Mangawhai East Private Plan Change

Coastal Processes and Hazard Assessment

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COASTAL MANAGEMENT AND ENGINEERING

Mangawhai East Private Plan Change

for

Cabra Mangawhai Ltd and Pro Land Matters Company Ltd

Coastal Processes and Hazard Assessment

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Table of Contents

1.0 Introduction

Application is being made by Cabra Mangawhai Ltd and Pro Land Matters Company Ltd for the rezoning of an area of land on the southern banks of the Mangawhai Estuary, termed for the project purposes as the Mangawhai East Private Plan Change (MEPPC).

Davis Coastal Consultants have been instructed to provide professional services to analyse and advise on the coastal processes and any coastal hazard risk associated with the Proposal.

1.1 Definitions

Within this report terminology for the site is consistent with those defined in the Resource Management Act, the Northland Regional Plan / Kaipara District Plan, or the Collins Dictionary (for Harbour/Estuary):

Coastal **M**arine **A**rea – CMA – *"means the foreshore, seabed, and coastal water, and the air space above the water -*
(a) of which the seaward boundary is the outer limits of the territorial sea:
(b) of which the landward boundary is the line of mean high-water springs…"

Common **M**arine and **C**oastal **A**rea – CMCA – *"means the marine and coastal area other than –*
(a) specified freehold land located in that area; and
(b) any area that is owned by the Crown…"

Estuary – *"an inlet or arm of the sea; the lower portion or wide mouth of a river, where the salty tide meets the freshwater current"*. The terminology 'Mangawhai Estuary' has been used in this report to refer to the entirety of the sheltered waterbody upstream of the mouth.

Mean **H**igh **W**ater **S**prings – MHWS – "*the average of the heights of each pair of successive high waters during that period of about 24 hours in each semi-lunation (approximately every 14 days) when the range of tides is the greatest"*

2.0 Description of Existing Environment

2.1 Location

The MEPPC area is located on the southern shore of the Mangawhai Estuary, and covers an area of approximately 94 hectares. The site is directly east of the Mangawhai Village township, with the MEPPC boundary meeting the southern end of the Insley Street causeway and being generally bisected by Black Swamp Road (Figure 2.1).

Figure 2.1: Location Plan

2.2 Wider Physical Environment

Mangawhai Estuary is an east coast estuarine system located at the northern extent of the Mangawhai-Pakiri embayment. The estuary has a narrow entrance, bounded on the north by a protruding rock headland and on the south by an extensive sand barrier spit. The spit is poorly vegetated and there is evidence of large volume aeolian sand movements.

The estuary has a relatively narrow (300-500m wide) sinuous form which is orientated approximately north-south behind the spit for some 4km, before widening and diverging into two upper arms west of the base of the sandspit. The site is a tributary on the northern, landward arm of the estuary.

The underlying geology of the site is detailed in the reporting by Initia for the northern area and by Wiley Geotechnical Consultants for the land south of Black Swamp Road. and notes the site includes areas of Holocene river deposits, Late Pleistocene river deposits, and Pakiri Formation of the Warkworth Subgroup to the southern portion of the site (Figure 2.2a).

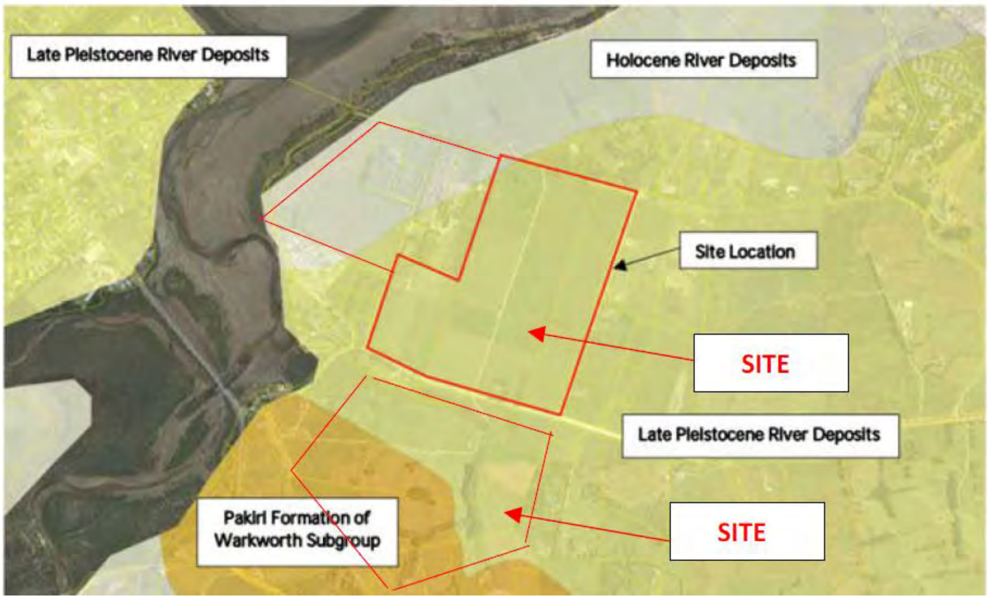


Figure 2.2a: Geology of the site (ex Aspire Reporting)

Hydrographic Chart NZ 522 published by Land Information New Zealand (LINZ) includes the Mangawhai Estuary (Figure 2.2b). The site sits within the upper reaches of the estuary, and, the Chart does not provide depth information for any of the channels. The available bathymetry data is only provided outside the entrance.

