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Memo

From	Dr Terry Hume
To	Rowan Johnstone, Engineering Manager, Port of Tauranga Ltd [redacted]
CC	
Date	11 June 2026
Subject	Port of Tauranga dredging and reconsenting – Peer review of technical reports
File path *(right click to update)*	[redacted]

Port of Tauranga dredging and reconsenting – Peer Review of technical reports

Introduction

My name is Terry Martyn Hume. I am a Director of Hume Consulting Ltd which I established in 2015. Prior to that I was employed by the National Institute of Water and Atmosphere Research (NIWA) from 1992 to 2014 where I was National Projects Manager and Principal Scientist - Coastal Geomorphology.

I have a BSC in geology from the University of Auckland and a MSc (Hons) and DPhil in Earth Sciences from the University of Waikato. I am a member of the Royal Society of New Zealand, a Life Member of the NZ Coastal Society, an Honorary Associate Professor (Environmental Sciences) at the University of Auckland, and an Honorary Lecturer (Earth Sciences) at the University of Waikato. I have been certified as an RMA Hearings Commissioner (2006 - 2019). I have worked on projects as a team member, project manager and project director. I have undertaken environmental research and consulting for government departments, local authorities and private companies and led NIWA's coastal and estuarine research programmes and science teams. I have more than 50 years' experience as a scientist and consultant. I have authored or co-authored over 80 publications in refereed journals and over 150 technical reports for various clients.

I have expert knowledge as a marine geologist, coastal geomorphologist and coastal oceanographer. I have experience in applying numerical models to inform the understanding of coastal processes. Because of my role in NIWA as a Principal Scientist and Project Director I undertook technical reviews and evaluations of work by other specialists where models were used. Of particular relevance to my role as a peer reviewer in this matter are the following:

- Port of Nelson dredging and spoil disposal. Assessment of sedimentation in Nelson Haven and of the effects of capital dredging and marine disposal at the Port of Nelson to advise maintenance and capital dredging operations.
- Port of Napier dredging and spoil disposal. Assessment of the effects of capital dredging and disposal at the offshore dump ground, and stormwater runoff from reclamation areas at the Port of Napier; advise the RMA consenting process.

- Reviews of technical reports relating to the potential effects on coastal processes of the proposed deepening of the Wellington Harbour entrance shipping channel for Greater Wellington Regional Council.
- Reviews of technical reports related to coastal physical processes for consent hearings for Port of Napier hearing expansion, relating to dredging and disposal and beach nourishment.
- Peer review for Gisborne District Council of technical reports and advice on adequacy of assessment and information provided with respect to coastal physical processes relating to Eastland Port – Twin Berth project. The focus was on natural hazards, coastal processes and surf breaks, construction effects and operational effects relating to outer port maintenance dredging and disposal.
- External assessor for PhD by Andi Ramli on the impact of dredging on the stability of Matakana Banks ebb-tidal delta[1]
- I have undertaken studies of coastal processes in Tauranga Harbour[2] [3] and on the continental shelf offshore[4]
- I have undertaken research on the stability of New Zealand's tidal inlets[5] [6]and an extensive work on the classification of NZ's coastal hydrosystems and estuaries[7].

Code of Conduct statement

I have read and complied with the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2023 in preparing this report. I agree to comply with the Code of Conduct in presenting this review. The opinions and assessment within this review are within my area of expertise, except where I have stated my reliance on other identified evidence.

Background

Currently, the Port of Tauranga Ltd is preparing to reconsent maintenance dredging activities for the shipping channels. This application also includes a small amount of capital dredging and will be processed via the Fast-track route. Ongoing consultation has raised numerous claims regarding the widespread effects of dredging throughout the harbour. Of particular importance are concerns about erosion following storm events at Panepane Point, the Matakana Island shoreline adjacent to the ebb tide delta and entrance.

I have been engaged by Port of Tauranga Ltd to undertake an independent technical peer review of the report prepared by Dr Willem de Lange titled "Assessment of Effects on Turbidity and Morphodynamics" (February 2026). The review also includes consideration of the underlying MetOcean Solutions modelling reports that inform the de Lange report. This modelling was undertaken for an original larger capital dredging project to deepen and widen the channel which the Port has chosen to dredge now under the existing consent, rather than re-consent.

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[1] Ramli, A.Y. 2016. The Impact of Dredging on the Stability of Matakana Banks Ebb-Tidal Delta. PhD Thesis, University of Waikato, Hamilton, New Zealand.

[2] Hume, T.M.; Green, M.O.; & Elliot, S. 2010. Tauranga Harbour Sediment Study: Assessment of predictions for management. NIWA Client Report: HAM2009-139.

[3] Hancock, N.; Hume, T.; & Swales, A. 2009. Tauranga Harbour Sediment Study: Harbour bed sediments. NIWA Client Report: HAM2008-123.

[4] Hume, T.M.; Beamsley, B.; Green, M.O.; de Lange, W.P.; Hicks, D.M. 1995. Influence of seabed topography and roughness on longshore wave processes. Coastal Dynamics '95', International Conference on Coastal Research in Terms of Large-Scale Coastal Experiments, Gdansk, Poland. Pp975-986

[5] Hicks, D.M. & Hume, T.M. 1996. Morphology and size of ebb tidal deltas at natural inlets on open-sea and pocket bay coasts, North Island, New Zealand. Journal of Coastal Research, 12: 47–63.

[6] Hicks, D.M. & Hume, T.M. 1997. Determining sand volumes and bathymetric change on an ebb-tidal delta. Journal of Coastal Research, 13: 407–416.

[7] Hume, T.; Gerbeaux, P.; Hart, D.; Kettles, H.; Neale, D. 2016. A classification of New Zealand's coastal hydrosystems. NIWA Client report HAM2016-062. 120pp.

Review process

The review comprises:

- Assessment of the methodology, assumptions, and inputs used in the hydrodynamic, sediment transport and turbidity modelling;
- Review of the interpretation of modelling outputs and conclusions presented in the report;
- Identification of any material errors, omissions, or inconsistencies that could affect the reliability of the conclusions;
- Commentary on whether the assessment is reasonable and fit for purpose in the context of the Port of Tauranga dredging reconsenting fast-track application.
- A peer review memorandum suitable for lodgement as supporting technical evidence.

This review focusses on the de Lange 2026 report. I have discussed some matters in the report with Dr de Lange for points of clarification. I have read and relied on information mainly from the following documents:

- de Lange 2026. Port of Tauranga Dredging Reconsenting Assessment of Effects on Turbidity and Morphodynamics. Report prepared for Port of Tauranga Ltd. 74 pp.
- de Lange evidence - Appendix 1 – Comparison of erosion and siltation before and after Port Development – 58 pp.
- Watson H. Berthot A. 2024. Hydrodynamic and Wave Modelling. MetOcean Solutions report prepared for Port of Tauranga. 112 pp.
- Montaño M. 2024. Dredged Plume Modelling. Dredging sediment plume dispersion over existing and proposed port configurations. MetOcean Solutions report prepared for Port of Tauranga. 85 pp.
- Watson H, & Berthot A, 2025. Tauranga Harbour historical configurations modelling, MetOcean Solutions report prepared for Port of Tauranga. 82 pp. and Appendix A Difference maps. Capital dredging of 2015-2016. Pp 83-164.
- Montaño M. 2024. Nutrient and Sediment Dispersal. MetOcean Solutions report prepared for Port of Tauranga. 39 pp.
- Berthot A, Cussioli M, & Carle E, 2024. Shoreline change assessment, MetOcean Solutions report prepared for Port of Tauranga, MetOcean Solutions, December 2024. 66 pp.

