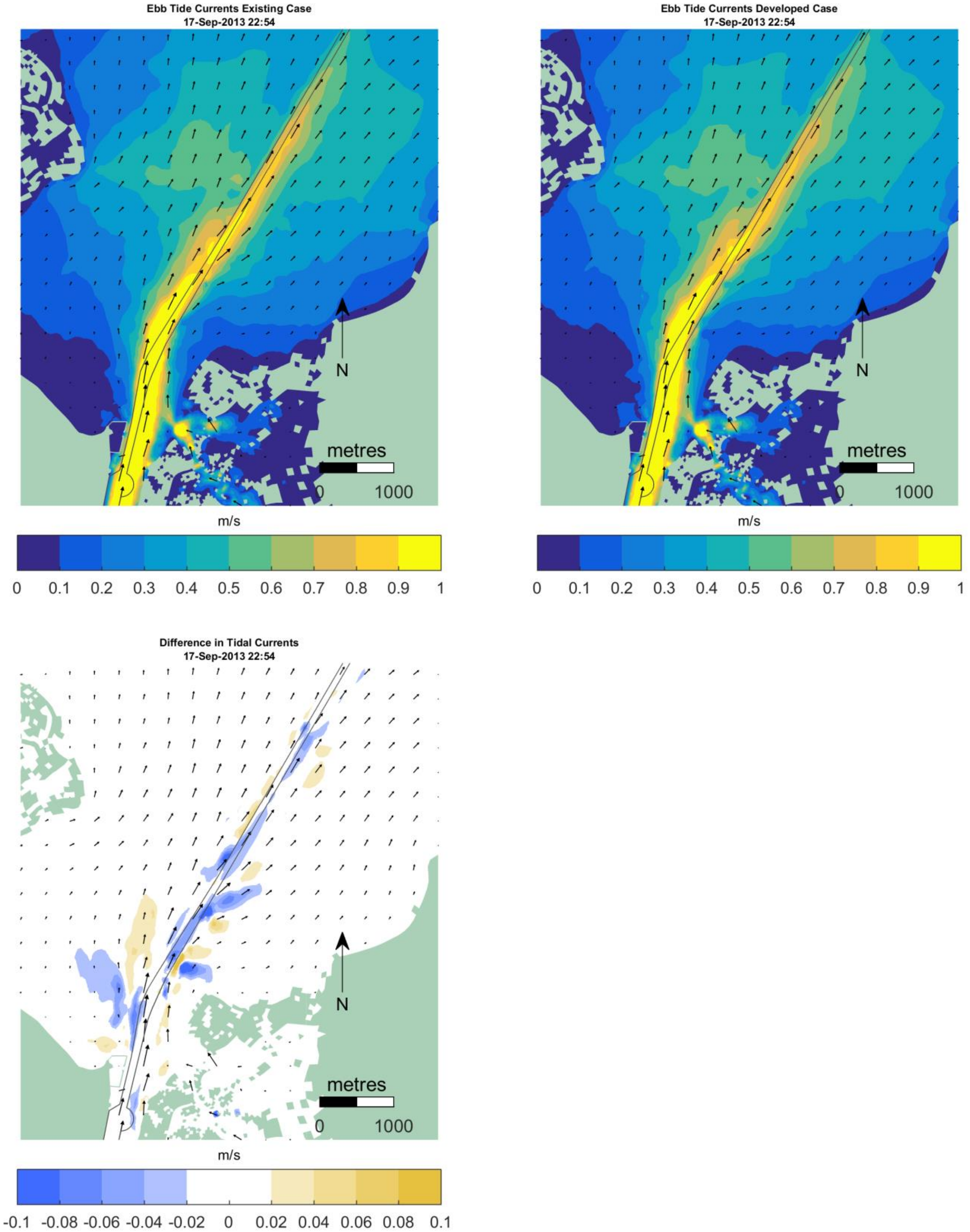


Figure 2-8 Modelled Spring Tide Ebb Currents and Impacts – zoomed. Base Case (*top left*); Developed Case (*top right*) and Impacts (*bottom*). Vectors indicate Direction; Contours indicate Magnitude

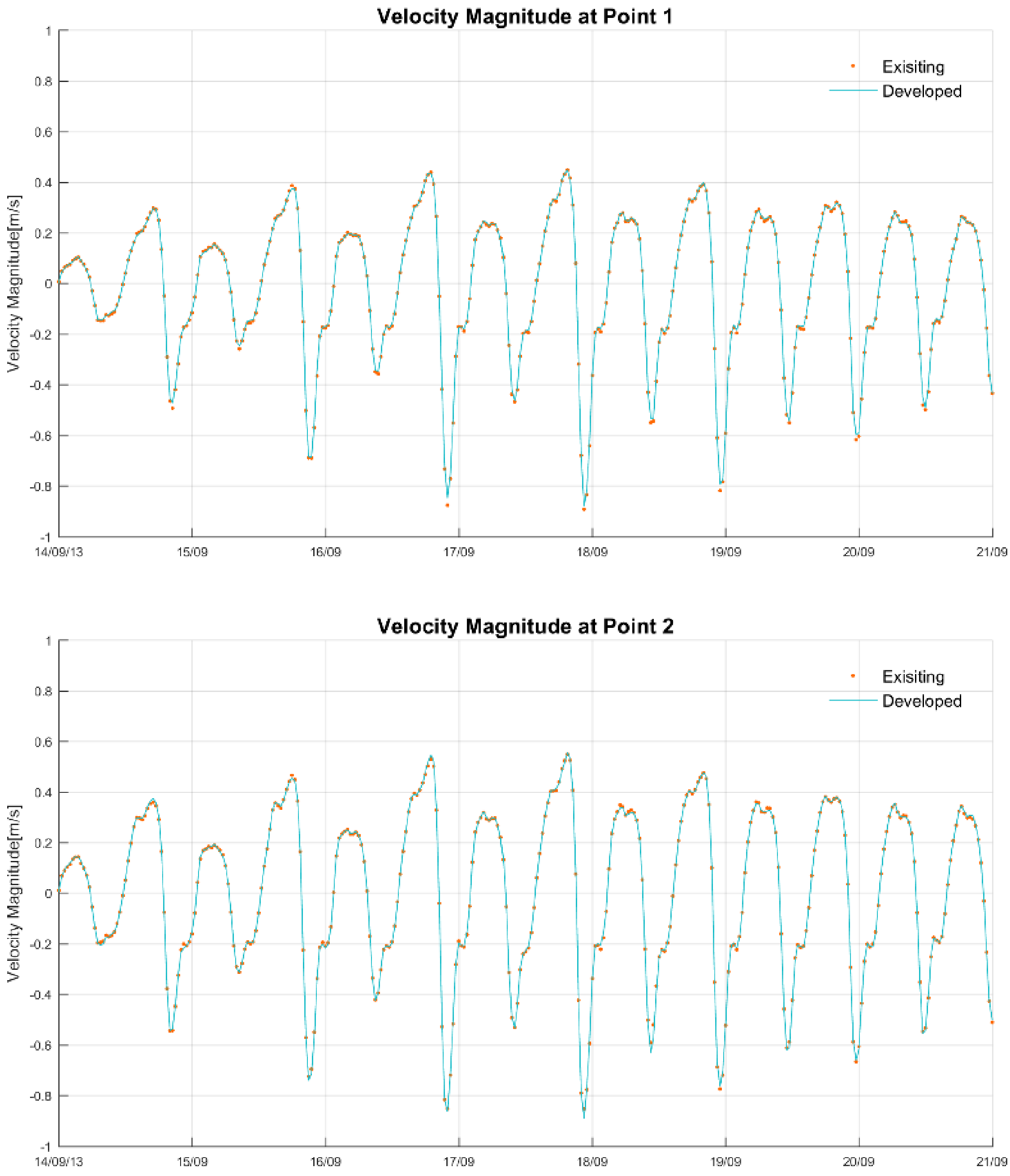


Figure 2-9 Existing and Developed Case Current Speed Timeseries (Points 1 to 2). Positive current speeds are during flooding tides

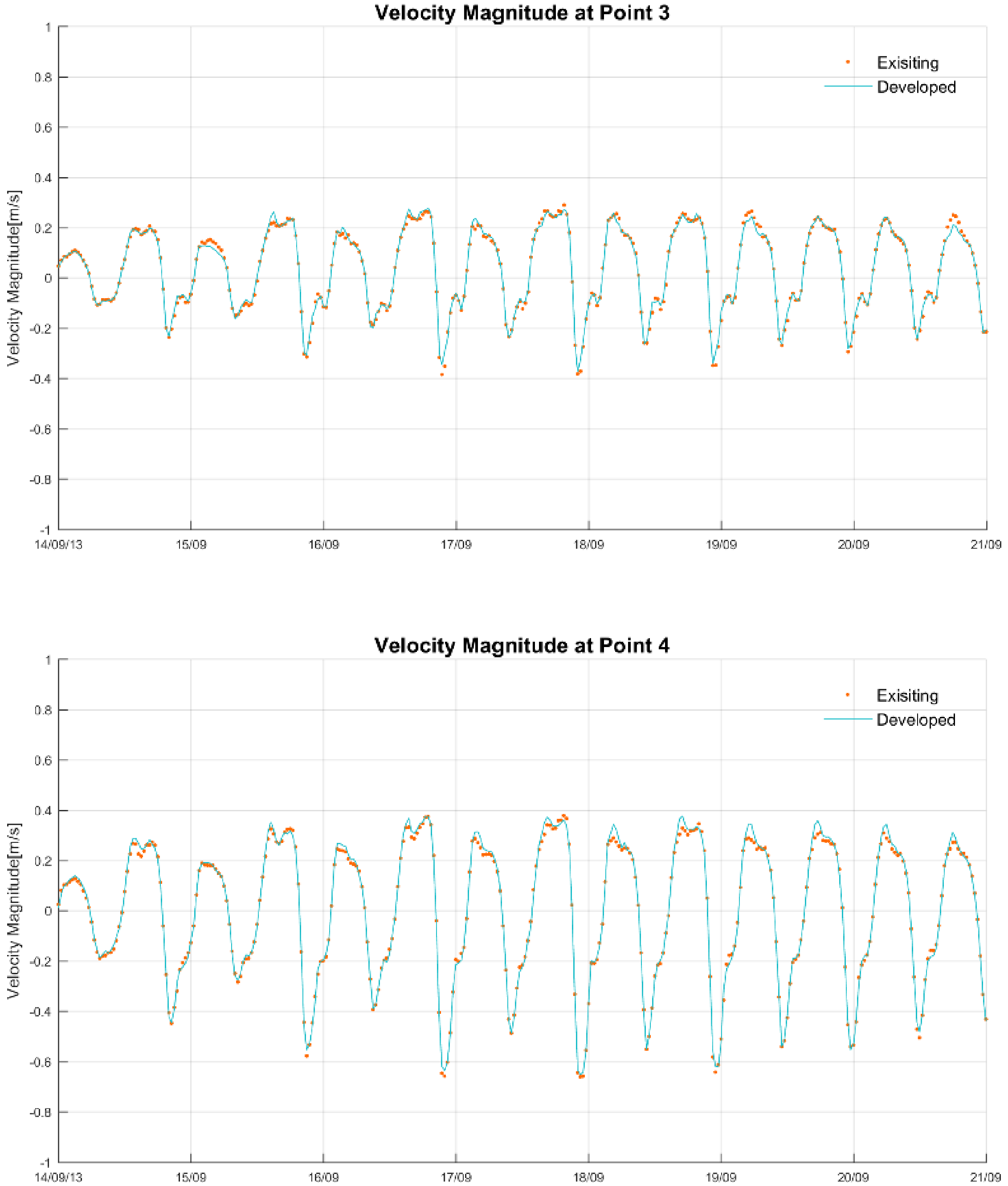
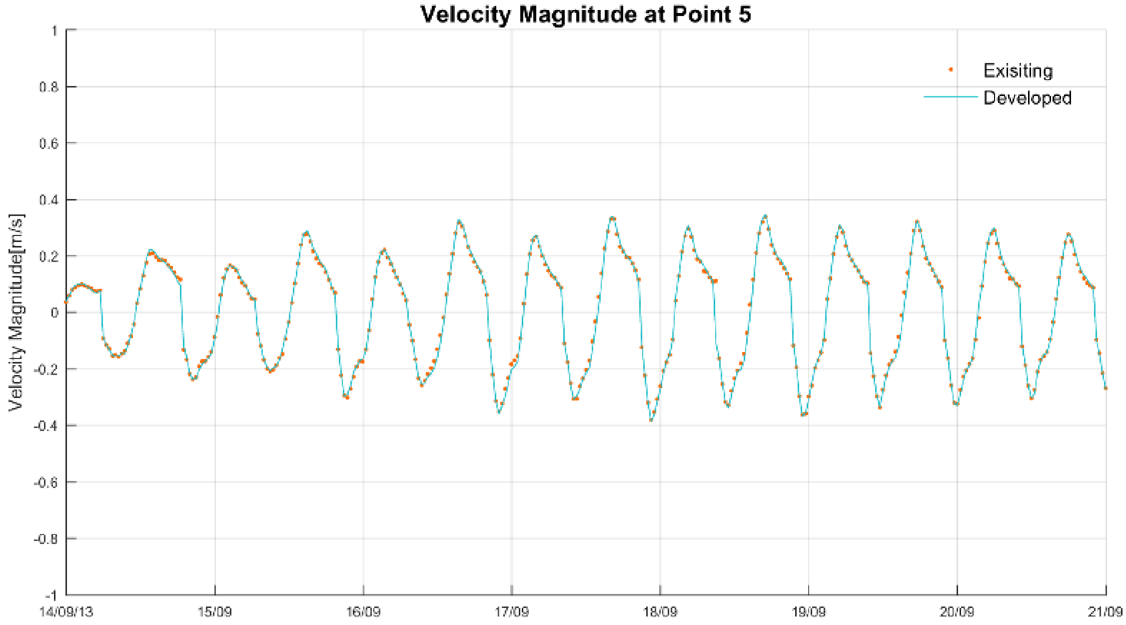