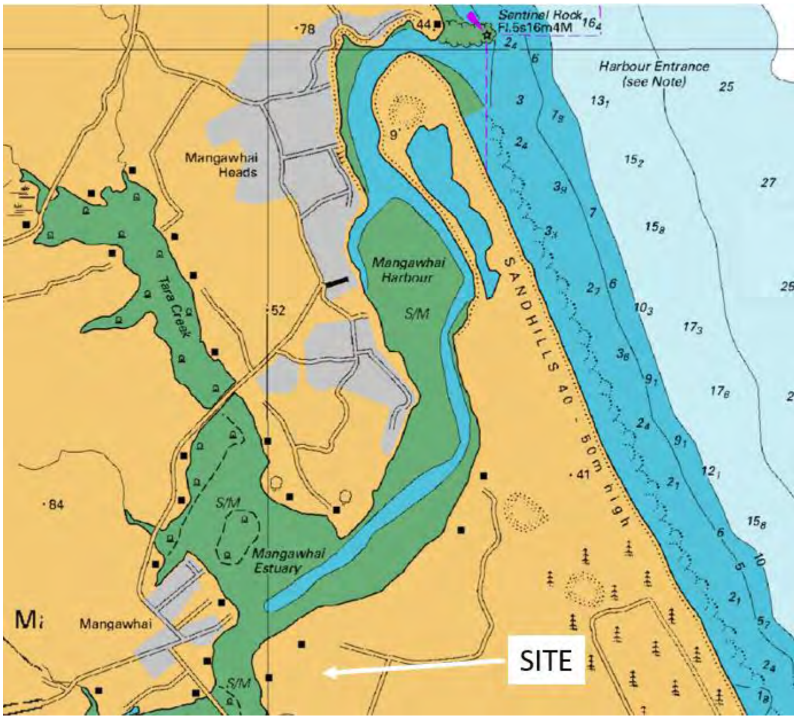


Figure 2.2b: Bathymetry of site ex LINZ Chart NZ522

2.3 Site Description

The site is bisected by Black Swamp Road, which runs approximately east-south-east from where it meets the coast. The road also marks a dividing point between two quite different geomorphologies through the PPC area. South of the road is primarily sloping hill country and north of the road is generally flatter and more low lying (Figure 2.3).

To the south of the road, raised hillslopes are present to the southern boundary of the PPC area, up to approximately RL 50 (to NZVD2016) at the crest of the southern ridgeline. The hillslope generally falls to the north, at approximately 1:10, where it meets a tributary of the Mangawhai Estuary which extends east, inland from the causeway at Black Swamp Road. With the exception of the causeway this upper estuarine arm appears relatively unmodified for approximately 250m before it has been shaped by surrounding land activities.

Black Swamp Road runs along the northern side of this watercourse. The land north of the road is separated into an elevated plateau, generally at RL 4 and above, and an extensive low-lying area to the north-west of this, typically at and below RL 2. These two areas are separated by a north-east orientated, relatively steep bank, marked on the figure below, which also represents the interface between the Late Pleistocene river deposits at the upper plateau and the more recent Holocene deposits to the lower area.

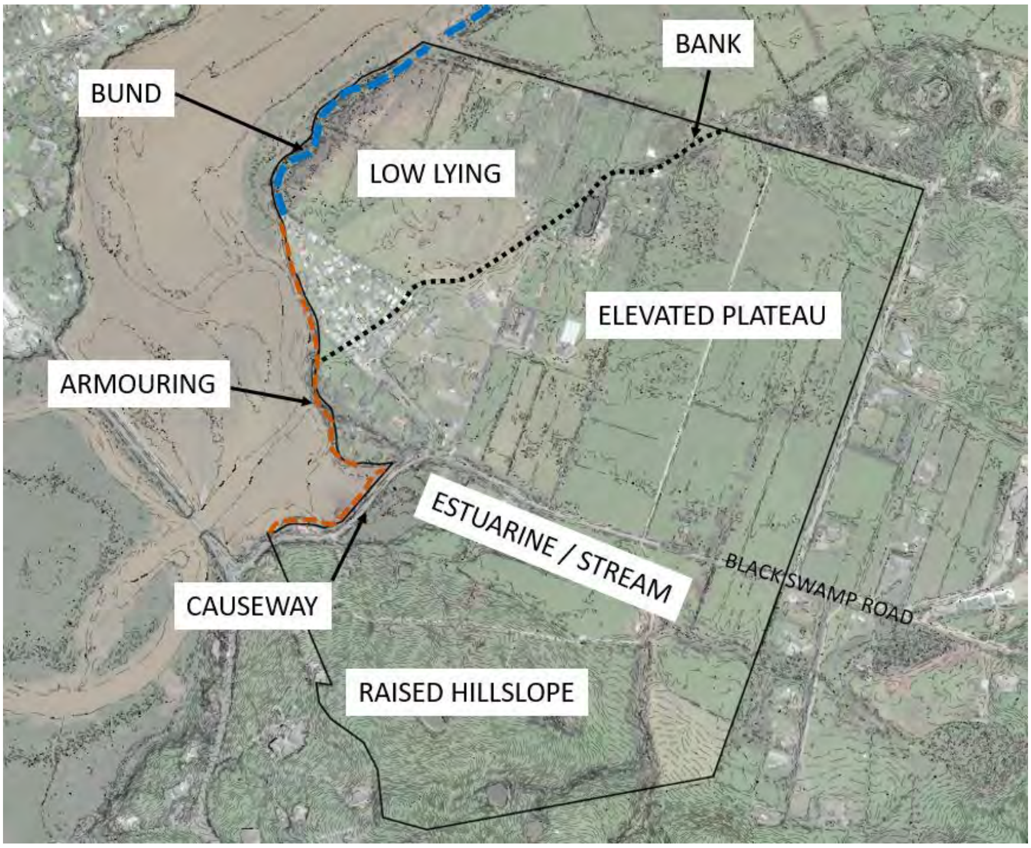


Figure 2.3: Landform through PPC area

A discontinuous raised bund is located at the coastal edge at the northern extent of the PPC area (demarcated by the blue dashed line above), starting approximately at the northern end of the campground and extending north-east. The bund ranges from approximately 1.5-1.8m high and is typically comprised of sandy fill but there are also areas where loose concrete is also present. The bund terminates at the northern boundary of the PPC area, where a beach access point is present, and continues again further north. A drain runs parallel to the bund on the landward side, with this area being still affected by tidal waters. Mangroves and other salt-marsh species are colonising the area immediately behind the bund.

Existing armouring is present to part of the estuary edge, demarcated by the brown dashed line on the figure. At the southern extent, the causeway is armoured by gabion baskets with a rock riprap toe (Photograph 2.3b) to both sides. There is a short extent of rock riprap around the house at 13 Black Swamp Road. Rock riprap continues to the stretch of coastline between the causeway and the campground (Photograph 2.3c), before a timber wall armours the coastal margin at the campground.

Photograph 2.3a: Area behind bund

Photograph 2.2b: Gabion and rock riprap to causeway

Photograph 2.2c: Rock riprap to coastline south of campground

3.0 Coastal Processes

3.1 Wind

Met Ocean Solutions, who are a division of the Meteorological Service of New Zealand, provide a MSL WRF wind model from their 'Met Ocean View' website. No model location is available for the estuary, however data from an output location outside the mouth (3.4km northeast from the site) is reproduced below (Figure 3.1a).

According to this record, prevailing winds are from the southwest and west sectors, with the strongest (10-15m/s) and most frequent winds (5-10m/s) arriving from a south-westerly direction. The coastal edge of the PPC area has a short exposure to the south-westerly wind, acting across the upper estuary from the Insley Street causeway towards the campground area, and an exposure to the north-westerly wind, across the more open estuary basin (Figure 3.1b).