Review of: de Lange 2026. Port of Tauranga Dredging Reconsenting Assessment of Effects on Turbidity and Morphodynamics. Report prepared for Port of Tauranga Ltd. 74 pp.

Overall summary

- This report considers the characteristics of the sediment to be dredged, and the potential impacts during the excavation and disposal phases for different dredging methodologies focusing on turbidity. It examines the potential impacts for the post-dredging phase, including changes to the tidal circulation and seabed morphology, and the implications for Te Awanui.
- The work is underpinned and informed by a very large body of scientific and technical studies. Studies on Tauranga Harbour since the 1960's (some 90 theses and 400 technical reports peer reviewed papers, government reports, university theses technical reports) make this the most well studied harbour in New Zealand.
- The report has good structure and logic flow and is well edited. The author exhibits a thorough knowledge of studies that have been undertaken in the harbour and on coastal processes in general.

- Overall, it describes project work based on a very comprehensive suite of appropriate site-specific studies including: field studies of tidal, wave processes and geomorphic processes, experimentation with dredging methodologies, substrate sampling (surface and subsurface by coring and CPT), and monitoring (turbidity, dredged channel shape, ecology, shorelines).
- The calibrated and validated numerical models are particularly valuable in providing a spatial picture.
- Mitigation options to reduce effects (e.g., mitigation of sediment plumes from the TSHDs used for the 2015/16 Capital Dredging Programme involved using a low turbidity green-valve technology and staging dredging about tide state) are valuable.
- I agree with the overall interpretation that that shoreline change at Panepane is primarily driven by sediment supply and wave, weather and longer-term climate patterns rather than dredging.
- I strongly recommend that monitoring of coastal processes continue in the area encompassing Te Paritaha, the western channel, the shoreline tip of Panepane and channel flank, and the southeastern part of Matakana shoreline and offshore flood marginal channel.
- I would note that the detailed field studies and numerical modelling used to inform this report were undertaken for an original larger capital dredging project (which the Port has chosen to dredge now under the existing consent, rather than re-consent). Thus, the detailed work has informed the current application for consent for the ongoing maintenance dredging and some limited capital dredging which is a more conservative project in terms of potential effects.
- In my opinion the report provides a sound assessment and is reasonable and fit for purpose in the context of the Port of Tauranga dredging reconsenting fast-track application.

Executive summary?
In my opinion the report would benefit from an Executive summary - most of the information required for this is in Section 6.0 Summary.

1.0 Introduction
Provides a clear description of the types of dredging and potential effects during the three phases of activity – excavation, disposal of dredgings and post-dredging or recovery period.

This section needs a map showing all the major places/features of the harbour (as it stands the reader has to wait to p36 for a map – see Figure 1). I suggest using Figure 24, or reproducing Figure 1-4 from Watson H. Berthot A. 2024. Hydrodynamic and Wave Modelling. MetOcean Solutions report prepared for Port of Tauranga. 112 pp.

2.0 Geology, geomorphology and hydrodynamics of Te Awanui
This section shows that there is a good understanding of the wider geological setting, and development of the harbour in the last 7,000 years. Studies of the subsurface geology by CPT probing, vibracoring, particle size analysis and seismics identified the underlying geology is a major control on the characteristics of the sediment being dredged, and disposed of, and hence, the potential impacts of capital versus maintenance dredging.

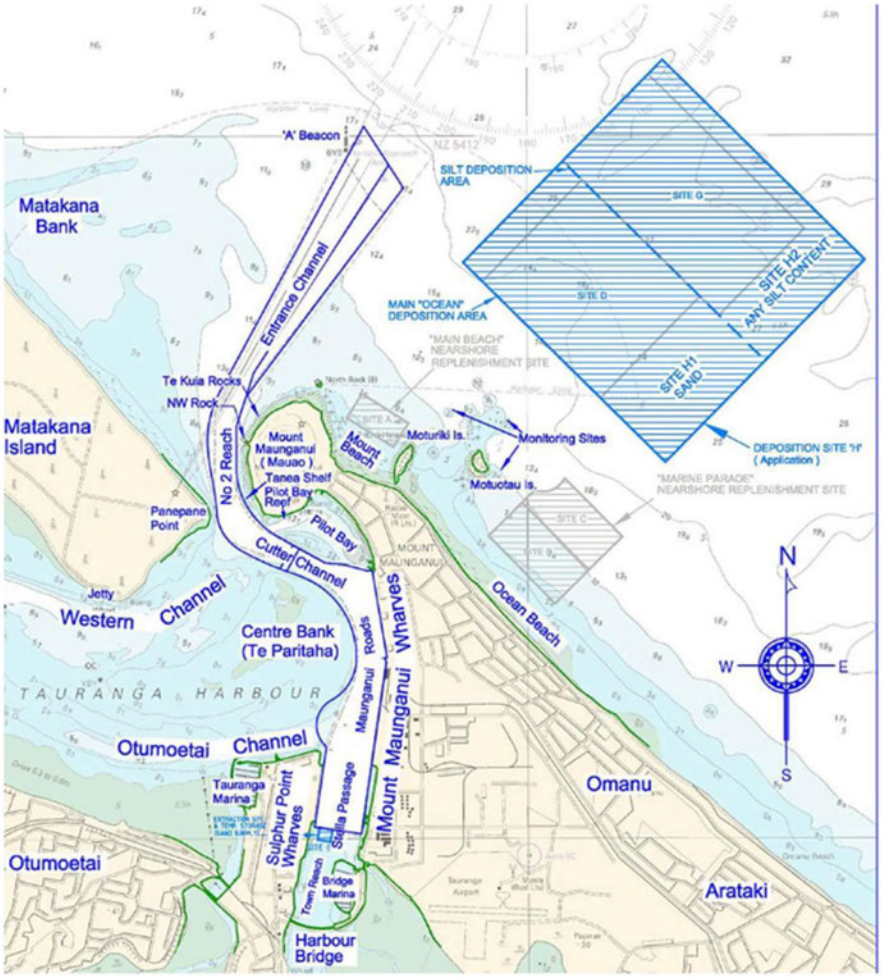


Figure 1. Section of Chart 324-126 showing the main areas involving dredging extraction and disposal for the Port of Tauranga. Source: de Lange (2026) Figure 24.