Figure 2-10 Existing and Developed Case Current Speed Timeseries (Points 3 to 4). Positive current speeds are during flooding tides



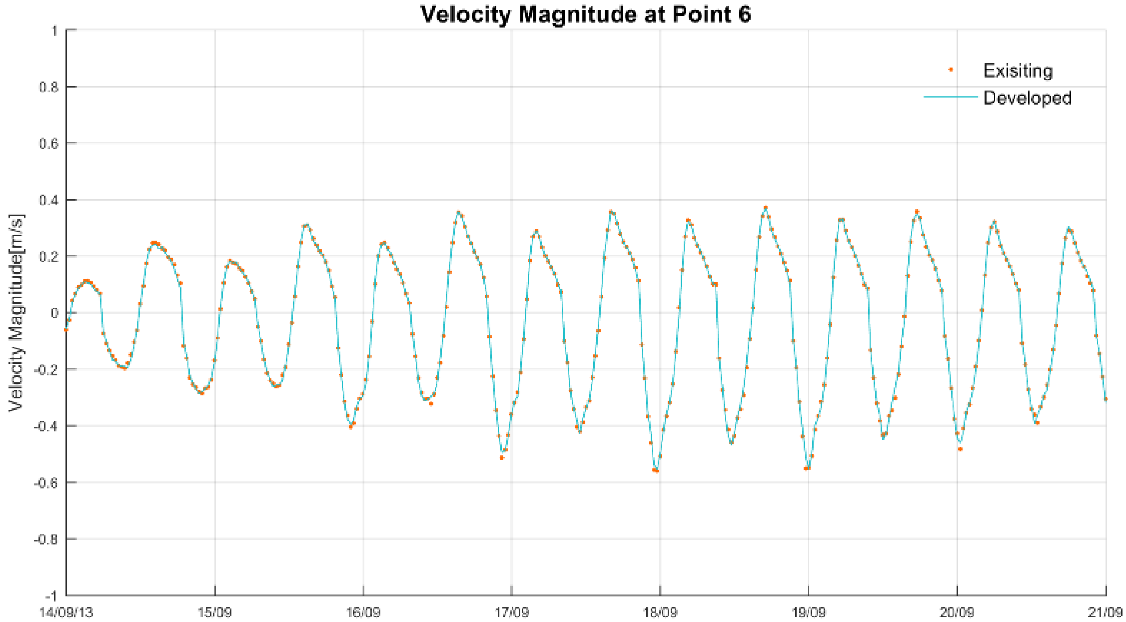


Figure 2-11 Existing and Developed Case Current Speed Timeseries (Points 5 to 6). Positive current speeds are during flooding tides

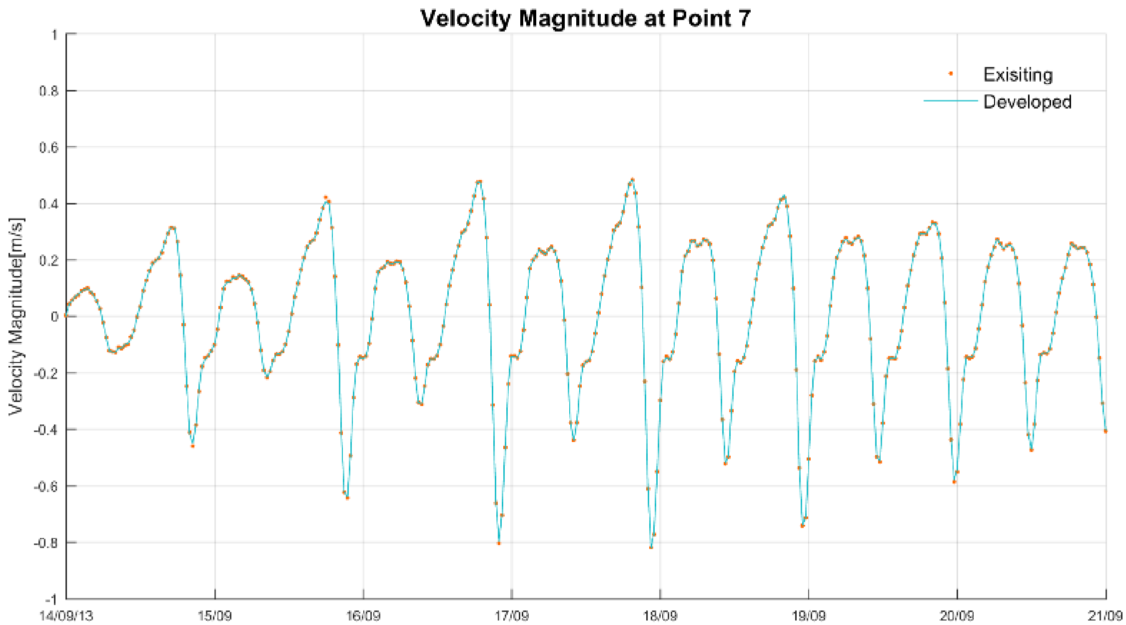


Figure 2-12 Existing and Developed Case Current Speed Timeseries (Point 7). Positive current speeds are during flooding tides

2.4.2 Water Level Impacts

Water level variations within Trinity Bay are predominantly driven by tidal oscillations (refer Draft EIS Section B3.4.7). The dredging works have some (limited) potential to impact on flow patterns and hence water levels in the vicinity of the works as well as further upstream within Trinity Inlet. If large enough, water level impacts could potentially be significant in terms of morphological processes (e.g. bank stability) and ecological processes (e.g. mangrove health).

Spatial water level impacts were analysed by differencing the Base Case and Developed Case simulation results.

The results of this analysis were that water level differences due to the Project dredging were negligible. Spatial plots of the water level impacts are not shown due to the negligible magnitude of the changes.

Time series of water level were extracted from Base Case and Developed Case simulations at the analysis sites shown in Figure 2-4. The timeseries comparisons also show no discernible difference between Base Case and Developed Case water levels. The water level timeseries at Point 7 (within Trinity Inlet) are shown below in Figure 2-13 in order to illustrate this result.

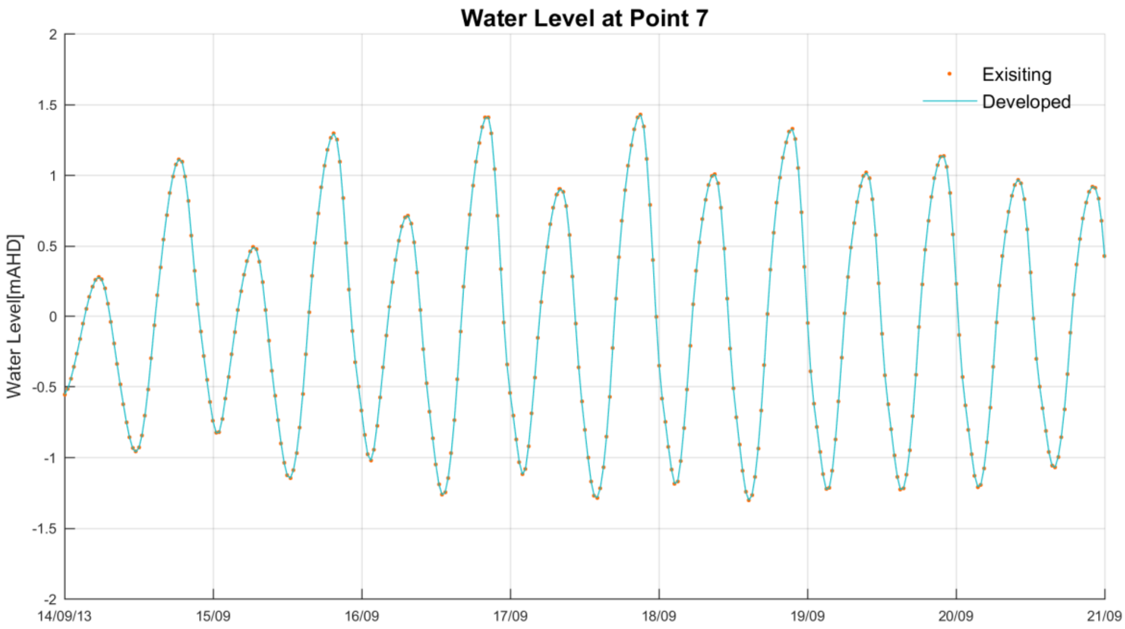
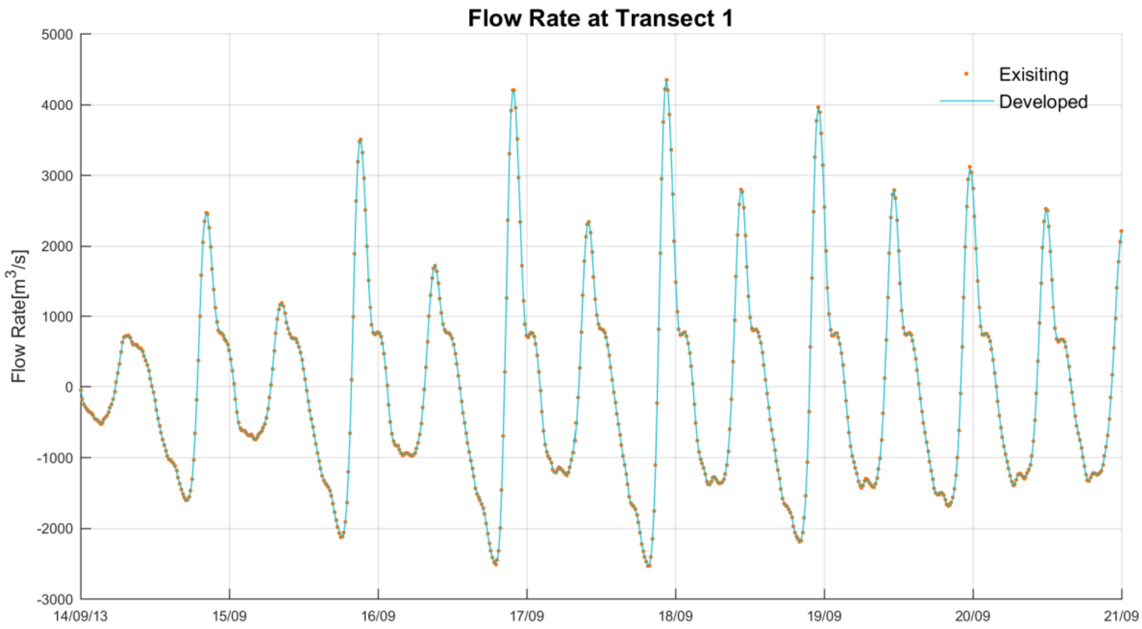


Figure 2-13 Existing and Developed Case Water Level Timeseries (Point 7 – Trinity Inlet)

2.4.3 Tidal Flow and Volume Impacts

The impact of the Project dredging on tidal flow rates and volumes were analysed in order to assess the implications of the project on tidal flushing of Trinity Inlet.