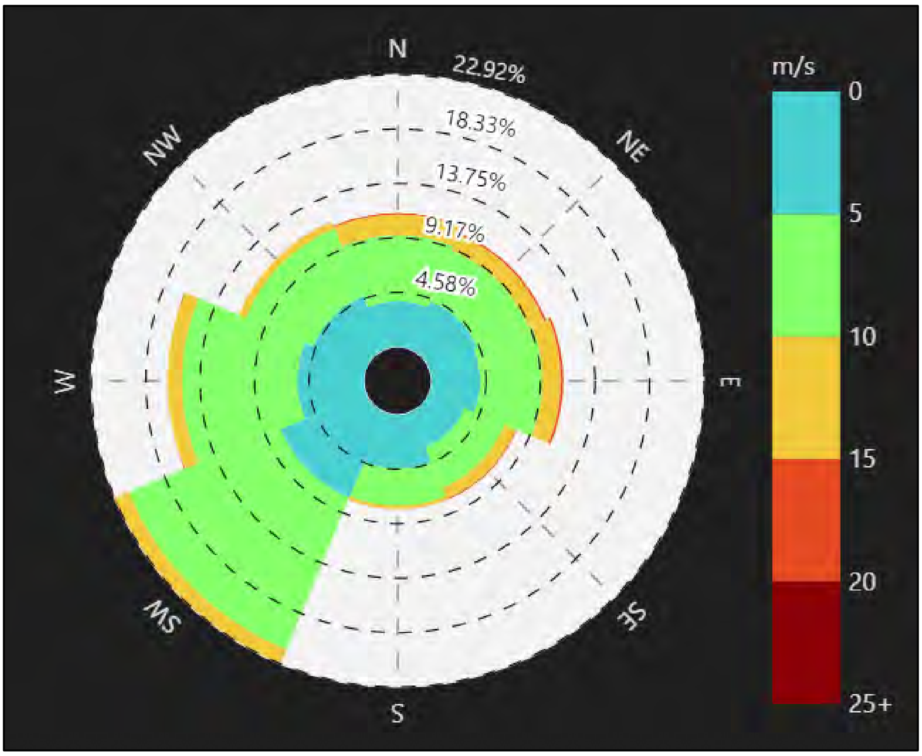


Figure 3.1: Wind rose obtained from app.metoceanview.com (site 36.0841S 174.5991E)

Figure 3.1b: Exposure of coastal parts of PPC area

3.2 Tides

3.2.1 Standard LINZ Data

Tidal data is published by Land Information New Zealand (LINZ) based on a tide gauge at Marsden Point, Whangarei, approximately 30km to the north of Mangawhai. Tidal information has recently been provided for a Secondary Port at Mangawhai Heads, located at the estuary mouth (approximately 4km north from the site). MHWS for the Secondary Port at Mangawhai is 0.3m lower than recorded at Marsden Point. Given its closer proximity, the Secondary Port is considered much more likely to reflect the tidal range at the site, and has been adopted.

Standard LINZ port tidal levels published online by LINZ are in terms of Chart Datum (CD). All levels expressed in this report (denoted 'RL') are in terms of New Zealand Vertical Datum 2016 (NZVD2016), as this is the datum used for the local topographic survey. Relevant tidal data has been expressed in terms of both CD and Relative Level (RL) to NZVD16 below (Table 3.2.1).

Port	HAT*	MHWS	MHWN	MLWN	MLWS	LAT*
Marsden Point CD	3.01	2.7	2.3	0.9	0.5	0.13
Mangawhai Heads CD	2.63*	2.4	2.1	0.8	0.4	-0.13*
Mangawhai Heads RL (NZVD16)	0.9*	0.7	0.3	-1.0	-1.4	-1.6*

Table 3.2.1: LINZ predicted tide levels at Marsden Point & Mangawhai Heads, *= calculated using range ratio method

3.2.2 Storm Tides

During storm events water levels become higher due to lower atmospheric pressure and the effect of onshore wind energy "pushing" water towards the coast and up harbours in an effect called storm surge. Storm tides can be defined as tides that include the effect of storm surge and these represent the highest range of water levels experienced in coastal regions in decadal time scales. There are also other oceanic driven variations in the water level that affect extreme tidal levels that are captured in the tidal record.

In locations with a long tidal record, analysis of past data provides a reliable method of predicting future high-water levels. A report prepared by NIWA (2016) performed an in-depth study using hydrodynamic models calibrated against tide-gauge and wave buoy measurements to calculate storm tides along the Auckland coastline (including at and within the Mangawhai estuary). Joint probability modelling techniques were then applied to calculate the occurrence likelihood of the extreme sea-level elevations. Modelling following a similar approach has also been undertaken by Tonkin & Taylor on behalf of the Northland Regional Council (NRC) for the coastline of the Northland region, which also includes the Mangawhai estuary.

These storm tide predictions incorporate the astronomical tide combined with the joint effects of storm surge and monthly, seasonal and longer timescale oscillations in water level.

The simulated extreme storm tide level calculated in both reports, for within the Mangawhai Estuary, are shown below (Table 3.2.2). Levels provided in the NIWA reporting are relative to Auckland Vertical Datum 1946 (AVD1946). This has been converted to NZVD2016 using the online converter provided by LINZ, including the X and Y co-ordinates of the modelled location.

The model output location for the NIWA work is immediately offshore from the site, in comparison to the model site for the TnT study being further north, closer to the estuary mouth.

Accordingly, the NIWA value has been adopted for consideration of the future flood hazard risk to the site.

Storm Tide	AVD1946	NZVD16
1% AEP (1 in 100-year event) per NIWA - adopted	1.81	**1.51**
1% AEP (1 in 100-year event) per TnT		1.6

Table 3.2.2: Maximum storm tide values for site (ex NIWA, 2016), Mangawhai Harbour, Table 3-2

Figure 3.2.2: Comparison in modelling sites

3.3 Wave Climate

Due to the narrow Harbour entrance, the wave environment is sheltered from open ocean swell waves. This is reinforced by research (Santoso et al, 1998) sited in recent work by NIWA (2016), which notes *"the wave setup component that is generated on the open coast is unlikely to propagate far inside the entrance of an estuary"*. Due to the upper estuary location, neither open ocean swell waves nor the associated setup are considered to be relevant to the PPC area.

The area of coastline adjoining the PPC area will be subject to locally generated wind waves. The generally thin and narrow form of the Harbour constrains wave development. The bounding land masses typically restrict fetches to approximately 500 – 1000m, and although slightly larger fetches are available (up to 2.0 – 2.4km), these have a narrow angle along which the wind can generated wave energy.