Appropriate numerical models were calibrated and validated and used to:

- Undertake a sediment connectivity analysis and provide a conceptual model of sediment sources, pathways and sinks (de Ruiter 2022[8]).
- Numerical modelling of waves and currents for Te Awanui and the Western Bay of Plenty was used to examine the effects of seasonality (Summer versus Winter) and climate variability associated with the El Niño-Southern Oscillation (ENSO) focussing on the El Niño and La Niña extremes for Te Awanui and the Western Bay of Plenty (Watson and Berthot 2024[9]). Modelling was performed with a coupled hydrodynamic model (Semi-implicit Cross-scale Hydroscience Integrated System Model – SCHISM) and a Wind Wave Model (WWM version III).
- Calibration and validation of the SCHISM model using all available measurements of bathymetry, tidal currents, water levels, and freshwater inflows for the period 2014 to 2023. The WMM-III model was calibrated with offshore wave measurements from the BOPRC directional wave recorder offshore from Bowentown, the Port of Tauranga Ltd A Beacon, and hindcast wave data from the SWAN wave model used for operational wave

[8] de Ruiter, P.J. 2022. Hypsometric and geometric controls on hydrodynamics, tidal asymmetry, and sediment connectivity in shallow estuarine systems. PhD Thesis, The University of Waikato, Hamilton, NZ. 116 p.
[9] Watson, H. & Berthot, A. 2024. Hydrodynamic and wave modelling, Report prepared for Port of Tauranga, MetOcean Solutions. 112pp.

forecasting around New Zealand. The calibrations for both the SCHISM and the WMM-III models were acceptable.

Model results are informative, showing the hydrodynamic response to both seasonality and climate (ENSO) variability:

- Surface and depth-averaged current velocities within Te Awanui and at the offshore disposal sites H1 and H2 show little change in response to both seasonality and climate variability.
- Residual currents provide a good picture of net tidal circulation patters and potential pathways of sediment transport within harbour and between ebb and flood tidal deltas.
- Residual currents do not show any obvious differences within Te Awanui due to seasonal or ENSO impacts. However, there are differences evident outside the tidal inlet, with increased residual circulation around Moturiki and Motuotau Islands during El Niño conditions and strengthening of flood flow along the foreshore of Matakana Island during La Niña conditions.
- Predicted significant wave heights within Te Awanui show no variations with season or climate variability. However, in the offshore disposal area outside Te Awanui extreme waves are larger for La Niña conditions, particularly during the winter.

3.0 Sediment extraction impacts

This section shows a good understanding of the way dredging by a trailing suction hopper dredge (TSHD) and back-hoe dredge (BHD) are likely to impact the seabed and water column through sediment plume turbidity via cutter head disruption of the seabed, overflow discharge of water pumped into the hopper and propellor wash/jet disrupting the seafloor or settling process for the plumes produced by the other two sources.

Useful field studies were undertaken to understand the nature of dredging plumes and inform mitigation of effects as follows:

- Studies of the sediment plume showed the concentration of suspended sediment in far-field plumes is low, concentrations being at the lower end of the natural range. An important observation with respect to visual effects was that although, the concentrations are low, the sediment grains involved may have a significant effect on the visual appearance of the water by the way they scatter light. For instance, a very distinct plume formed during the dredging of a weathered ignimbrite due to the presence of bladed glass shards in the fine silt and very fine silt fraction. This means that assessing turbidity (and associated biological effects) solely on the suspended sediment concentration is not entirely reliable.
- Improved methodology for the 2015/16 Capital Dredging Programme was guided by: 1) a 3-dimensional model of the subsurface geology that allowed the dredge operators to adjust their dredging methodology for the predicted sediment characteristics before they excavated material, 2) an array of turbidity sensors surrounding the area being dredged to detect any potentially adverse plume in real time, 3) observers on board the dredges to monitor the water appearance, and 4) an improved management of overflow from the hopper (including stopping overflow completely if necessary).
- Mitigation of the THSDs plume was achieved for the 2015/16 Capital Dredging Programme by using:
    - Reducing the entrainment of air bubbles into the overflow, using a low turbidity valve (green-valve technology), thereby facilitating the fine material to settle rather than stay suspended.
    - Controlling the duration of overflow so some of, or all, the water and sediment pumped from the seafloor is retained in the hopper.
    - Reducing the production rate of fine sediment by using a smaller TSHD or a BHD.

- Controlling the direction the plume can travel after leaving the source region by the dredge (mixing zone) by only dredging when the tidal currents transport plumes away from areas of concern.

Detailed numerical modelling studies complemented the above understanding and informed mitigation options:

- Modelling simulations of plumes generated by a large TSHD and a BHD for 7 locations in the shipping channels in Te Awanui (Montaño 2024[10]). This enabled identification of distances of travel of the plumes and locations where suspended sediment concentrations exceed threshold levels under different tidal and seasonal conditions (La Niña and La Niña summer and winter).
- The modelling indicates the plumes following the channels (Western Channel, Cutter Channel, and Maunganui Roads), so the suspended sediment is transported away from Te Paritaha.
- The modelling indicates that the additional suspended sediment due to dredging using a large TSHD and BHD is unlikely to boost ambient levels above the threshold level under normal weather conditions. However previous capital dredging campaigns have indicated that it may be possible under stormy weather conditions that high sediment discharge from catchments into the harbour could produce sufficiently high background suspended sediment levels within Stella Passage that may combine with dredge plumes to exceed threshold levels.
- The recommendation that the turbidity issue is addressed through real time monitoring and appropriate consent conditions[11] is sound. Conditions recommended to mitigate effects are to modify dredging operations if average ambient levels exceed the 70 $mg.1^{-1}$ threshold, or a lower threshold to allow for the additional sediment associated with the dredge plumes.

4.0 Sediment disposal impacts

The dredge site selection is based on my understanding of accepted scientific principles namely:

- The sediment texture of the seabed having natural characteristics as similar as possible to the deposited dredged sediment, so that the disposed sediment would behave the same way in response to natural processes and preserve the natural habitat for any biota present
- Whether the sites would be non-dispersive or dispersive based on the critical proportion of fines.

Follow up monitoring showed the disposal sites working as intended:

- Surveys showed the surficial texture within the disposal sites post-dredging is very similar to the pre-dredging conditions, apart from the presence of biota that normally occur inside the harbour. The deepest H1 and H2 disposal sites appear to be non-dispersive as intended, with no sediment loss detected by post-disposal surveys
- Nearshore sites A, B and C were intended to be dispersive sites. This is to allow the sandier sediment (sediment fines threshold of <5%) to move onshore and renourish the beach. Monitoring indicates these sites are behaving as intended.

[10] Montaño, M. 2024. Dredge plume modelling: Dredging plume dispersion over existing and proposed port configurations. Report prepared for the Port of Tauranga. MetOcean Solutions. December 2024

[11] Recommendation is that real time monitoring and appropriate consent conditions be applied to prevent elevated levels of turbidity from occurring in Stella Passage, such as restricting dredging with no overflow during peak flood tidal flows, or only dredging on an ebb tide, or ceasing dredging while background levels are above threshold.