Flow timeseries were extracted from the existing and developed case model simulations at the three transect locations shown in Figure 2-4. Transect 1 is located across the main Trinity Inlet channel at the location of the Smith Creek swing basin. Transect 2 is located across the northern arm of Smith Creek. Transect 3 is located across the main Trinity Inlet channel around 1.8km upstream of the Smith Creek swing basin. The timeseries comparisons presented in Figure 2-14 and Figure 2-15 show no discernible difference between Base Case and Developed Case flows. There was correspondingly no discernible impact on tidal prism within Trinity Inlet.



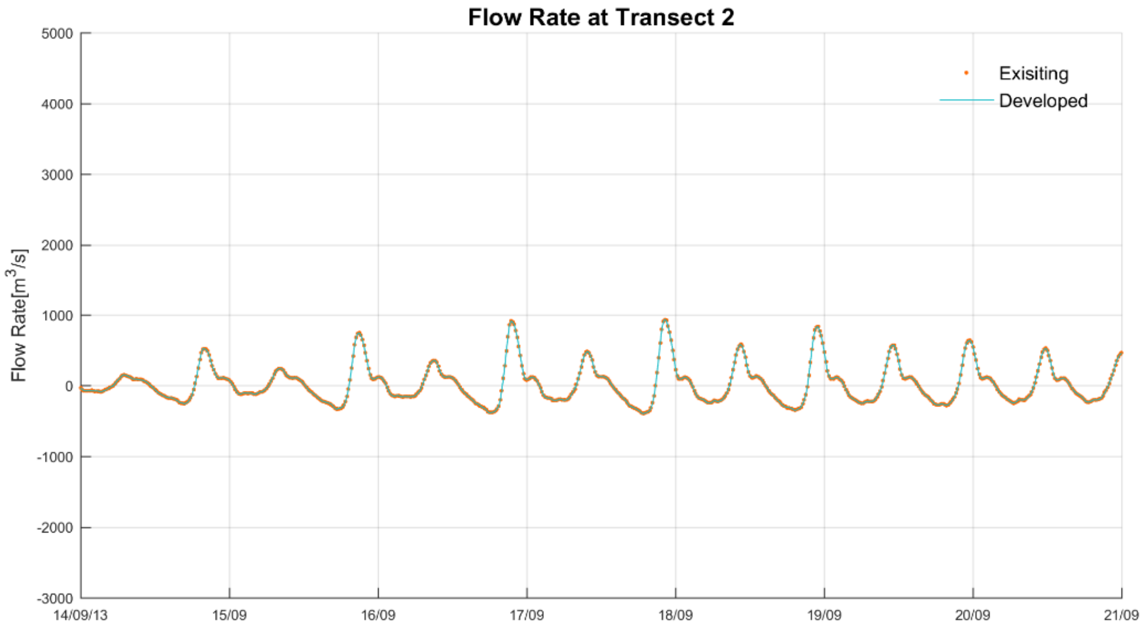


Figure 2-14 Existing and Developed Case Flow Timeseries at Transect 1 and 2 (shown in Figure 2-4)

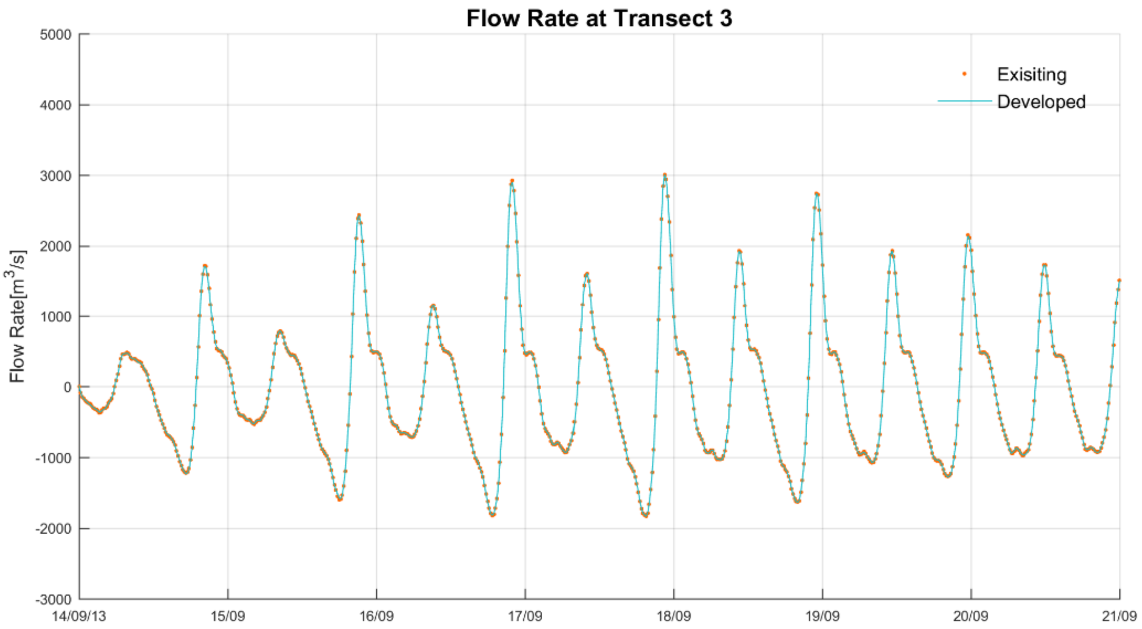


Figure 2-15 Existing and Developed Case Flow Timeseries at Transect 3 (shown in Figure 2-4)

2.4.4 Bed Shear Stress Impacts

Bed shear stresses represent the capacity of current (and wave) induced water motions to re-suspend sediment from the seabed and to transport it as bedload. Impacts to current related bed shear stresses have been analysed using the 3D hydrodynamic model output in order to provide a high-level understanding of the potential for morphological change induced by the Project dredging.

The 95th percentile current related bed shear stress magnitudes, which represent conditions that are typically exceeded during spring tide flows, are shown in Figure 2-16 and Figure 2-17 (zoomed in). These figures present spatial plots of Base Case, Developed Case and predicted impacts (the difference between the Base Case and the Developed Case).

The spatial impacts to current related bed shear stress generally follow the current velocity impacts presented in Section 2.4.1. The changes in bed shear stress magnitude associated with the Project are confined to the Project Area and the immediate surroundings. The highest magnitude changes are not large (generally up to ±0.1 N/m^2). The bed shear stress in the deepened and widened channel are generally reduced, with some localised areas of increased bed shear stress immediately adjacent to the dredging footprint. Impacts are not predicted within Trinity Inlet or other further afield locations.

Impacts to bed shear stress are not of magnitudes likely to cause noticeable morphological changes, accepting the reduced bed shear stresses in the vicinity of the Developed channel are likely to cause slightly increased siltation and maintenance dredging requirements over the Base channel configuration. The impact to channel siltation is addressed separately in Section 2.6.3.

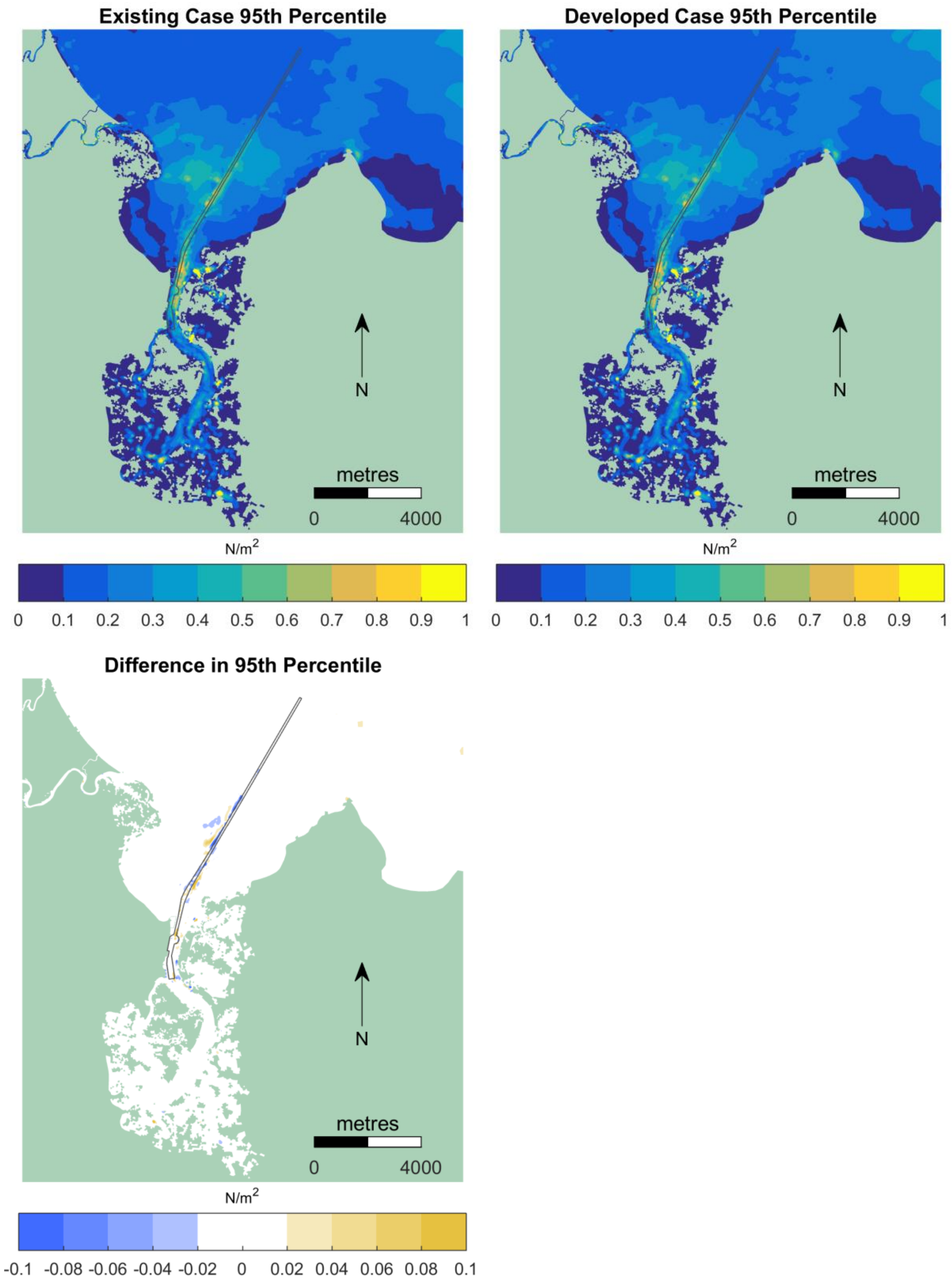


Figure 2-16 Modelled 95th Percentile Current Related Bed Shear Stress (N/m²) and Impacts. Base Case (*top left*); Developed Case (*top right*) and Impacts (*bottom*)