Wind wave generation within the elongated shape of the Harbour is significantly reduced below that expected over similar fetches over a more open waterbody (e.g. Lake or wide harbour). The Saville method (Saville et al, 1962), in CIRIA C683 (2007) has been used, which was formulated for such conditions, to calculate the effective fetch. The wave climate along this effective fetch was then calculated using the SMB wave prediction formulae for open waters (Equations 4.78 and 4.79) as prescribed by CIRIA. Wind speeds for this hindcast were firstly obtained from the New Zealand Design Actions Standard (AS/NZS 1170:2011), and transformed into 1 hour wind speeds using Formula II-2-1 3(c) of the Coastal Engineering Manual (CEM, USACE, 2008). The 20% AEP (1 in 5 year event) and 1% AEP (1 in 100 year event) wind speeds were adopted for the hindcast.

The results for the 20% and 1% AEP events are shown below (Table 3.3), along with a 'regular wave' hindcasting using a 10m/s wind, to give a comparison to a typical wave to be expected in the Harbour a number of times a year.

Event	Wave Height (m)	Period (s)
'Regular wave'	0.2 – 0.3m	2s
20% AEP (1 in 5 year event)	0.5 – 0.6m	2-3s
1% AEP (1 in 100 year event)	0.6 – 0.7m	3s

Table 3.3: Wave hindcast

The ability of short-period wind waves, generated inside the estuary, to drive significant set-up is considered to be limited. The simple method of Thornton & Guza (1983) takes this as a proportion of the breaking wave height, per Equation 3-3 below. Even with the maximum wave calculated above, this indicates wave set-up with the 1% AEP wind event would be in the order of 0.1m. This event is not necessarily the same event causing the 1% storm tide, and given the very small set-up factor this has been excluded from the maximum coastal flood calculation.

$$\overline{\eta_{max}} = 0.17H_b \quad (3\text{-}3)$$

3.4 Sea Level Rise

There are two sources of guidance for sea-level rise allowances and the most up-to-date data. The MfE document "Coastal Hazards and Climate Change Guidance" released in 2024 provides precautionary relative sea-level rise allowances recommended for coastal planning and policy, before a Dynamic Adaptive Pathways Planning approach is implemented. For *'coastal subdivision, greenfield developments and major new infrastructure'* a timeframe to 2130 is specified, with the *'medium confidence SSP-8.5H+ based RSLR projection that includes the relevant VLM rate for the local and/or regional area'*. The document notes that the prescribed H+ prediction is the 83rd percentile projections (p83).

In addition to projections of sea-level rise, a relatively recent addition to the future sea-level rise risk scenario is the potential for vertical land movement (VLM). This is where the land at the coast can be slowly changing in elevation (up or down), and in the case of sea-level rise risk, if the ground is sinking lower (due to subsidence) the rising sea-level can reach higher and further inland (Figure 3.4a). With respect to the most recent data, the NZ Sea Rise programme has released location specific sea-level rise projections out to the year 2300 for every 2 kilometres of coastline, which is available in an online tool.

Estimates of local VLM rates (mm/year up or down) for the period of 2003 – 2011 are also available in the online tool. Despite the relatively short period of measurement, the potential for subsidence of the land to increase the effect of sea-level rise in the future needs to be accounted for, especially in planning for greenfield sites, in order to sufficiently identify future hazard risk and allow sufficient planning for this risk.

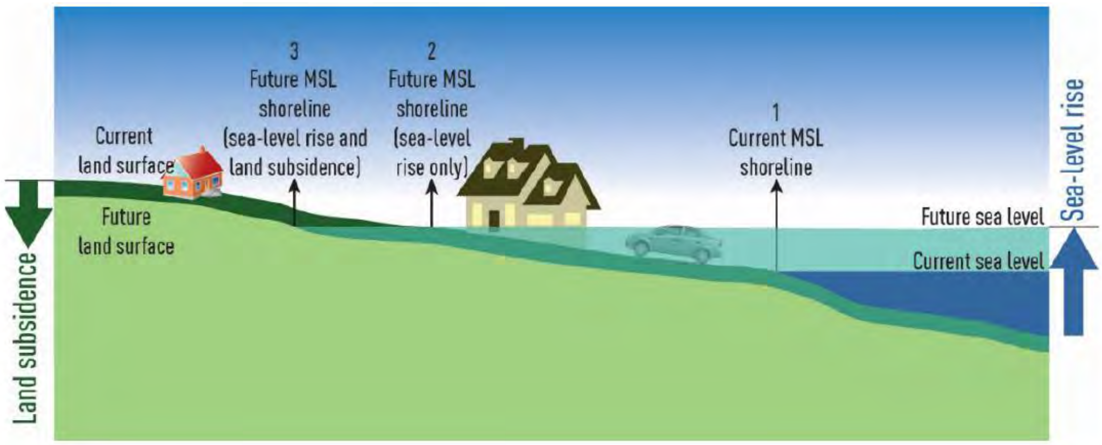


Figure 3.4a: Effect of relative sea-level rise on the shoreline (ex MfE coastal hazards guidance, A Wadhwa, NIWA)

The Intergovernmental Panel on Climate Change (IPCC) previously used Representative Concentration Pathways (RCP) to represent plausible climate futures. These potential future scenarios were focused on a radiative forcing of warming that could be reached by 2100, going from RCP 2.6 – 8.5. The latest assessment reports (published 2021-2022) shifted to a new core set of future representative scenarios, based on Shared Socio-economic Pathways (SSPs). The new SSP's offer five different narratives of how the world may evolve in the future, that also combine the RCP's, related to increases in global mean temperature. The SSP5-8.5 scenario is a worst-case prediction, based on high future emissions.

The closest mapped location on the NZ Sea Rise online tool to the subject site is located within the PPC area, on the Black Swamp Road causeway (Site 897). The predicted effective sea-level rise depends both on the future scenario, and the probability within each scenario. These are summarised in the table below (Table 3.5). The H+ scenario, as prescribed by MfE for coastal subdivision and greenfield developments, is the 83rd percentile (17% chance of occurrence, termed 'p83') scenario. The local sea-level rise prediction with the VLM component is included, and the VLM component is also set out separately. Based on the MfE guidance above, the future hazard assessment must consider a base relative sea-level rise (RSLR) value of 1.7m.