- Offshore (deeper water) sites D, G, H1 and H2 were intended to be non-dispersive sites for finer material. Shallow seismic surveys, surficial sediment sampling, and vibracores to examine the D, G, H1 and H2 disposal sites and the surrounding seafloor indicate that there is some reworking but limited dispersion of the dredged material from the site (Blackler 2024[12]).

Numerical modelling of the formation and dispersion of sediment plumes during the disposal of dredged sediment (Montaño 2024) was undertaken to better understand the behaviour following release of dredgings from a split hopper TSHD during phases of convective descent, dynamic collapse, and passive dispersion, finding:

- The surface sediment plume from a large TSHD hopper release at the centre of the combined sites D and H1 is restricted to a small area around the release point.
- The near-bed plume travels further due to the initial momentum of the density current releasing sediment into the water column but is still confined to the disposal site.
- If the sediment was released close to the boundaries of the sites, then the near-bed plume would extend beyond the boundaries (although this is not normal practice).
- Numerical modelling indicates most sediment is deposited on the seafloor within 100 m radius of the release point.

Ecological studies at the offshore site supported limited impacts as follows:

- Foster et al. (1991)[13] and Foster (1992)[14] examined the effects of sediment disposal on benthic fauna for an existing disposal site (within site D). They concluded that burial was the main adverse effect, which was linked to a reduction of biodiversity 6 months after disposal. However, there was limited movement of the sediment, so they assessed the site as stable, and it was expected that the site would recover quickly as suggested by Dr Roger Grace in Healy et al. (1988).
- Ecological monitoring of the disposal site was undertaken annually after the 1991/92 Capital Dredging Campaign. Cole and Healy (1997)[15] reviewed 3 years of data as part of an analysis of the effectiveness of the sampling design. While the data showed the recovery of the main species present before the campaign, they identified that the sampling design didn't adequately address the natural variability in species presence and abundance, particularly for rare species.

5.0 Post-dredging impacts

Dredging is identified as having potential to change: 1) The tidal range, the timing of high and low tide within the harbour, 2) the duration of flood and ebb flow (and therefore increasing or decreasing ebb or flood currents), and 3) the wetted cross-sectional area and wetted perimeter length of the channels (and therefore increasing or decreasing ebb or flood currents).

Measurements following previous capital dredging in Te Awanui showed that the dredging increased the channel cross-sectional areas (the purpose of the dredging) with resulting very small effects (within the error bounds of the models) on tidal range, timing of high and low water, and durations of flood and ebb flows due to a slight reduction in the total friction and

[12] Blackler, C. 2024. Assessing dredge spoil dispersion on the inner shelf off the coast of Tauranga Harbour, Aotearoa New Zealand. MSc Thesis, The University of Waikato. Hamilton. 186 pp.

[13] Foster, D.M., Healy, T.R., & Warren, S.K., 1991. Environmental impacts of a recent dredge spoil dumping operation off Tauranga, New Zealand. Coastal Engineering - Climate for Change: 10th Australasian Conference on Coastal and Ocean Engineering, Auckland, New Zealand. Pp 141-145.

[14] Foster, D. M. 1992. Environmental impacts of recent dredging and inner shelf spoil disposal at Tauranga. MSc Thesis, The University of Waikato, Hamilton. 230 pp.

[15] Cole, R.G. & Healy, T.R. 1997. Dredge spoil disposal off Tauranga and sampling designs to detect its impacts. Pacific Coasts and Ports' 97: Proceedings of the 13th Australasian Coastal and Ocean Engineering Conference and the 6th Australasian Port and Harbour Conference; Volume 2, Pp 586-590.

constrictions experienced by the tide: tidal ranges decreased slightly, and the differences in flood and ebb tide durations decreased slightly. These changes resulted in a reduction in current velocities, particularly within the dredged channels.

The report describes a thorough re-analysis based on theory, more recent modelling[16] and observations for historic capital dredging[17] to show that within the Port:

- Dredging has had little impact on the tidal range.
- There has been a small impact on the timing of the tide along the shipping channels from dredging.
- Dredging has significantly increased the channel cross-sectional areas (with an associated increased in wetted perimeter length).

However, these changes have resulted in some reduction in tidal velocities. The largest change in velocities was associated with the large-scale initial capital dredging in the 1960s, particularly the excavation of the Cutter Channel that resulted in greatly reduced tidal currents in Pilot Bay Channel. Subsequent capital dredging programmes have had less impact, except for areas of significant deepening in Stella Passage. The changes at the southern end of Stella Passage are also the result of the constriction of flow by the Tauranga Harbour Crossing.

Numerical modelling of the originally proposed 2026 capital dredging predicted:

- Little change in the tidal characteristics, and hence, unsurprisingly, it predicted a reduction in tidal velocities for the dredged areas of the shipping channels proportional to the increased cross-sectional area.
- Consistency with before and after observations of previous capital dredging.
- No detectable changes to tidal characteristics and tidal velocities beyond the immediate area of the dredged channels
- The key interpretation was that the smaller proposed reconsenting capital dredging will have correspondingly smaller impacts than modelled for the originally proposed 2026 capital dredging.

Modelling undertaken to assess the impact of the 2015/2016 capital dredging on tidal currents, using the 2023 bathymetry as a baseline showed:

- At a local level that the batter slopes adjusted rapidly to the excavation of lower parts of the slope. The batter slope adjustments had negligible impact on the extent of Te Paritaha (the flood tide delta – Centre Bank), or the trend of shoaling that the bank has seen occurring since the 1852 hydrographic chart was surveyed.
- That current velocities increased within part of the Lower Western Channel following the capital dredging. This was a consequence of shoaling decreasing the channel cross-sectional area. The shoaling appears to have been due to erosion of Panepane Point by changed storm wave conditions due to lowering of the ebb tidal delta swash platform during a higher incidence of La Niña conditions over the last decade, which increased the sediment transport into the harbour.

Shoreline changes at Panepane Point

de Lange (2026) reports that some locations, such as Motuhoa and Rangiwaea Islands, are too far from the port areas dredged and reclaimed for any detectable changes in physical processes due to port development and that erosion for distal areas is driven by local

[16] Watson, H. & Berthot A. 2025. Tauranga Harbour historical configurations modelling, Report prepared for Port of Tauranga, MetOcean Solutions, January 2025. 82 p.

[17] The simulations covered off three historic bathymetric configurations – 2015 pre-capital dredging, 2016 post-capital dredging, and 2023 – and one proposed capital dredging scenario – delivering current output time series at 9 sites.

processes unconnected to port development. I agree with this and would add that this probably also holds true for areas such as in the vicinity of the outlet of the Wairoa River and the upper harbour causeways.

Panepane is a location identified by some observers as being where dredging and reclamation are having an impact on currents and sediment transport and contributing to coastal erosion and accretion. Panapane has seen erosion associated with severe storms since aerial photographs became available in the 1940s. There has been intensive monitoring, modelling and analysis undertaken to investigate shoreline movement of the Matakana Island shoreline focusing on Panepane to better understand the processes and effects.

de Lange 2022[18] and de Lange 2023[19] analysed shoreline surveys of the Matakana Island to identify trends in shoreline change and any erosion that could pose a threat to areas of cultural significance. The analysis found that erosion that occurs episodically, along approximately 1 km of the offshore margin of Matakana Island and 400 m into the harbour, around Panepane Point. Since 1992, phases of erosion occurred in: 1998-2001, 2011-2015 and 2018-2023. However, the overall trend has been for continuing net accretion of southeastern end of Matakana Island from 1966 up to about 2013 despite dredging campaigns.