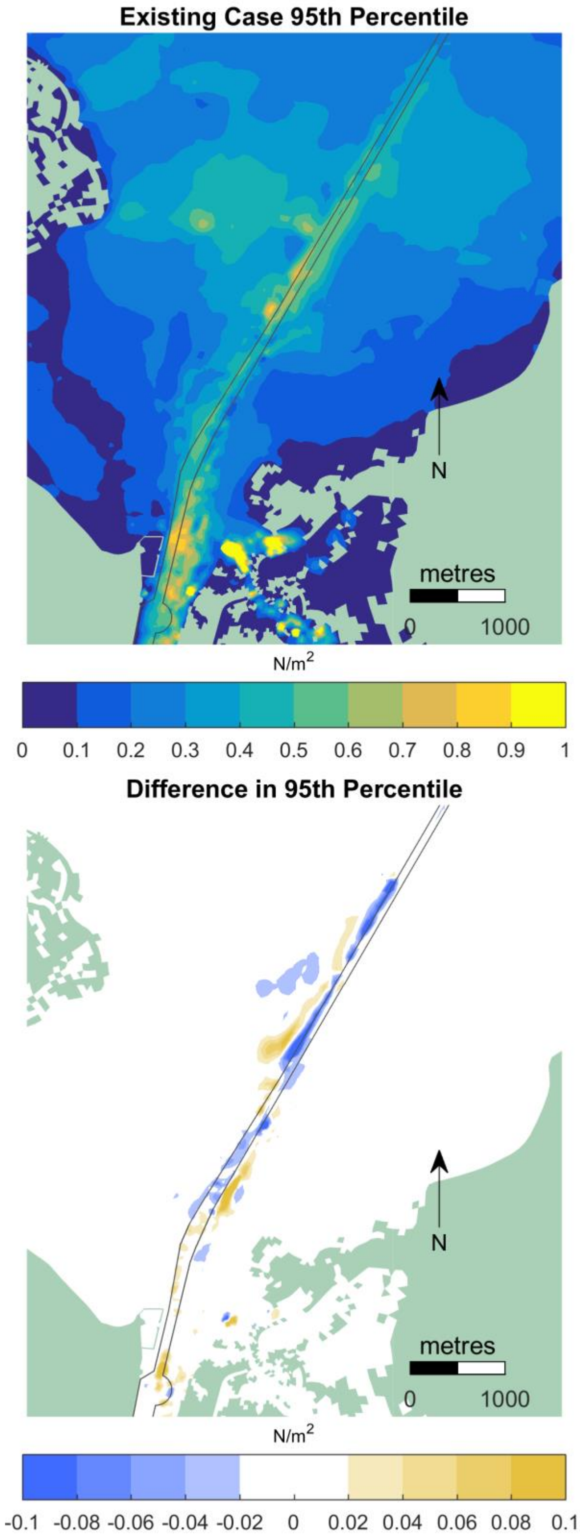


Figure 2-17 Modelled 95th Percentile Current Related Bed Shear Stress (N/m^2) – zoom. Base Case (*top left*); Developed Case (*top right*) and Impacts (*bottom*)

2.4.5 Extreme Water Level Impacts

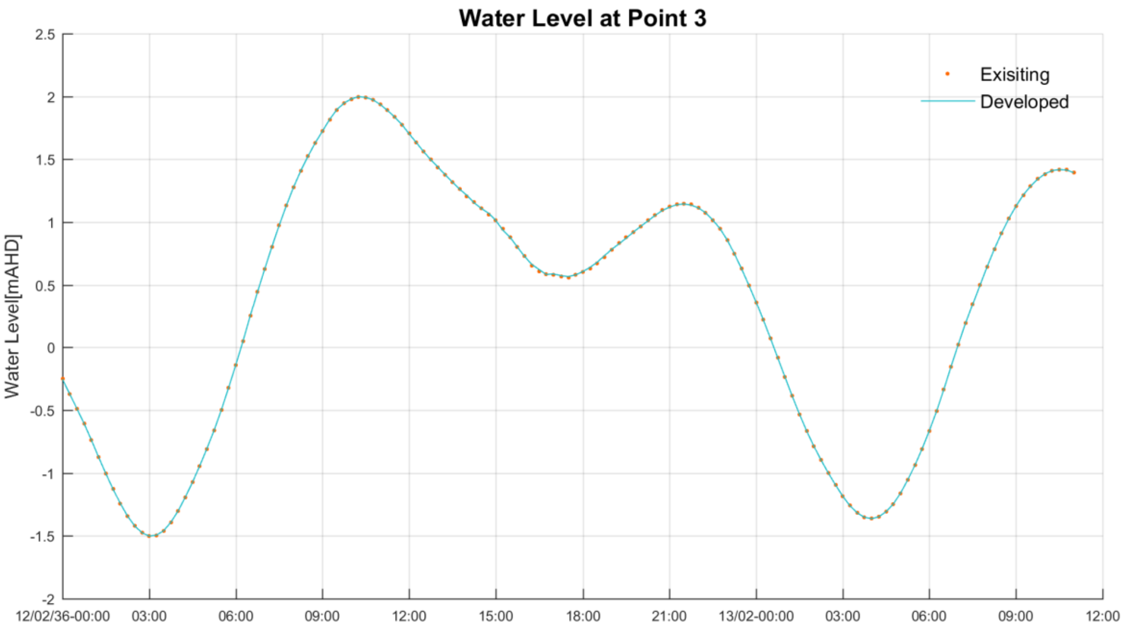
The impact of the channel development on surge propagation was analysed in order to assess the potential of the Project to affect vulnerability to storm tide inundation on adjacent shorelines and properties.

The hydrodynamic model was used to simulate the surge generated by a severe tropical cyclone event impacting on Cairns. The atmospheric pressure and wind field inputs to the hydrodynamic model were described using the Holland (1980) parametric tropical cyclone model. The synthetic event was approximately 100-year ARI storm tide event (surge plus tide) derived from the Cairns Regional Council Storm Tide Study (BMT WBM, 2013).

Spatial peak water level impacts were analysed by differencing the Base Case and Developed Case simulation results. The result of this analysis is shown in Figure 2-19 which demonstrates that the peak storm tide level difference due to the Project dredging is negligible.

Time series of storm tide level was extracted from Base Case and Developed Case simulations at the analysis sites shown in Figure 2-4. The timeseries comparisons also show no discernible difference between Base Case and Developed Case water levels. The water level timeseries at Point 3 (adjacent Cairns Esplanade) and Point 7 (upstream within Trinity Inlet) is shown below in Figure 2-18 in order to illustrate this result.

These results indicate that the proposed channel expansion works will not increase or otherwise change surge propagation or increase the relative vulnerability of the locality to extreme water level impacts.



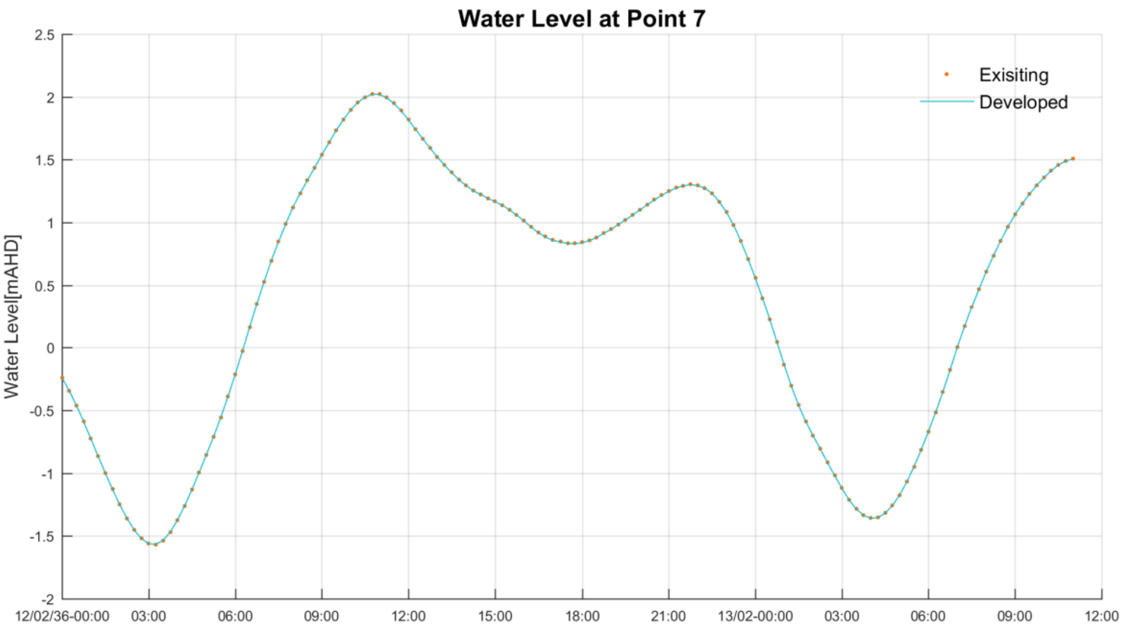


Figure 2-18 Existing and Developed Case Surge Level Timeseries. Point 3 – Adjacent Cairns Esplanade (*top*); Point 4 – Upstream Trinity Inlet (*bottom*)

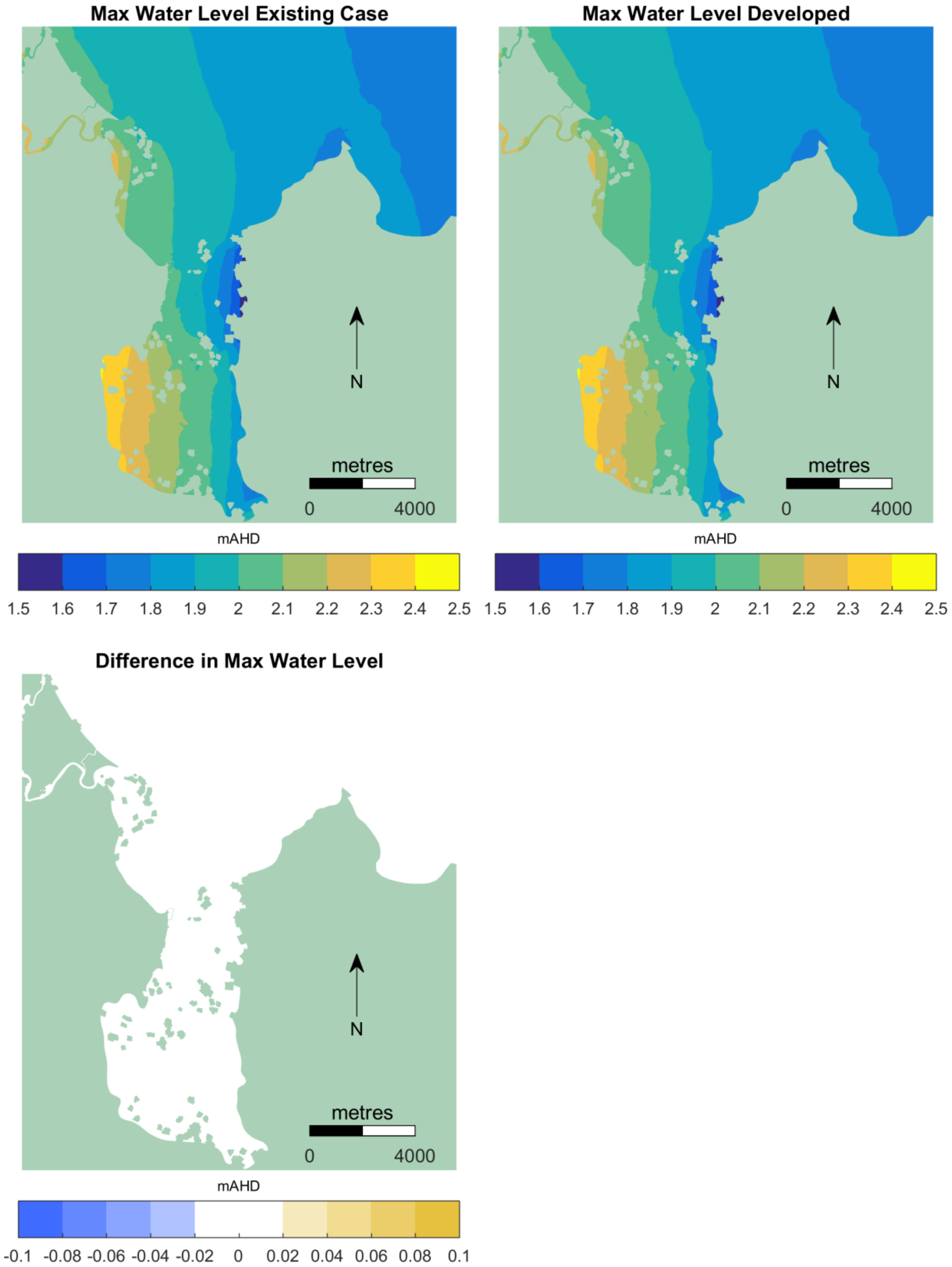


Figure 2-19 Modelled Peak Storm Tide Level (m AHD): Base Case (*top left*); Developed Case (*top right*) and Impacts (*bottom*)

2.4.6 Flood Plume Impacts

The potential impact of the Project channel dredging on the conveyance of flood plumes containing suspended sediments and other pollutants was assessed by running base and developed case hydrodynamic model simulations of a representative runoff event. A wet season rainfall event occurred in early February 2015 with modelled daily runoff predicted from the Trinity Inlet catchments corresponding to around a 5 year ARI event magnitude. In order to aid tracking of the associated flood plume a passive tracer was applied to the catchment inflow boundaries with a concentration of 100 units. The flood plume extent has been tracked as the maximum percentage of passive tracer concentration during the flood event simulation.