The average VLM rate for the site is -2.3mm/year (+/- 2.6mm), which over the 100 year timeframe would effectively add 0.23m to the RSLR prediction. The p83 prediction for VLM allows for a rate of -5.2mm/yr for the next 100 years. Whilst later work at the site-specific level may consider a summation of these extreme values to be overly conservative, this is considered appropriately conservative for the PPC hazard mapping for a greenfield site and the p83 predicted value has been adopted.

The adopted SLR + VLM value is 2.2m.

Sea Level Rise + Vertical Land Movement (100 years)		
Shared Socio-Economic Pathway	p50	p83 (H+)
SSP5-8.5	1.25m	1.71m
SSP5-8.5 + VLM	1.57m	2.23m
VLM Component	0.32m	0.52m

Table 3.4: Sea-level rise and VLM to 2130 – SSP5 8.5 scenario, Site 897

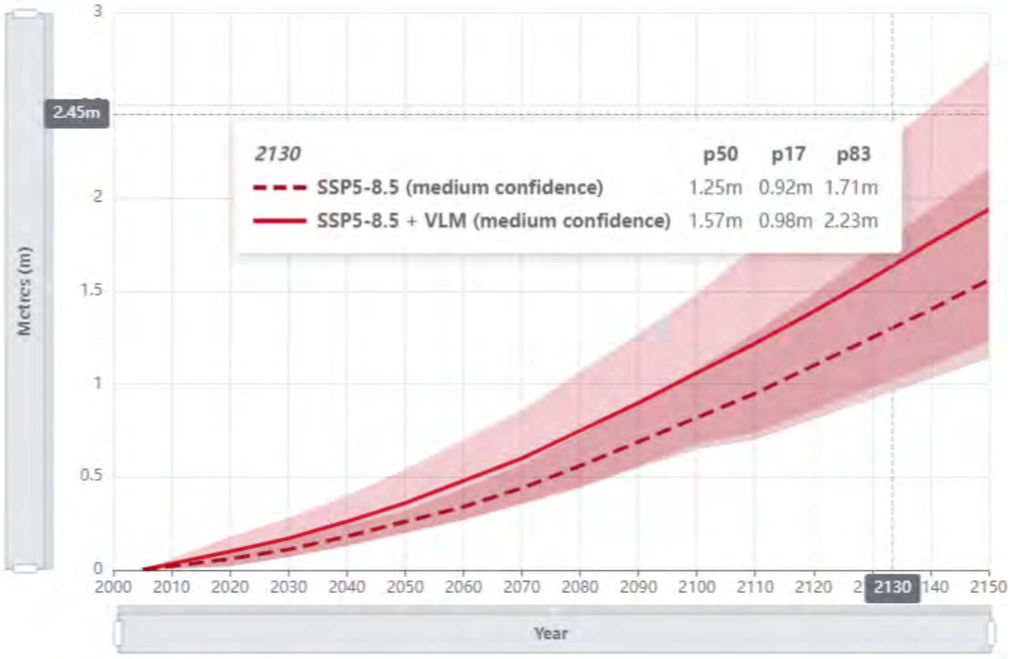


Figure 3.4b: Sea-level rise and VLM to 2130 – SSP5-8.5 scenario, Site 897

3.5 Existing Coastal Flood Hazard Reporting

The Northland Regional Council commissioned a Coastal Flood Hazard Assessment for the entire Northland Region, with that work being undertaken by Tonkin & Taylor (March 2021). That work used a very similar methodology to that applied by NIWA (2016), as referred to in Section 3.2.2 above.

Four Coastal Flood Hazard Zone (CFHZ) scenarios were adopted for that reporting:

- CFHZ0 – Present day 1% AEP
- CFHZ1 – 2% AEP + 0.6m RSLR
- CFHZ2 – 1% AEP + 1.2m RSLR
- CFHZ3 – 1% AEP + 1.5m RSLR

For the Mangawhai Estuary these values are shown below (relative to NZVD2016) (Table 3.5).

Future Inundation Scenario	Level to NZVD2016
CFHZ0	2.0
CFHZ1	2.5
CFHZ2	3.2
CFHZ3	3.5

Table 3.5: Mangawhai Estuary future CFHZ scenarios (NRC, 2021)

The baseline water level, from which sea-level increases were taken from, was the 'static inundation level'. This is the storm tide, with the addition of wave set-up. That reporting states that *"for this regional-scale assessment an allowance for proportional wave set-up within estuaries connected to the open coast have been assumed being 20% of the open coast wave set-up. The proportional wave set-up is added to the wave set-up generated by local breaking waves within the estuaries"*. This explains why the static inundation case for the Mangawhai estuary, for the 1% AEP event, is 0.4m higher than the storm tide (1.6m) at 2.0m (NZVD2016). For the subject site in the upper reaches of the estuary, approximately 6km from the mouth, the potential for wave set-up driven by the open ocean wave environment is considered highly unlikely. This is reinforced by work undertaken by NIWA (2016) where the wave set-up component was removed from their in-estuary model outputs, based on research which indicated that open coast wave setup was unlikely to propagate far inside the entrance of an estuary.

The future sea-level changes were based on the most recent guidance available at the time, which was MfE (2017). The science regarding VLM had not yet been released and accordingly the incorporation of the potential for this to exacerbate any future increase in RSLR had not yet been factored in.

3.6 Coastal Erosion

The erosion drivers in sheltered harbour shorelines, such as at the site, are a combination of weathering of exposed strata from wetting and drying cycles, frittering of weak soils through small locally generated wind waves, and tidal / river currents acting against land, most notably on the outside of bends where these are moving fastest. Two of the locations where existing armouring is present (Figure 3.6a) are where the ebb currents and river flows passing under the Insley Street and Black Swamp Road causeways meander close to the bank. The exposure of these sites to the predominant south-westerly will also be a factor in slow retreat in these locations, which will have motivated the placement of armouring. Armouring is also often required where the coastal margin has been artificially moved seaward, through reclamation, and this appears to be the case at the base of Black Swamp Road where filling has occurred at the edge of the hillslope to form the road and create the building platform for the dwelling on the seaward side of the road.

Figure 3.6a: Tidal currents and presence of armouring

There are two existing regional erosion assessments for the Auckland/Northland Region:

- ACTP 2020/021 – 'Predicting Auckland's Exposure to Coastal Instability and Erosion'
- 1012360.v3 - 'Coastal Erosion Hazard Assessment for Selected Sites 2019-2020' NRC

The Auckland study terminates at the boundary between the Auckland and Northland/Kaipara Council, and does not provide any information for the Mangawhai estuary. The NRC document makes assessment of erosion risk inside the estuary, but only for the residential area of the Mangawhai Heads, from the Molesworth Drive causeway around the promontory and north towards the estuary mouth. No data is provided for the PPC area. However, for the facing coast to the north, which has less effect of tidal currents but is more exposed to the predominant south-westerly, the 100 year future erosion hazard zone is offset approximately 15m from the existing coastal edge. Existing contours through this area are relatively low, at and below RL 3, which means any relaxing of the bank gradient will have a limited effect. This indicates a likely erosion allowance of 0.15m/yr for this area.