Berthot et al. (2024)[20]) reported trends in shoreline change through examination of high-resolution aerial photographic images from 1943-2023, analysis of satellite imagery from the 1990s to 2023 using CoastSat61 software, numerical modelling using the one-line ShorelineS model and empirical analysis that combined wave and tidal currents to assess longshore sediment transport. Berthot et al noted that there is a persistent flood-directed tidal residual current along the Matakana Island foreshore towards the harbour entrance. This could transport sediment entrained by waves away from the beach and into the harbour. Overall, Berthot et al (2024) concluded the effect of originally proposed 2026 capital dredging could be a reduction in wave energy near Panepane, resulting in lower longshore sediment transport and reduced potential for erosion. Although this is the opposite of the trends evident from their shoreline analysis, and reported by de Lange (2022, 2023, 2024).

In my opinion it is important that any interpretation of the cause of shoreline change must be made in the context of understanding that the tip of barrier spits (such as Panepane) are by nature typically unstable and frequently subject to phases of erosion and accretion driven by the interplay of multiple drivers including: tidal currents, sediment supply, changes in wave climate as influenced by their passage over the ever changing topography of the ebb tidal delta, short term weather events and longer term fluctuations in wave conditions associated with interannual and decadal scale changes in wave conditions related to ENSO climate variability.

de Lange recognised two distinct patterns of shoreline erosion (Figures 2):

- Frequent localised embayments occurring at relatively fixed positions along the shoreline due to focussing of waves by swash bars on the ebb tidal delta (Matakana Banks. The embayments rapidly recover from erosion (weeks to months).
- Rarely an extensive zone of erosion on the seaward side of Panepane associated with the formation of a wide shallow flood marginal channel, which occurs when ENE storm waves refract and diffract around Mauao during a flood tide, focussing wave energy on the foredunes near high tide. Recovery from erosion is slow (several years).

[18] de Lange, W.P. 2022. Morphological changes for southeastern Matakana Island (Panepane Point) and Matakana Banks (ebb tidal delta) 2016-22. Report to the Port of Tauranga Ltd. August 2022. 15 pp.
[19] de Lange, W.P. 2023. Morphological changes for south-eastern Matakana Island (Panepane) and Matakana Banks (ebb tidal delta) 2016-23. Report prepared for Port of Tauranga Ltd, November 2023. 27 pp.
[20] Berthot, A., Cussioli, M. & Carli, E. 2024. Shoreline change assessment. Report prepared for Port of Tauranga, MetOcean Solutions, December 2024. 66 pp.



Figure 2. Part of Figure 6 from de Lange Appendix 1. Google Earth images for June 2018 and January 2022 of the entrance to Tauranga Harbour showing changes to Panepane associated with the formation and burial of a marginal flood channel on the seaward side of the spit. Small localised embayments associated with swash bar formation are shown on the 2018 image. A wide shallow flood marginal channel is shown along the Matakana shore on the 2022 image.

These are important observations as in my opinion they suggest that the frequently occurring localised embayments are caused by short-term storm events during which waves attack the shore though gaps in the ebb tide delta banks/shoals (which shift about). Whereas the rarer more extensive and longer lasting zone of erosion flood tide channel on the seaward side of Matakana is caused by a series of events driven by longer term climate change forcing.

I agree with the de Lange (2023)[21] hypothesis that interprets the patterns of erosion and accretion at Panepane as being primarily associated with longer term fluctuations in wave conditions associated with interannual and decadal scale changes in wave conditions related to ENSO climate variability, with erosion occurring during La Niña. This contention is supported by modelling of different wave height patterns across the ebb tidal delta and along the Matakana Island coast under El Niño and La Niña winter conditions (Watson and Berthot 2024a) showing increased large waves reaching Panepane during La Niña conditions, and changes to the dominant wave approach directions. The historical erosion events are associated with periods of increased La Niña conditions in terms of duration, but not necessarily in terms of intensity (de Lange, 2025). Figure 3 summarises how the relative influence of the various factors affecting sediment transport within the Tauranga tidal inlet system vary with ENSO state/patterns, and the frequency and magnitude of storms.

[21] de Lange, W.P. 2023. Morphological changes for south-eastern Matakana Island (Panepane) and Matakana Banks (ebb tidal delta) 2016-23. Report prepared for Port of Tauranga Ltd, November 2023. 27 pp.

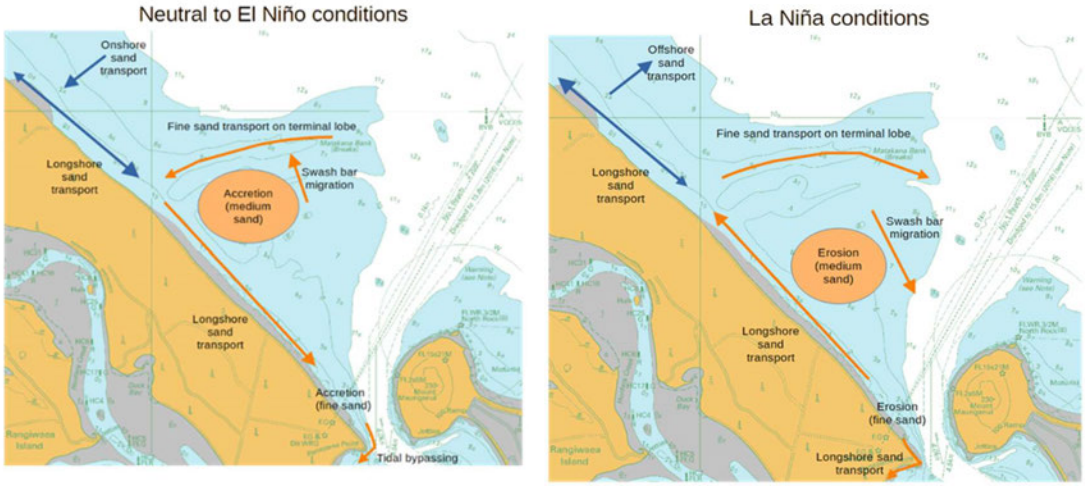


Figure 3. Figure 53 – Schematic diagrams of the sediment transport patterns and associated areas of erosion and deposition associated with different ENSO patterns.

de Lange reports that erosion events at the Tauranga entrance are associated with super-long La Niña events as evidenced in Figures 4 and 5. In part this reflects an increase in wave energy, associated with an increase in waves approaching from the NNW sector. The other critical components are the availability of sediment, and the sediment transport patterns over the ebb tidal delta (de Lange, 2025). Tidal inlet theory dictates that tidal inlets act as barriers to longshore sediment transport, commonly trapping sediment resulting in accretion of the tidal deltas, and then episodically releasing sediment for downdrift transport, resulting in erosion. The rates and timing of accretion and erosion depend on the rate of updrift longshore sediment transport, and the frequency and magnitude of episodic events, usually storms, triggering bypassing (de Lange, 2025).