The Project impacts on flood impact propagation have been assessed in Figure 2-20 which compares the maximum surface tracer concentration from the base and developed case simulations. The impact plots derived as the difference between base and developed case maximum tracer concentrations show some very minor reductions on the western side of the channel. There are no significant areas of increased tracer concentration and in particular no further seaward propagation of the flood plume. Based on this assessment, the flood conveyance properties of the Trinity Inlet are not likely to be substantially changed as a result of the Project channel works.

2.4.7 Summary of Hydrodynamic Impacts

Based on the analysis presented in the sections previous, the hydrodynamic impacts of the Project are not large in magnitude or extent, being confined to changes in velocity magnitude in the immediate vicinity of the channel dredging footprint.

Within and immediately adjacent to the Project dredging footprint depth-averaged current speeds are predicted to increase/decrease (depending on location) within a range of ±0.1m/s.

There are no discernible water level impacts associated with the Project dredging either within the Project Area or further afield. The tidal prism impacts within Trinity Inlet of the Project are also predicted to be negligible.

Current only bed shear stress impacts are localised to within and immediately adjacent the dredging footprint. The magnitude of these impacts is modest and would not be expected to be associated with broad- scale morphological changes within or beyond the Project Area.

The behaviour of Trinity Inlet flood plume conveyance was not substantially changed by the proposed channel dredging.

As previously stated, the predicted changes to hydrodynamics are not expected to have a measurable influence on the wider ecological processes occurring within Trinity Bay. The potential impacts of the Project on marine ecology are assessed separately in elsewhere in the EIS.

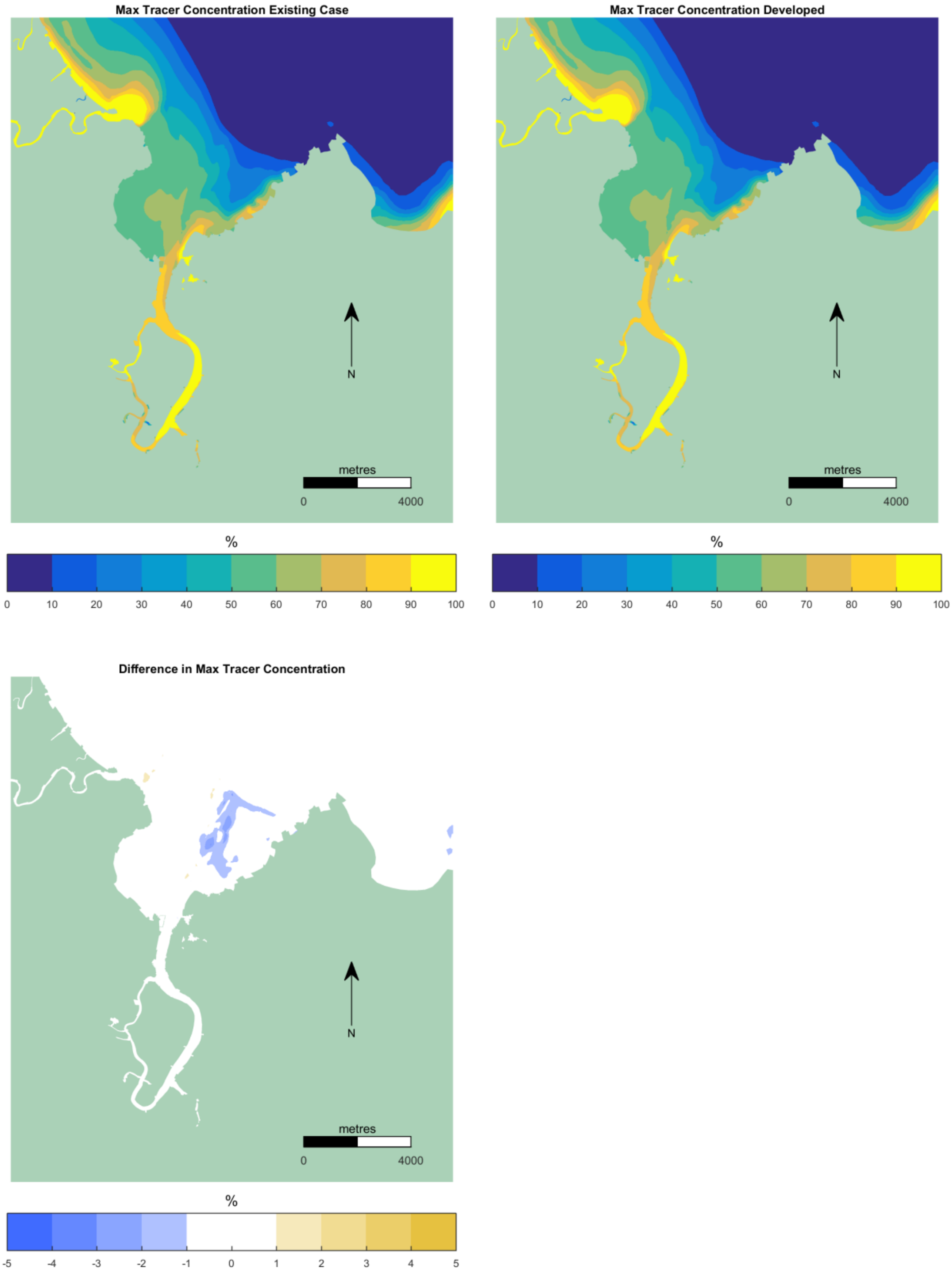


Figure 2-20 Modelled Flood Plume Tracer Concentration (%): Base Case (*top left*); Developed Case (*top right*) and Impacts (*bottom*)

2.5 Operational Impacts - Waves

The widened and deepened dredge channel may potentially impact the propagation of waves towards the shoreline/s of the Project Area. The potential wave impacts were analysed using a high-resolution (25m grid) SWAN model of the Project Area. Boundary conditions for the high-resolution SWAN model were obtained from the 100 m grid SWAN model covering Trinity Bay (refer BMT WBM, 2017).

Base Case and Developed Case simulations were undertaken using the high-resolution SWAN model for the year 2013. Snapshots from the model simulation representing a typical trade-wind driven south-easterly (SE) wave case and a high-energy northerly (N) wave case (driven by Ex-Tropical Cyclone Oswald) were selected to illustrate the Project spatial impacts. The modelled wave fields predicted from the 100m grid SWAN model are shown in Figure 2-21. The Base Case, Developed Case and Impact predictions from the high-resolution SWAN model are shown in Figure 2-22 for the SE waves and Figure 2-23 for the N waves.

The snapshot model predictions indicate that the existing channel already has some localised influence on wave heights as indicated by larger wave heights on one side than the other. The channel is acting to reflect/refract some of the incident wave energy. This is particularly evident in the N-wave case results shown in Figure 2-23.

Consequently, the widened and deepened Project channel has the potential to further influence the wave field. However, as seen in the difference plots (bottom plots in Figure 2-22 and Figure 2-23), wave heights are only affected to a very minor degree by the additional channel widening and deepening. The magnitude of the wave height differences is generally less than 1cm.

Timeseries comparisons of significant wave height, wave peak period and direction at the two nearshore locations (Point 3 and Point 4 in Figure 2-4) are shown in Figure 2-24 and Figure 2-25. Energy weighted mean heights and directions were also calculated from the entire continuous timeseries with the results confirming that the Project is unlikely to have a significant impact on nearshore wave conditions driving littoral and beach system processes.

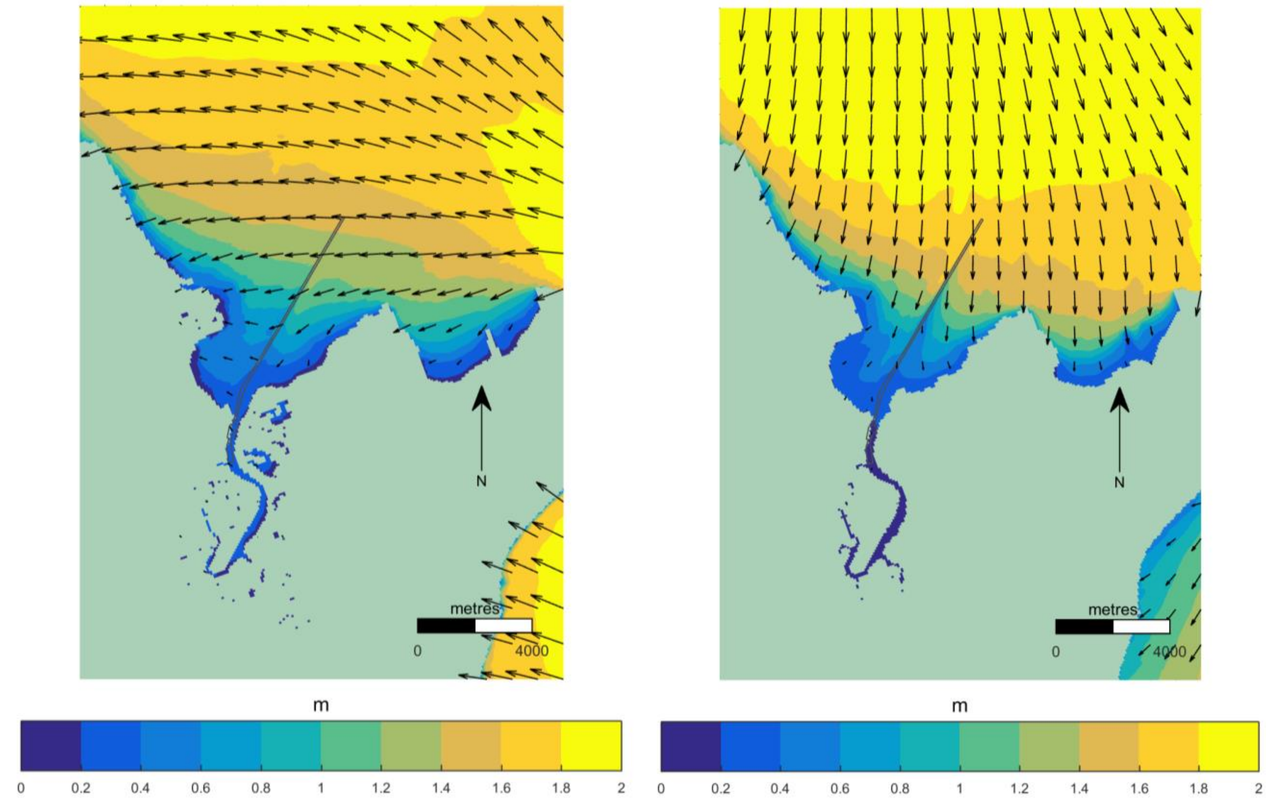


Figure 2-21 100m Grid Modelled Wave Fields
South Easterly Wave Case, 9/4/2013 (*top left*)
Northerly Wave Case, 24/1/2013 (*top right*)