Figure 3.6b: Erosion hazard zones – Estuary Drive – north of site

3.7 Sand Dune Migration Risk

In response to a Section 92 request from the Consent Authority the risk of dune migration from the coastal dunes of the Mangawhai coastal spit was investigated and response provided (Appendix D).
It was concluded that no morphological evidence at the PPC site that indicates the dune line has impacted even close to the site historically. No geological evidence underlying the site that indicates the dune line has been there historically.

Over the last 30 years, based on aerial photography the active dune line has not become any closer to the PPC site. It is therefore, considered highly unlikely, from a geomorphological point of view, that the dune will continue to migrate inland to the point that it reaches the PPC area.

However, irrespective of the above, if the dune was to migrate continually towards the PPC area, the maximum observed drift rate is 7m/yr. Based on this rate, for the dune to migrate the 1.7km between the closest dune point and the closest part of the PPC area, it would take nearly 250 years.
Given that this highly unlikely chance of occurrence and the significantly long time before it could occur affect the site even assuming the maximum drift rate, it is considered the PPC area is not at risk of the dune eroding and burying residential development.

4.0 Future Coastal Hazards

4.1 Future Coastal Flooding Hazard

A long-term combined water level is comprised of the predicted sea-level rise, the potential for Vertical Land Movement, added to the predicted storm tide value. The calculation of the individual components has been set out below (Table 4.1). Levels are relative to NZVD 2016.

	1% AEP
Mangawhai estuary storm-tide – RL	1.5
Relative Sea-Level Rise (2130, SSP5-8.5H+)	1.7
Vertical Land Movement (p83)	0.5
100 year Future Inundation Level	**3.7 (NZVD16)**

Table 4.1: Future 100 year coastal flooding level

The calculation above uses the 1 in 100 (1% AEP) storm tide as the base still water level. It then includes allowance for the most extreme current predictions for sea-level rise, over the 100 year timeframe. It also conservatively allows for VLM to occur at the highest predicted rates which are significantly above the average measured rate for the site, and also the surrounding area. It has resulted in a future inundation level that is 0.2m above the existing CFHZ3 value, and more appropriately accounts for the current understanding in future hazard risk posed by sea-level rise and VLM. This has been mapped on the attached Plan (**Appendix A**).

4.1.1 Coastal Flooding Mitigation

It is a common requirement that the mitigation measures demonstrate that they will not result in the increase of the hazard elsewhere. This is highly relevant for filling to mitigate the risk of stormwater flooding, as the catchment flood and catchment storage is a specific volume. The placement of fill reduces the storage capacity of the catchment, directly leading to increased effects elsewhere. This is not the case with coastal flooding hazard. The coastal flood is of near infinite volume, in relation to the size of any flooded area. In close proximity to the ocean an area of any extent will be flooded if below inundation level, independent of the level of the balance of the catchment. Accordingly the reduction in size of the flooded area due to filling does not increase the coastal flood risk elsewhere.

The extent of filling that would be required to mitigate the inundation hazard was investigated as part of this reporting, in order to inform the proposed natural hazard provisions for the PPC. As assumed filling to 200mm above the 100 year future inundation level of RL 3.7 would mitigate the inundation risk in that area. The fill requirement for mitigation was plotted and characterised as three scales:

- 0.5m or less
- 0.5 – 1.0m
- 1.0 – 1.5m

These Plans are attached (**Appendix C**). The assessment showed that for the area around Black Swamp Road (Figure 4.1.1a), with the exceptions of right at the margins with the estuarine area, a fill depth of 0.5m or less is required to raise the land level above the 100 year inundation level. Conversely, the exercise highlighted the nature of the low-lying area to the north-west of the PPC area. Even considering filling up to 1.5m only results in a slightly larger area of land being able to be considered flood-proof (Figure 4.1.1b), with regard to the 100 year inundation level, with filling of 1.5 – 2.5m being required for this area.