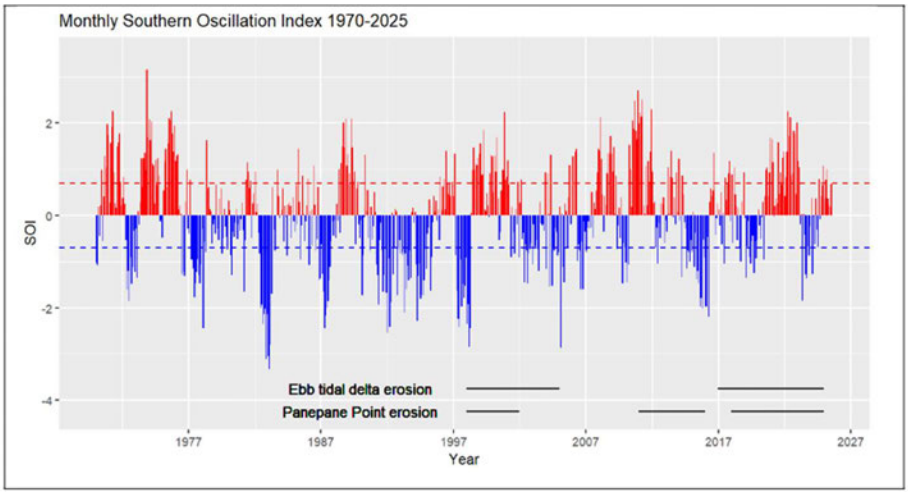


Figure 4. Monthly Southern Oscillation Index for January 1970 to August 2025. Values above 0.7 (red dashed line) correspond to La Niña conditions; below -0.7 (blue dashed line) correspond to El Niño conditions; and between 0.7 and -0.7 correspond to neutral conditions. The calendar years with periods of erosion for the ebb tidal delta and Panepane Point shoreline are shown. SOI data from Australian Bureau of Meteorology. Source (de Lange 2026).

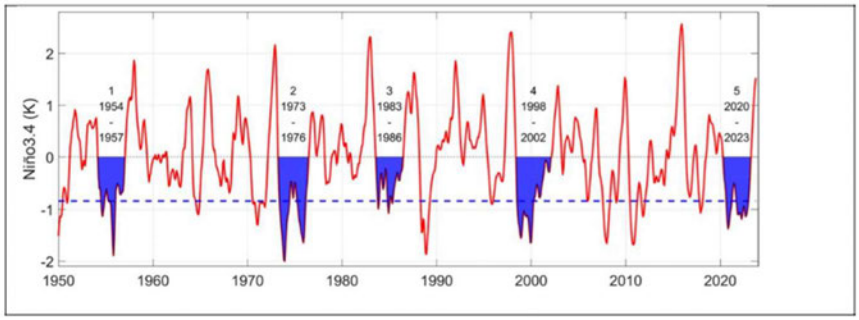


Figure 5. - Time series of 3-month running average Niño3.4 index between 1950 and 2024. The blue dashed line corresponds to an index of -1 (1 standard deviation), and the blue shaded areas are super-long La Niña events. (Figure 1, Wang et al, 2024). Source (de Lange 2026).

de Lange (2023) noted that this flood-tide directed current residual along the Matakana Island shoreline should produce a flood marginal channel, but this is not a permanent feature. His explanation for this (which is reasonable) is that it's possible that when the longshore sediment transport rate from further west along the Matakana Island coast is sufficiently high, the rate of deposition exceeds the rate of removal, so this channel is infilled and the Matakana shoreline progrades. This would suggest that the ENSO climate variability affects the overall longshore transport along Matakana Island. Support for this more regional scale long term cause and effect is suggested in studies by Mathews (2024) who noted that similar changes at Katikati entrance coincide with the changes in the Lower Western Channel at Tauranga.

Considering all the port developments since 1954, de Lange identifies two specific changes to the bathymetry of the tidal inlet that appear to have impacted the development of Panepane since the early 1970's:

- The dredging of the Entrance Channel in 1971 created a deeper and wider Entrance Channel resulting in a change to the orientation of the ebb tidal jet and associated ebb-tidal eddies. This caused a change from a predominantly bar-bypassing sand system to a tidal bypassing system. Increased tidal bypassing involves a higher volume of marine sediment transported into the harbour along the western margin of the tidal inlet (Panepane foreshore) during flood tide, followed by an exit of some of that sediment out of the entrance through the Entrance Channel on the ebb tide. The impact on Panepane was to increase the rate of accretion due to the higher sediment availability, although the effect was limited by the tidal flows through the entrance.
- Lowering Tanea Shelf resulted in an increase in the cross-sectional area of the tidal inlet between Panepane and Mauao, which reduced the current velocities. Lower tidal velocities allowed the western margin (Panepane) to accrete further eastward than it would otherwise have done. This continued until the pre-lowering velocities were re-established and began eroding the tip of the spit once more. The same effect occurred in response to further (but smaller) removal of Tanea Shelf during the 1991-92 Capital Dredging Programme.

I agree with the opinion that the overall impact of port development on Panepane was to temporarily enhance the natural growth of the shoreline to the south resulting in a narrowing of the harbour entrance (a few 10s of metres) by more than it would have become naturally. Panepane now appears to be back in equilibrium with the supply of sediment driving accretion, which makes the erosion associated with episodic storms more evident (e.g. de Lange, 2022). With Panepane in equilibrium, a higher proportion of the marine sand transport into Te Awanui is likely to be deposited within the Lower Western Channel and then make its way onto Paritaha (the flood tide delta) which shows accretion in the long term.

The above highlights the difficulty of identifying the impacts of dredging on sediment transport and the patterns of erosion and accretion at Panepane, since the changes due to the impacts of dredging on currents have been shown to be small, and also driven by the interplay of multiple drivers including sediment supply, changes in wave climate due to short term weather events and longer term fluctuations in wave conditions associated with interannual and decadal scale changes in wave conditions related to ENSO climate variability.

I strongly recommend that monitoring of coastal processes continue in the area of sand transfers encompassing Te Paritaha, the western channel, the shoreline tip of Panepane and adjacent channel flank, and the southeastern part of Matakana shoreline and offshore flood marginal channel. Not only will this provide data that can be assessed against anecdotal evidence and observation but, overtime, an improved understanding on the drivers of shoreline change.

5.4 Implications for dredging

The analysis indicates that capital dredging is not a controlling factor in the evolution of Panepane Point or the ebb tidal delta (Matakana Banks). For maintenance dredging, it is evident that the infill rates for the Tauranga Entrance to the harbour vary over time: both in terms of the total volume, and the locations where infill occurs.