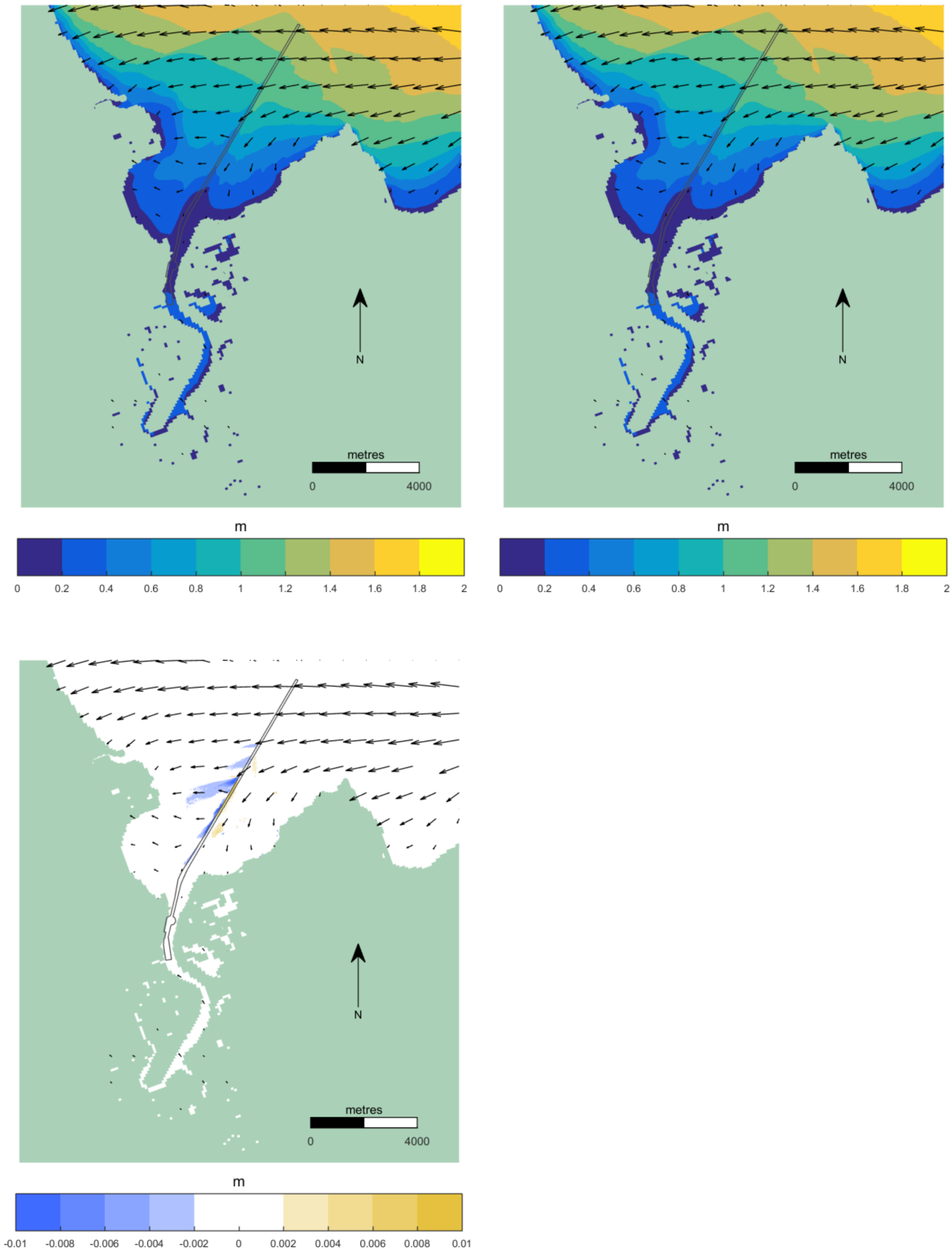


Figure 2-22 25m Grid Typical South-Easterly Wave Case: Base Case (top left); Developed Case (top right); Difference (bottom). Vectors indicate Direction; Contours indicate Magnitude

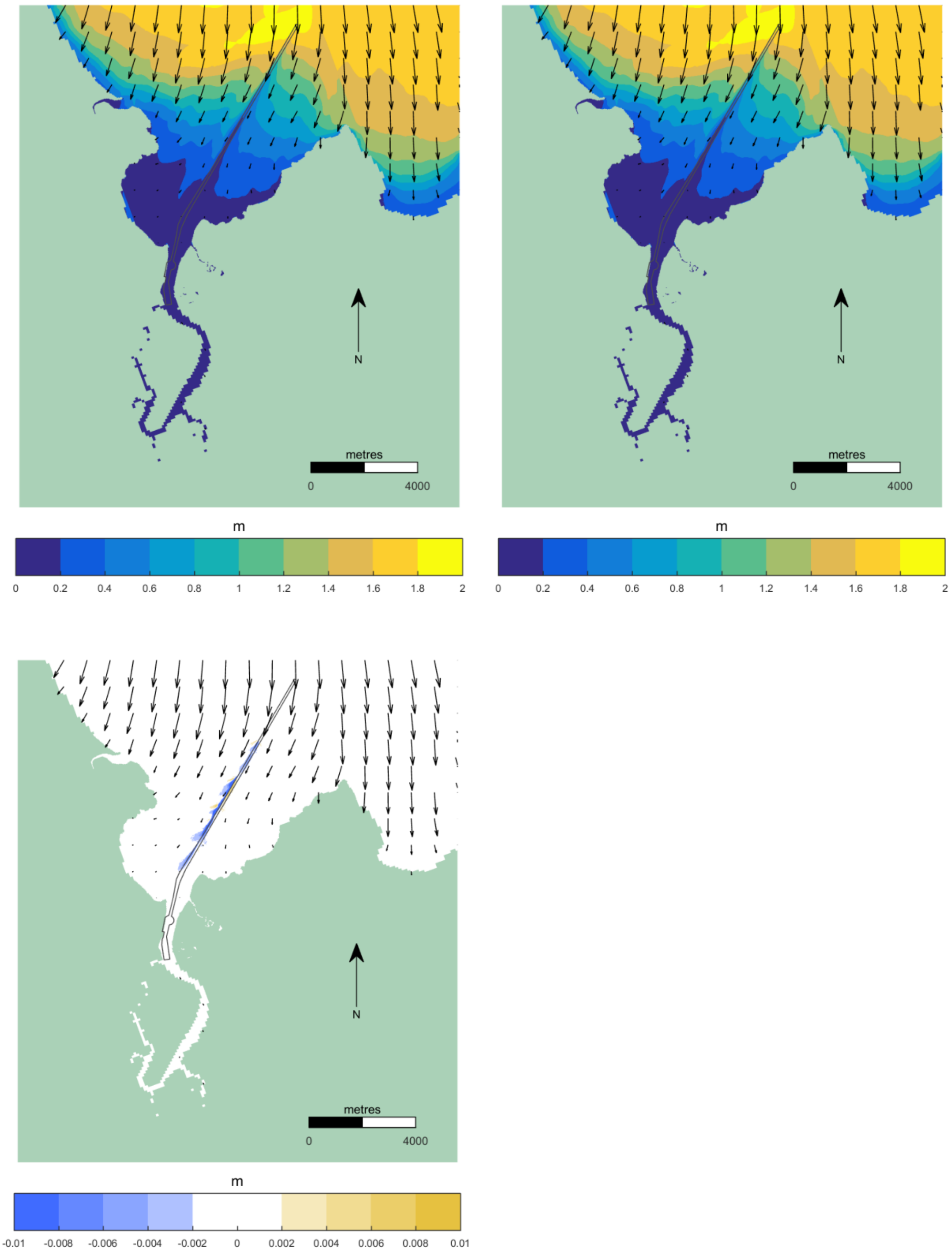


Figure 2-23 25m Grid Northerly Wave Case: Base Case (*top right*); Developed Case (*top left*); Difference (*bottom*). Vectors indicate Direction; Contours indicate Magnitude

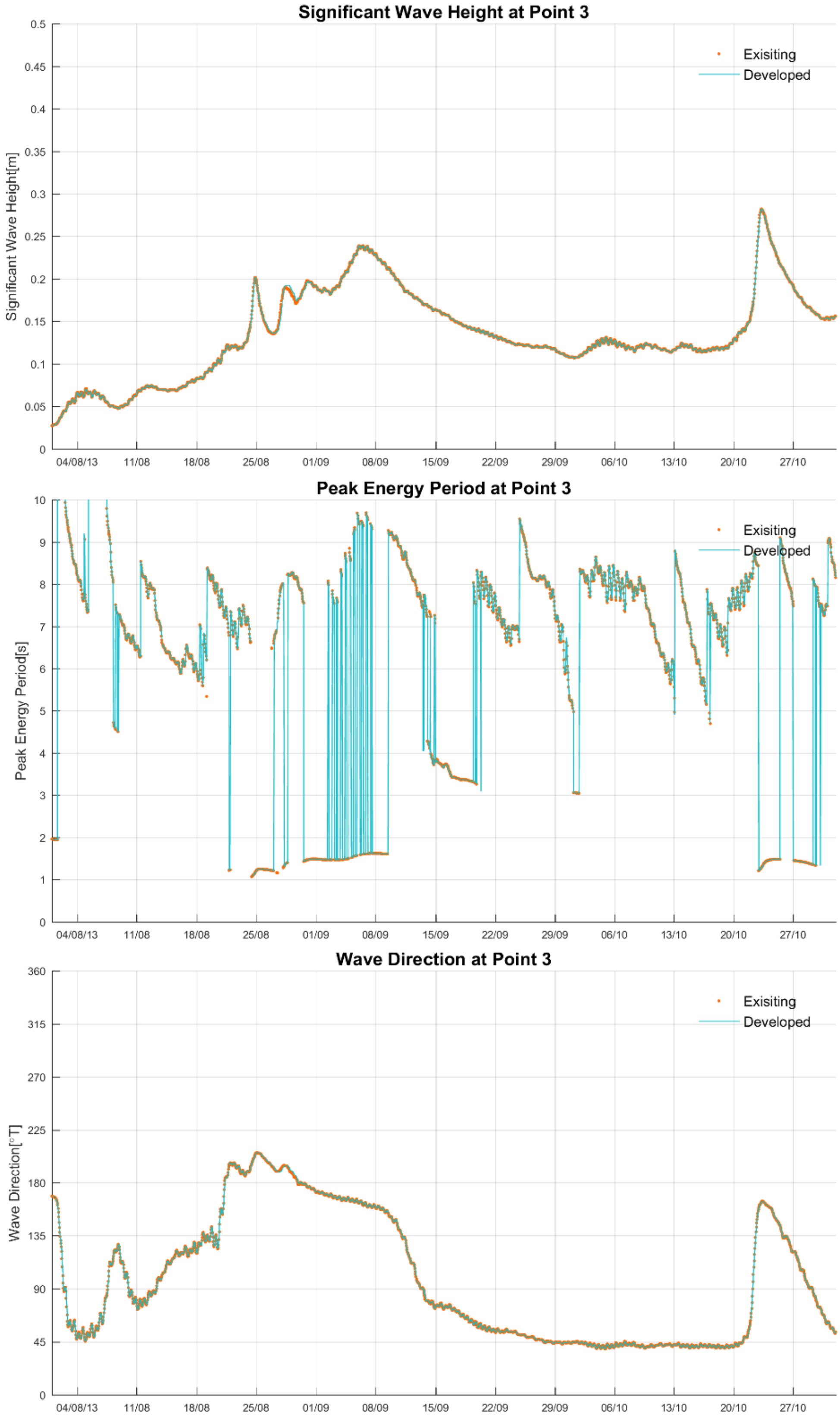


Figure 2-24 Base Case and Developed Case Wave Parameter Timeseries Comparison (Nearshore Location Point 3 in Figure 2-4)