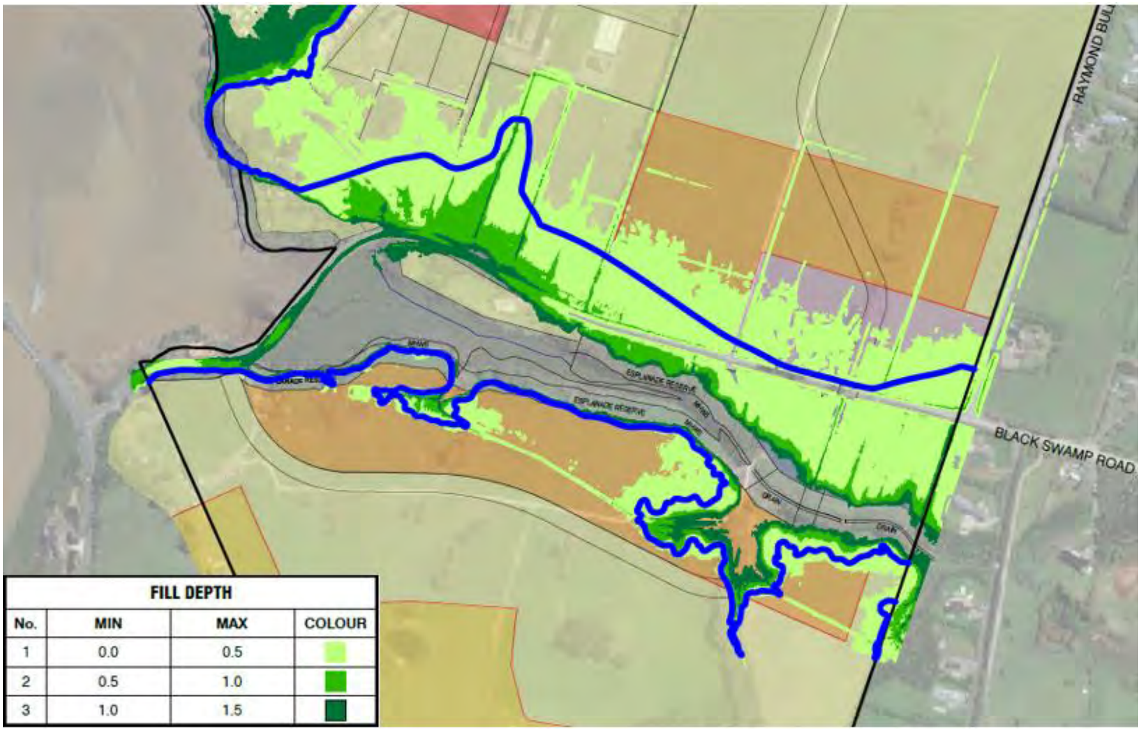


Figure 4.1.1a: Filling around Black Swamp Road

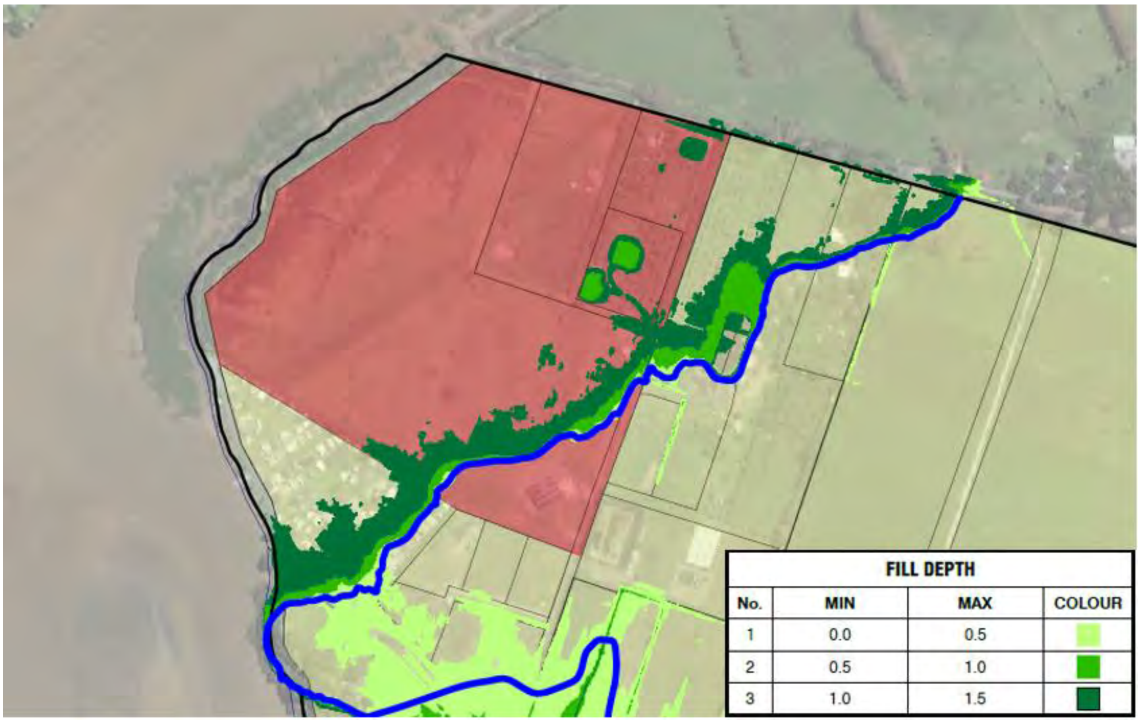


Figure 4.1.1b: Filling to north-west PPC area

4.2 Future Coastal Erosion Hazard

Development at the coastal edge in the future PPC area will also need to be cognisant of the potential for the coastal edge to continue to retreat over time. A 'Coastal Hazard Management' Overlay is proposed, and if development is proposed within this Overlay, site-specific assessment will be required at the time of subdivision to ensure that any development will not exacerbate or be adversely affected by coastal hazards.

The following area has been specified, as an offset from MHWS, for the Future Erosion Hazard Zone:

- 30m offset from MHWS for all coastal land within MEPPC outside Black Swamp Road causeway
- 10m offset from MHWS for all land within MEPPC upstream from Black Swamp Road causeway

5.0 Conclusion

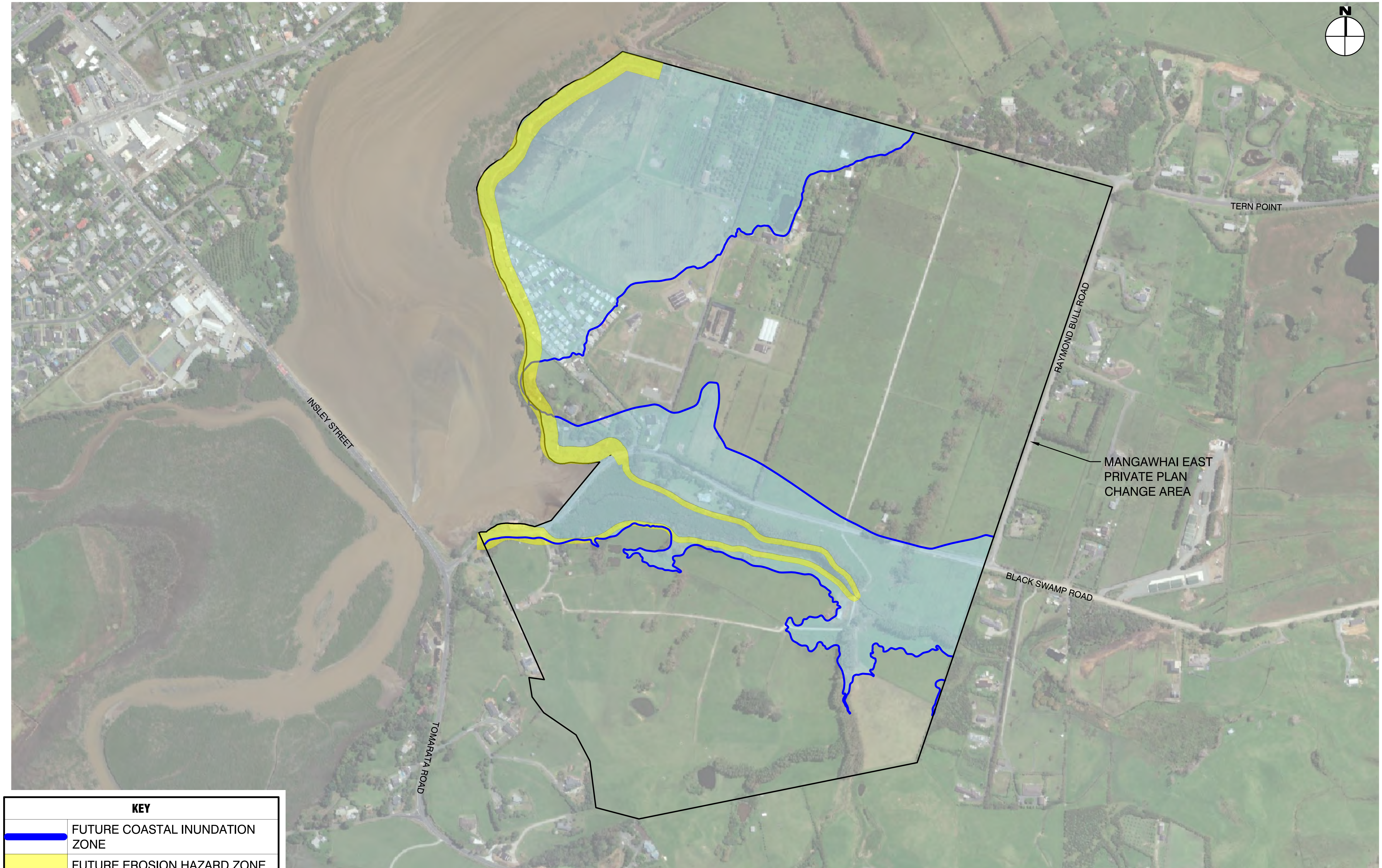
This report has reviewed the existing coastal processes of the site of the MEPPC area, at the southern extent of the Mangawhai estuary. It has considered the existing hazard reporting on both coastal inundation and erosion hazards, and provided an update to this existing work to a suitable level of detail for the PPC process.