In terms of forecasting of future maintenance dredging volumes, the report suggests that although there is difficulty in reliably forecasting future ENSO states, and the magnitude and frequency of storms, that El Niño events are likely to dominate ENSO for the next 20-30 years until the next transition to a negative IPO. Further, once a negative IPO phase reoccurs, it is likely that there will not be a super-long La Niña until the last half of the phase. Hence, once the IPO transition occurs there will be at least 25-30 years when, assuming sufficient longshore transport, sediment will accumulate over the western side of the ebb tidal delta, and the Matakana Island shoreline will accrete. This is likely to result in further shoaling of the Lower Western Channel and Te Paritaha.

Based on this inferred pattern for the next 20 to 30 years and assuming a stable longshore sediment transport supply and taking into account the historical patterns of maintenance dredging, a continuation of previous consented volumes would be appropriate, with an allowance for episodic extreme events. Hence, the limits could be:

- An average limit of 250,000 m^3y^{-1} over the period of the consent.
- A cap of 350,000 m^3y^{-1} to allow for doubling of infill for the outer channels (No.1 and No.2 Reaches) in response to a wave dominated tidal inlet. It is expected that the extra volume will be balanced by reduced volumes in years when the inlet is tidally dominated.

In my opinion the estimates for future ENSO states are probably as good as any. I am unable to offer an opinion on the consented volumes that are suggested.

6.0 Summary

Overall, this is an accurate summary. In my opinion it would benefit by “beefing up” the narrative on the Panepane issue. While the report addresses this in detail (over 7 pages) the summary in this section is confined to one brief paragraph.

Review of: Watson H. & Berthot A. 2024. Hydrodynamic and Wave Modelling. MetOcean Solutions report prepared for Port of Tauranga. 112 pp.

P0621-01_Tauranga_Hydrodynamic_Modelling_Report_rev2.2-1.pdf

Summary

The MetOcean study uses a thorough and appropriate methodology involving a suite of appropriate numerical model systems underpinned by a good database and calibration with field data to replicate the key coastal forcing processes. This modelling effort provides useful outputs by way of data, graphs, stats and plots and maps fundamental to understanding processes at a wide spatial scale. It provides essential input to process specific models such as the plume modelling and forms part of a broader hydrodynamic and sediment transport modelling effort for the Port of Tauranga.

Review

The modelling is underpinned by substantial data sets used to set up and calibrate the models namely:

- Bathymetry was adequately resolved by compiling multiple datasets from Tauranga Harbour and Bay of Plenty including: multibeam surveys undertaken by the Port of Tauranga, LINZ DEM 1m topography tiles, GEBCO global bathymetry tiles and LINZ digitised navigation charts. Together these datasets underpin all the modelling of the wave and current conditions undertaken for the region.
- Wind hindcasts were derived from the fifth generation ECMWF (ERA5) reanalysis for the global climate and weather providing hourly estimates for atmospheric, ocean-wave and land-surface quantities. Measured data from Tauranga Airport weather station were used to validate the wind models.
- Measured current speeds and direction were obtained from the Port of Tauranga's ADCP current meter deployed in the Entrance Channel and from ADVs and S4 current meters deployed collected for the study.
- Wave directional data were sourced from the BOPRC wave buoy offshore at Bowentown and the Port of Tauranga non-direction waves at A Beacon.
- Water levels were provided by short term measurements from three ADCPs and S4 deployed along with the water levels from the three Port of Tauranga instruments and three BOPRC instruments.
- Fluvial discharge forcing was included for the five main river systems discharging into the harbour.

Appropriate calibrated and validated numerical model systems used included:

- SWAN to characterise the wave climate, both within and offshore Bay of Plenty
- SCHISM and the Wind Wave Model III (WWM-III) to simulate hydrodynamic and wave conditions over the study area

The report provides a very useful array of plots supporting the model calibration and illustrating the current and wave regime in the Port area and ebb tidal delta system for various states of the tide and seasons. The plots of residual currents for ebb and spring tides under different seasonal conditions are very informative particularly in terms of interpreting potential paths of sediment transport.

Review of: Montaño M. 2024. Dredged Plume Modelling. Dredging sediment plume dispersion over existing and proposed port configurations. MetOcean Solutions report prepared for Port of Tauranga. 85 pp.

P0621-04_Tauranga_Dredged_Plume_Modelling_rev1.0-1.pdf

Sediment plume dispersal and settling was simulated using particle-tracing simulations to characterize the dispersion patterns of the sediment plumes and deposition footprints produced during Trailer Hopper Suction and Backhoe dredging operations. Simulations were run for the two different types of dredging at 7 different locations (Figure 1 - extending from L1 Bridge Marina to L6 just outside the entrance channel) for 2 months, during La Niña Winter and Summer, in order to identify seasonal variability associated with each of these periods.

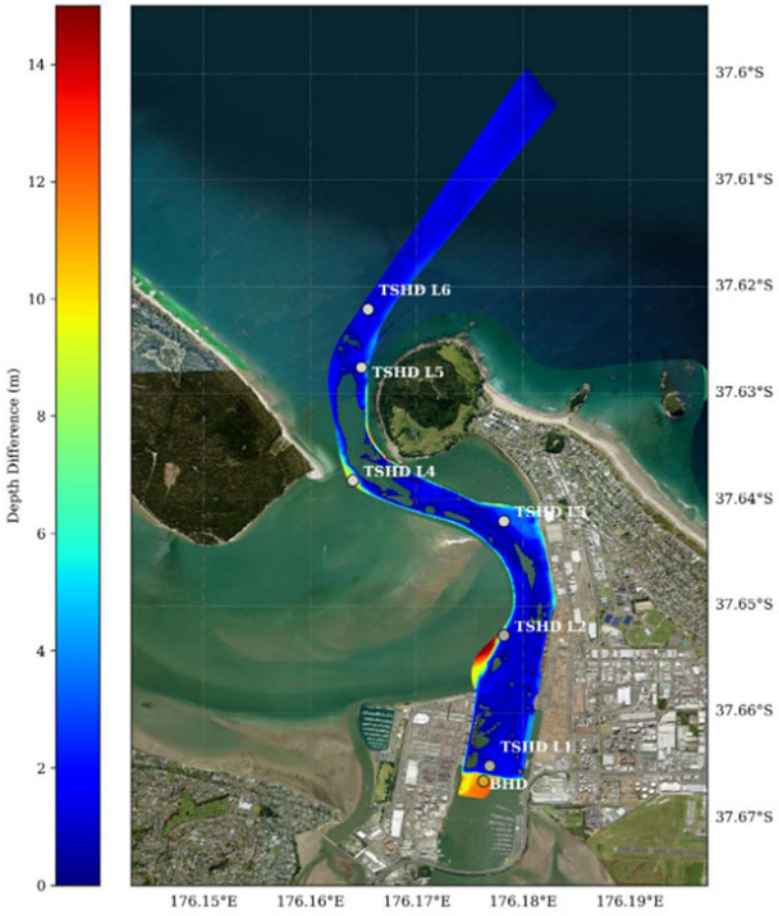


Figure 1. Map showing the locations for each of the release sites considered along the Port of Tauranga described in Table 2-1. The colour bar indicates the depth difference along the channel between the existing bathymetry and the proposed bathymetry in the region of interest. Source: Montaño M. 2024 Figure 2-1.