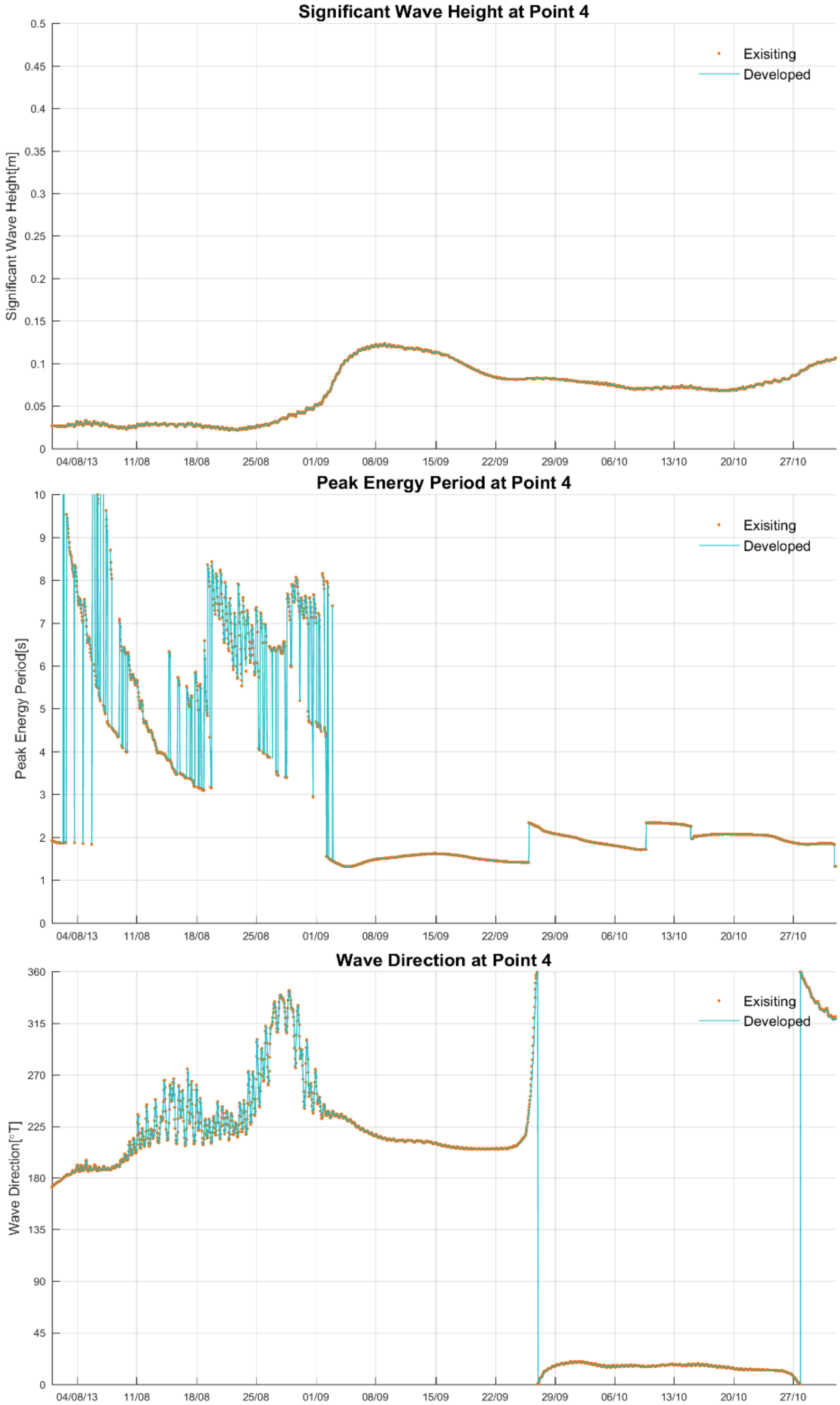


Figure 2-25 Base Case and Developed Case Wave Parameter Timeseries Comparison (Nearshore Location Point 4 in Figure 2-4)

2.6 Morphology and Sedimentation Impacts

In the context of determining impacts on sedimentation processes, including siltation rates in the harbour and shipping channel, the TUFLOW FV ST model was used to simulate the re-suspension and transport of seabed material due to the action of waves and currents. This analysis was undertaken for both the Base Case and Developed Case to determine the potential impact of the Project on bed morphology and siltation rates.

2.6.1 Littoral Sediment Transport and Shoreline Processes

Based on the limited hydrodynamic impacts (Section 2.4) and wave impacts (Section 2.5) being restricted to the vicinity of the target dredge area, there are not expected to be any detectable impacts from the Project on the adjacent shorelines or littoral beach systems within the wider surrounds.

2.6.2 Marine Sediment Transport

The predicted residual (net) sediment transport throughout the study area shown in Figure 2-26 illustrates the net transport occurring shore-parallel in a north-westerly direction. Highest transport rates are predicted around Cape Grafton and offshore to depths approximately -8 m AHD.

The Base Case, and Developed Case net sediment transport and corresponding impact (difference) are shown in Figure 2-26. It can be seen that the net sediment transport rate through the study area is not significantly altered by the Project. Following from this result, there would not be expected to be any perceptible morphological change within the Study Area either in the short or long term as a result of the Project.

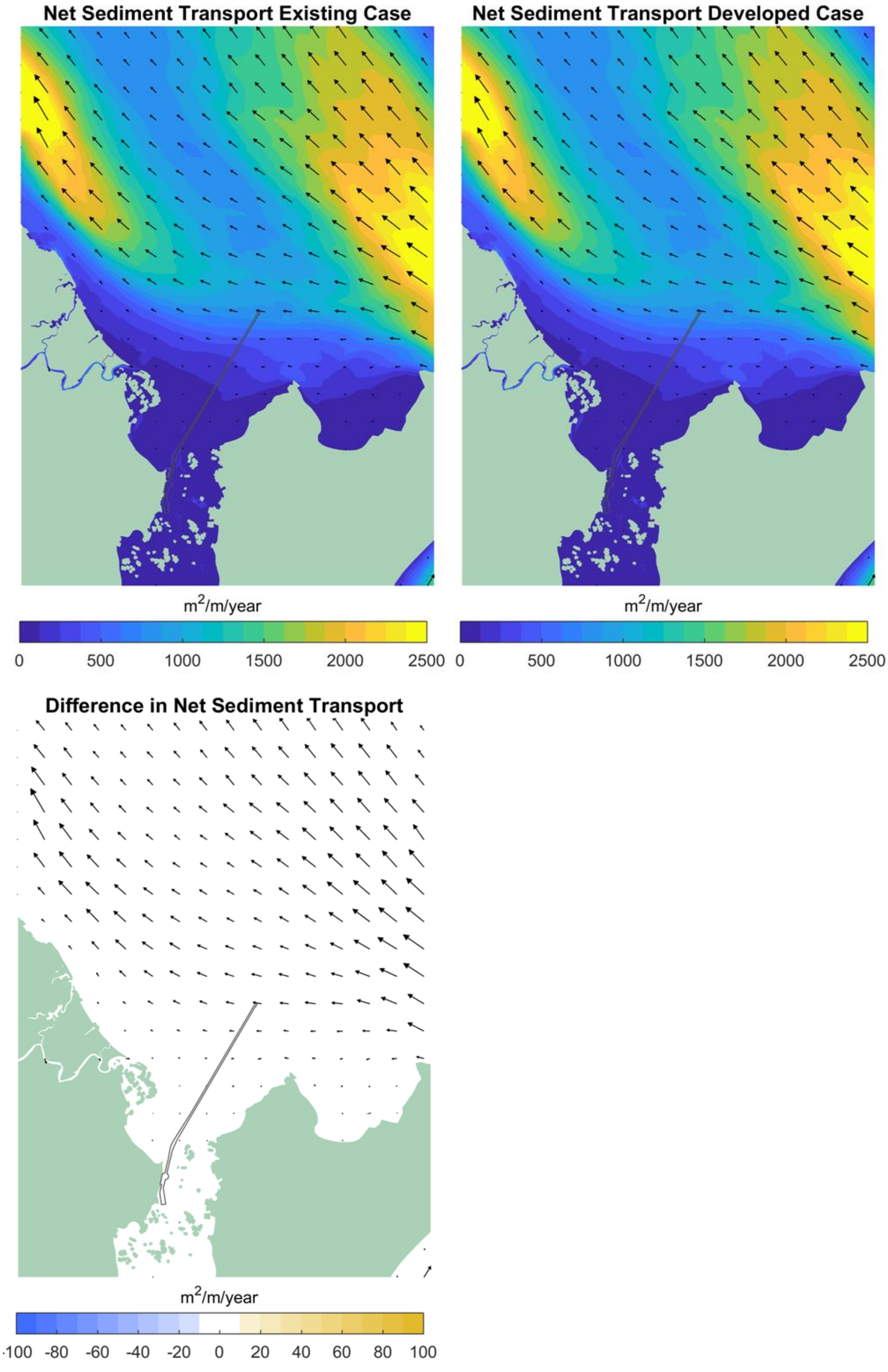


Figure 2-26 Modelled Net Sediment Transport (m^3/m/year): Base Case (*top left*); Developed Case (*top right*) and Impacts (*bottom*). Vectors indicate Direction; Contours indicate Magnitude

2.6.3 Channel Siltation

The purpose of the channel siltation impact assessment was to determine the likely percentage increase in siltation volume due to the Developed Case dredged channel configuration. The predicted percentage increase can then be more reliably applied to the historical siltation volumes (RHDV, 2016) to extrapolate the likely future maintenance dredging requirements.

The siltation impact assessment was performed by undertaking Base Case and Developed Case simulations using the calibrated 3D HD and ST model. The Developed Case model bathymetry was adjusted within the channel footprint to account for the Project channel widening and deepening. In all other respects the Base Case and Developed Case models were identical. The Developed Case dredged channel footprint is approximately 10% larger than the existing channel area.

The small increase in dredged channel area would be expected to result in a lesser percentage increase in annual siltation volume requiring maintenance dredging. The channel siltation impacts have been further investigated with base and developed case numerical model simulations. The Base and Developed Case simulations ran from the 01/01/2015 to the 01/01/2016, with net siltation calculations based on the period 21/01/2015 to 25/12/2015 to ensure that spring-neap cycle periods were equally sampled.

The Base Case and Developed Case siltation distributions are shown in Figure 2-27. The Developed Case siltation rate and volume is predicted to be 2 to 6% higher than the Base Case. Applying this increase to the average historical siltation (RHDV, 2016), the predicted annual average outer channel siltation volume is expected to increase to an in-situ volume of approximately 400,000 to 410,000 m^3 (from 390,000 m^3).

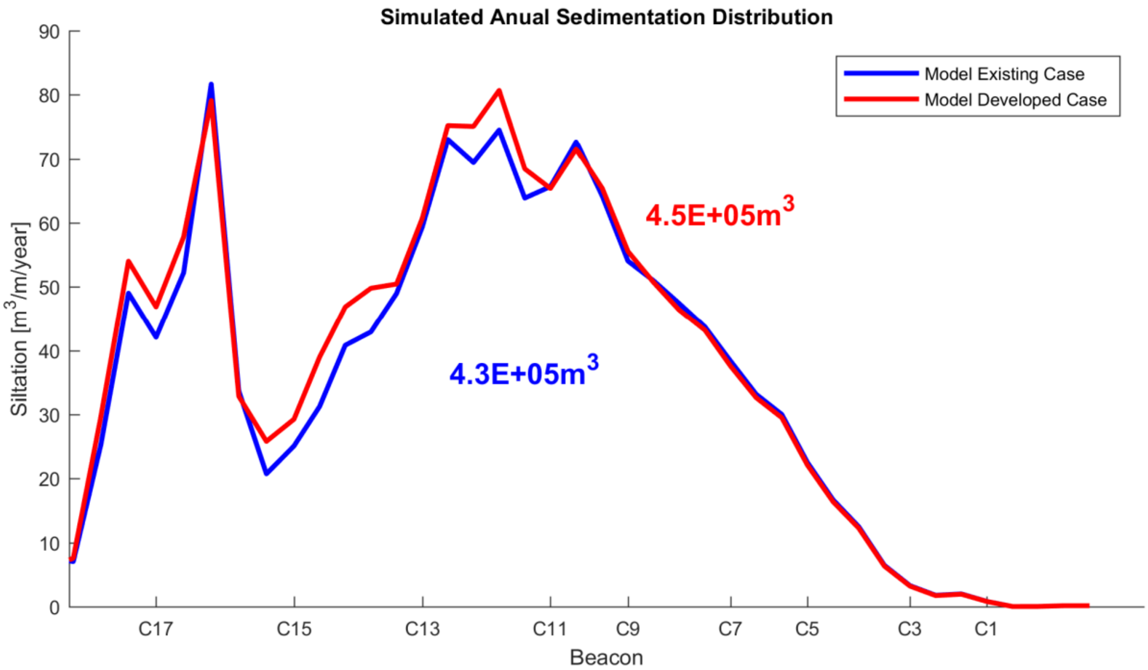


Figure 2-27 Modelled Base Case and Developed Case Channel Siltation

2.6.4 Implications for Future Maintenance Dredging

As outlined above the widening and deepening of the channel is likely to result in an increase in annual maintenance dredging volume on the order of 10,000-20,000 m^3 per year. The existing annual maintenance dredging volume for the inner harbour (approximately 30,000 m^3 in-situ volume largely undertaken by grab bucket dredge Willunga) is not likely to change significantly as a result of the Project as these areas do not accumulate sediment as rapidly as the outer channel, which intersects the dominant offshore littoral transport pathway.