I am not an expert of plume dispersion models and am unable to comment on the choice of parameters and coefficients input to the model that drive the equations. However, we can have confidence in the fact that the plume modelling was underpinned by a high-resolution coastal hydrodynamic model that was implemented and validated as part of the wider project.

I can comment on the value of the modelling in informing the understanding of plume dispersion. Examination of the output plots show the following interpretations are reasonable:

- Simulations for the TSHD show the sediment settling is rapid given the proximity to the seabed, showing the highest values of suspended solids concentration (SSC) are found in the bottom layer due to the proximity to the seabed.
- There are different dispersal patterns and extent of SSC clouds for the 6 large TSHD sites
- Sites L2 and L4 are the locations with a largest plume extent. For the L2 site particles can get entrained into Manganui Roads and follow the Cutter Channel towards the Entrance Channel and end offshore. For the L4 site particles can get entrained into the Western Channel and into the inner west region of the Tauranga Harbour.
- The deposition of dredged material shows a slightly larger spread during Winter.
- For TSHD disposal near the centre of the spoil ground the mean and extreme footprint SSC plumes have highest concentrations near the disposal point.
- While the 75 mg L^{-1} threshold for SSC can be reached at Te Paritaha and Bridge Marina it does not persist. Whareroa Marea shows no significant SSC contributions from the TSHD dredging activities.
- Te Paritaha does not show contribution of L1 and L3 sites, regardless of the season, and contributions from Site L2 are below 1 mg L-1. Sites L4, L5 and L6 have slightly higher SSC contributions, however these levels are not persistent through time through time.
- For the BHD simulations the highest concentrations are found near the disposal site with lower concentration values at the surface layer relative to the bottom layer and the plume is contained within the mixing zone.

Review of: Berthot, A., Cussioli, M., & Carle, E. 2024. Shoreline change assessment, MetOcean Solutions report prepared for Port of Tauranga, MetOcean Solutions, December 2024. 66 p.

P0621-03_Tauranga_Shoreline_Assessment_Report_rev1.0.pdf

Summary

This is a comprehensive piece of work underpinned by a sizable database (historical aerial photographs and satellite imagery, wave and current data), good analysis methodologies, and appropriate numerical modelling techniques. Interpretations look fair with respect to results presented and my understanding of coastal processes.

Overall, the results of longshore transport calculations highlight the complex interaction between wave and current dynamics in longshore sediment transport, with variations in transport rates and directions influenced by the different bathymetries, tides, and dredging activities, ultimately affecting coastal erosion patterns along the studied shoreline. This makes it difficult to separate out the contribution of dredging to the overall picture.

Review

The study describes results of modelling of predicted changes in Panepane Point shoreline for various dredging scenarios. It follows up work by de Lange (2023) who analysed shoreline surveys of the Matakana Island undertaken by the Port of Tauranga Ltd to identify trends in shoreline change and any erosion that could pose a threat to areas of cultural significance located in the region.

The study used accepted methods for:

- Analysis of aerial and satellite imagery to estimate historical shoreline retreat/accretion using manual and automated tracking methods. Aerial images from 1943-2023. Satellite imagery from the 1990s to 2023 using CoastSat61 software
- Wave and longshore transport analysis using the one-line shoreline model (ShorelineS) to simulate shoreline changes in response to different bathymetries. Namely, effect of changes in bathymetry on wave parameters across four scenarios: pre-dredge 2015 bathymetry, post-dredge 2016 bathymetry, pre-dredge 2023 bathymetry, and post-dredge future dredge bathymetry.
- Empirical analysis that combined wave and tidal currents to assess longshore sediment transport.

Some key findings:

- Shoreline position mapped as edge of vegetation (EoV) from historical imagery mapped showed pre-1990 vegetation extent was further inland at Panepane Point. Seaward expansion occurred from 1990s-2010s, with a maximum vegetated area in December 2018. There was a rapid loss of vegetation after 2020. The vegetated area to the north of Panepane Point expanded seaward between 1990-2010s with relatively consistent positions from 2000s-2010s. Rapid retreat occurred for subsequent years, primarily for the periods between 2011 - 2014, 2018 - 2020, and 2022 – 2023.
- Shoreline change (1999– 2024) extracted from satellite imagery showed a long-term trend of retreat along the seaward margin of Panepane Point and progradation of the sand spit towards the inner harbour. A seasonal trend was visible - sand spit prograded (moved seaward) during summer months and retreated during winter months. The reverse along the outer coast to the north of the spit, with shoreline retreat during summer months and progradation during winter.
- Changes in bathymetry on wave parameters were assessed across four scenarios: pre-dredge 2015 bathymetry, post-dredge 2016 bathymetry, pre-dredge 2023 bathymetry, and post-dredge future bathymetry. In general, the largest changes in wave climate

occurred between the 2015 and 2016 scenarios and the 2016 and 2023 scenarios, with smaller changes between the 2023 and the future dredge scenario. Key changes affecting longshore transport included shifts in wave direction, particularly the increase in the occurrence of waves coming from the north-north-east and an increase in the angle between incident waves and the shoreline normal, potentially leading to greater transport to the south.

- Shoreline modelling (undertaken using a one-line model ShorelineS) results showed erosion north of site W1 (north of the ebb delta) and transport of sediment mainly southwards, resulting in accretion along the coast from W2 to W4 (close to Panepane Point). The accretion leads to the elongation of the sand spit. The effect on longshore transport of the different bathymetries when forced by waves alone, showed dredging resulted in a reduction in wave height and a change in wave angle, which locally had the potential to decrease longshore transport.
- Currents in combination to the wave climate also play a role. Residual current maps, from the hydrodynamic simulations (MetOcean Solutions, 2024), suggests that sediment transported SE by longshore currents along Panepane Point is potentially redistributed by tidal flows. Some of this sediment likely flows into the harbour and may be carried into the main channel and transported offshore as a part of a bypassing system operating via the ebb and flood tidal deltas in the harbour.
- In my opinion this interpretation is consistent with the conceptual model for tidal inlets which would suggest the incoming tide will generate SE directed flow in the marginal flood channel along the seaward shore of Matakana and into the harbour. Some of this sediment will stay in the harbour and some will exit on the outgoing tide and returned to the ebb tidal delta (ETD) in a circulation loop termed tidal bypassing.
- Longshore transport calculated using wave-only transport empirical calculations (Kamphuis method), show sediment transport is mainly directed southeast along the shoreline south of Matakana Island. Transport rates increase moving southward from the longshore bar area but decrease approaching Panepane Point. Near the harbour entrance, dredging generally reduces transport. North of the ebb tidal delta, variations in longshore transport between dredging scenarios are minimal.
- Longshore transport calculated including currents in transport calculations (Bayram method), show the direction of transport becomes more variable, occurring in both southeast and northwest directions. Transport rates are highest north of Panepane Point and lowest at the entrance. The longshore bar area, located north of the ebb tidal delta, is mainly influenced by waves, with weaker currents.

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