Annual dredging at the Port of Cairns is likely to continue to be undertaken by the *TSHD Brisbane*, a similar but slightly smaller dredge vessel to that modelled for the Project capital dredging. Current channel maintenance dredging campaigns typically occur during the months of July and August and generally take about 3 to 4 weeks to complete. The Marine Water Quality Chapter of the EIS discusses the water quality impacts from future maintenance dredging undertaken by the *TSHD Brisbane*.

In the context of coastal processes, maintenance dredging clears the channel of sediment trapped within the dredge footprint. Current management practice is for the dredged material to be placed at the approved offshore DMPA. As shown in the bathymetry, marine placement sites in Trinity Bay have demonstrated a high degree of retentiveness of the dredge material placed within them over time despite the occurrence of extreme weather events.

A numerical modelling assessment has been undertaken of placed maintenance material resuspension from both the existing approved DMPA and the deeper Option 1A site that was investigated as part of the previous draft EIS as shown in Figure 2-28.

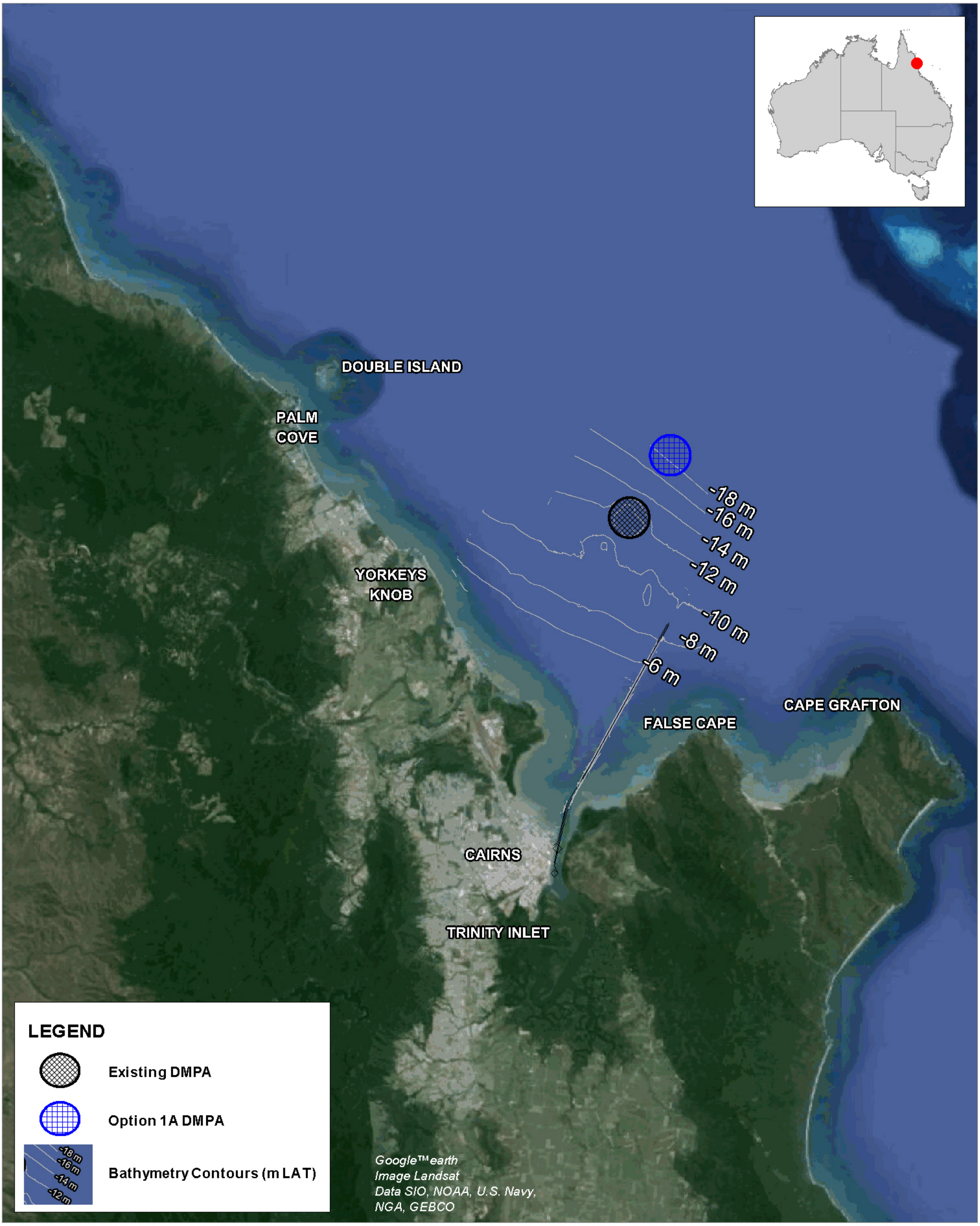
The two re-suspension simulations adopted the period from August 2011 to August 2012 for environmental forcing. This period was selected since it had been previously simulated as part of the Project draft EIS and was shown to be reasonably representative of the long term average wind and wave climate.

As expected the quantity of material dispersed to areas outside of the DMPA perimeter during the 12 month period is relatively low for each location. These results are summarised in Table 2-6.

While both sites are acceptable from a capacity perspective for the short to medium term, the deeper Option 1A site provides even greater retentiveness than the existing site. As such, in addition to limiting long term resuspension, this site would also have greater long term capacity than the current DMPA due to its depth and would likely provide adequate storage capacity for the longer term (20+ years).

Table 2-6 Predicted Dispersion from the DMPA over a 12-month Period

DMPA Option	Average Depth (mAHD)	Material Dispersed ($x10^3$ tonnes)	Percentage Dispersed (%)
Existing	-11.7	26	11.6
Option 1a	-20.3	>0.23	>0.1



Title:

Exisitng Maintenance Dredging DMPA and Option 1A DMPA

Figure: 2-28

Rev: A

N

0 km 5 km 10 km

Approx. Scale

BMT WBM

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3 Recommended Mitigation Measures

3.1 Construction Phase

During the construction phase, while the dredge material pipeline is in place (between 3 to 6 months) there will be a requirement to monitor the influence of any beach face instability on the pipeline integrity and there may be a requirement to manually bypass excessive build-up of material from one side of the pipeline to the other. This could be achieved with a reactive strategy involving regular inspections and assessment of accumulated beach sand volumes and a commitment to manually relocate the material (using a small excavator) to the active beach if an excessive volume had accumulated.

Hydrographic survey should also be conducted of the offshore pipeline corridor to monitor any bathymetric changes. As outlined previously, the offshore submerged pipeline would not be expected to be very efficient at trapping the predominantly fine-grain offshore sediments. The effect of any temporary trapping would be alleviated following removal of the pipeline.

3.2 Operation Phase

The channel works will have low to negligible operational impacts on coastal processes and additional mitigation or modifications to the channel design are not seen as necessary.

Maintenance dredging assessments have considered placement at both the existing approved DMPA and an alternative deeper water site. Modelling of a 12 month resuspension period has demonstrated the higher retentiveness of the deeper site. As such, consideration could be given to maintenance dredge material placement shifting to this deeper placement site at some point in the future where the current site is reaching capacity. Future updates to the LTDSDMP (also a LTMMP) for Cairns should include consideration of options such as outlined above as components of the application for and resolution of future Marine Park and Sea Dumping Permit process through consultation with the TACC and the GBRMPA.

4 Residual Impacts and Assessment Summary

The various coastal processes assessments have shown that impacts of the Project will not be of significance with respect to the adjacent shoreline areas. The impacts predicted using calibrated numerical models show relatively small zones of influence, typically within the immediate vicinity of the shipping channel. In reality, the magnitude of impact would not be detectable and is well within the natural, background conditions. As such, long term adverse impacts to coastal processes are highly unlikely.

The wave propagation modelling for this investigation indicates that there would be no changes in wave heights of any significance at adjacent shoreline areas associated with the proposed channel development. Under typical swell and sea state conditions, the absolute wave height levels along the adjacent shorelines within Trinity Bay are not affected.

Specially, the modelling assessment results show that:

- Generally, impacts on tidal currents are highly localised and in the immediate vicinity of the target dredge area where some local realignment and modification of current speeds will occur
- There will be minor (unmeasurable) impact to currents and tidal flows in Trinity Bay and Trinity Inlet
- There will be no detectable increase to storm tide vulnerability to adjacent areas
- There will be no substantive change to flood plume conveyance from Trinity Inlet
- There will be minor (unmeasurable) modification to wave propagation in the vicinity of the developed channel area and no detectable impact to wave conditions at far field areas
- There will be an increase of approximately 2 to 6% to the annual channel siltation and maintenance dredge requirements
- There will be no detectable impact to sediment transport pathways and beach processes.

The coastal processes impact assessments are summarised in Table B3.5.4a together with the anticipated risk and potential mitigation measures (where relevant). Based on the assessments, all risks to coastal processes and dredging related water quality that have been identified can be reduced to a low or medium residual risk through the application of controls inherent of the Project design.

Table 4-1 Coastal Processes Impact Assessment Summary

Coastal Processes	**Initial assessment with standard mitigation (i.e. statutory compliance) in place**				**Residual Assessment with additional mitigation in place (i.e. those actions recommended as part of the impact assessment)**			
Primary Impacting **Processes**	Statutory Mitigation Measures **Required**	Significance of Impact	Likelihood of Impact	Risk Rating	Additional Mitigation Measures **Proposed**	Significance of Impact	Likelihood of Impact	**Residual** Risk Rating
Trapping of beach sand by dredge material pipeline (beach).	Potential for minor beach sand trapping by temporary pipeline.	Minor	Possible	Low	Monitoring and reactive sand bypassing into downdrift active zone.	Negligible	Possible	Negligible
Trapping of sediment by submerged dredge material pipeline (offshore).	Potential for sediment trapping by temporary pipeline	Negligible	Possible	Negligible	Hydrographic survey to monitor bathymetric changes along the submerged pipeline corridor.	Negligible	Possible	Negligible
Modification to currents in the vicinity of the target dredge area	Minor impacts in vicinity of developed channel footprint; no detectable impacts to surrounding areas	Negligible	Likely	Negligible	NA	Negligible	Likely	Negligible
Modification to tidal flows and water levels within Trinity Bay and Trinity Inlet	No detectable increase to tidal flows or water levels	Negligible	Likely	Negligible	NA	Negligible	Likely	Negligible
Increased vulnerability to storm tide flooding	No detectable increase to storm tide inundation vulnerability	Negligible	Likely	Negligible	NA	Negligible	Likely	Negligible
Changes to flood plume conveyance	No detectable changes to flood plume conveyance	Negligible	Unlikely	Negligible		Negligible	Unlikely	Negligible

Coastal	Initial assessment with standard mitigation				Residual Assessment with additional mitigation in place			
Processes	**(i.e. statutory compliance) in place**				**(i.e. those actions recommended as part of the impact assessment)**			
Primary Impacting **Processes**	Statutory Mitigation Measures **Required**	Significance of Impact	Likelihood of Impact	Risk Rating	Additional Mitigation Measures **Proposed**	Significance of Impact	Likelihood of Impact	**Residual** Risk Rating
Modification to wave propagation in the vicinity of the target dredge area	Minor changes to reflection/refraction in vicinity of developed channel footprint; less than 5% change to significant wave height	Negligible	Possible	Negligible	NA	Negligible	Possible	Negligible
Detectable changes to wave conditions within Trinity Bay and Trinity Inlet	No detectable impact to wave height, period or direction to surrounding areas	Negligible	Unlikely	Negligible	NA	Negligible	Unlikely	Negligible
Change to shipping channel annual siltation rate and maintenance dredging	Increase of approximately 2 to 6% to annual siltation and maintenance dredging requirements	Minor	Likely	Medium	mend the Long-term Maintenance Dredge Management Plan (LMDMP)	Minor	Likely	Medium
Change to sediment transport pathways and beach processes	No detectable impact to sediment transport and beach processes	Minor	Unlikely	Low	NA	Moderate	Unlikely	Low
Long term fate of future placed maintenance dredge material	Minor re-suspension during high energy events; no impact to known sensitive habitats	Minor	Possible	Low	As part of LMDMP assess location of DMPA in deeper water to improve retentiveness	Minor	Unlikely	Low

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