Areas where a Coastal Hazard Management Overlay will be specified have been identified through this work, and are set out on the attached Plan, which is to be reflected in the proposed Development area provisions.

The investigation undertaken indicates the lower land area will require significantly greater mitigation in terms of filling to avoid the hazard. Hence an Overlay is proposed, and a Resource Consent will be required for development within the Overlay to enable the effects to be accurately determined at the future development stage.

Subject to the identification of the coastal hazard Overlay and the related planning provisions in the proposed Development Area, coastal hazard effects will not limit the development of land as proposed in the Plan Change.

Appendix A
Future Hazards Plan



KEY

(blue line)	FUTURE COASTAL INUNDATION ZONE
(yellow)	FUTURE EROSION HAZARD ZONE

DAVIS COASTAL CONSULTANTS

P04 FUTURE EROSION HAZARD ZONE

24022-01.1 CABRA MANGAWHAI PLAN CHANGE

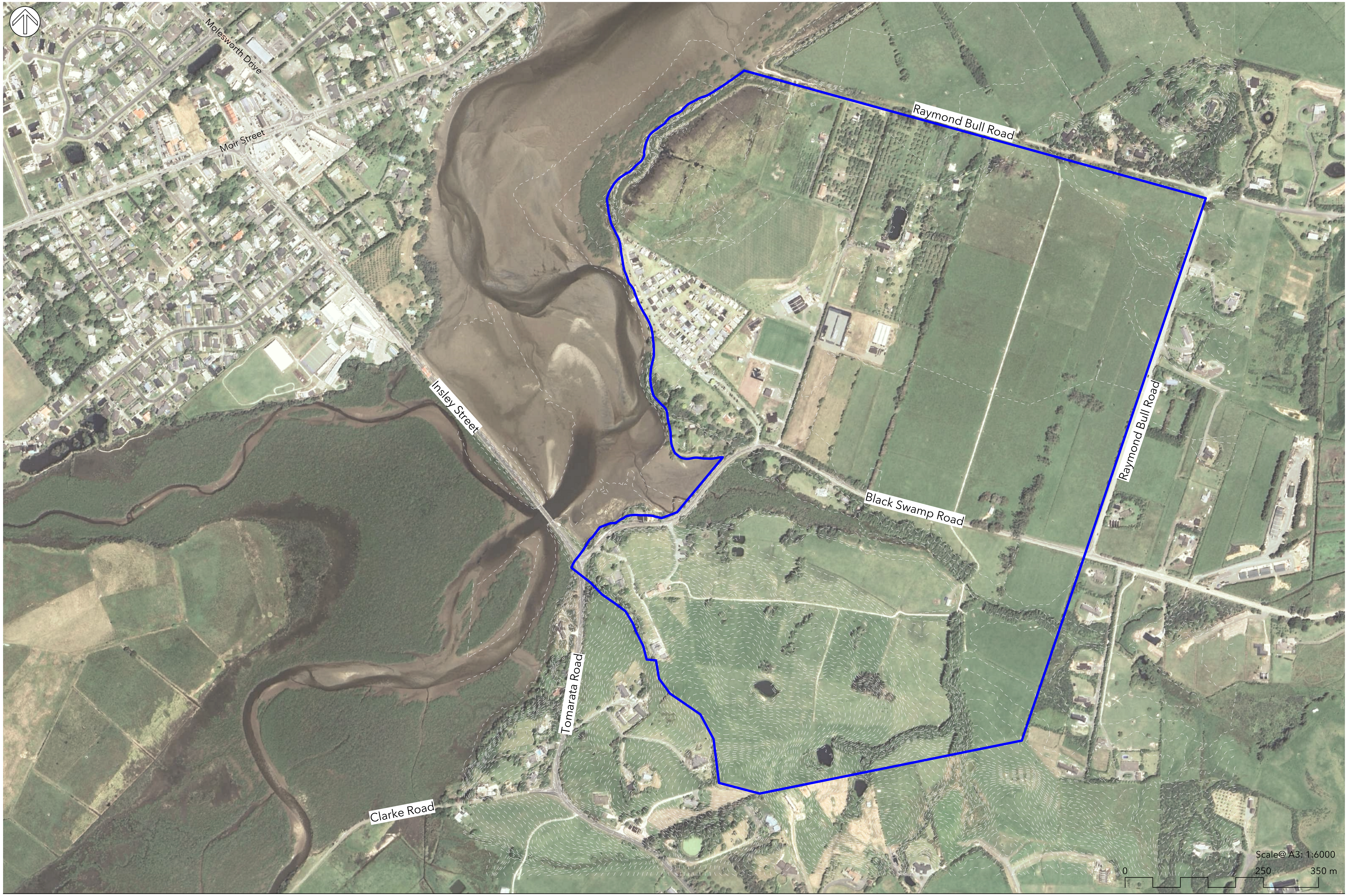
SCALE 1:6000

DATE: 12.08.24

REV: -

Z:\Projects\24022 Cabra Mangawhai Plan Change\Drawings\Dwg\24022-01 Preliminary\24022-01.1 Cabra Mangawhai Plan Change

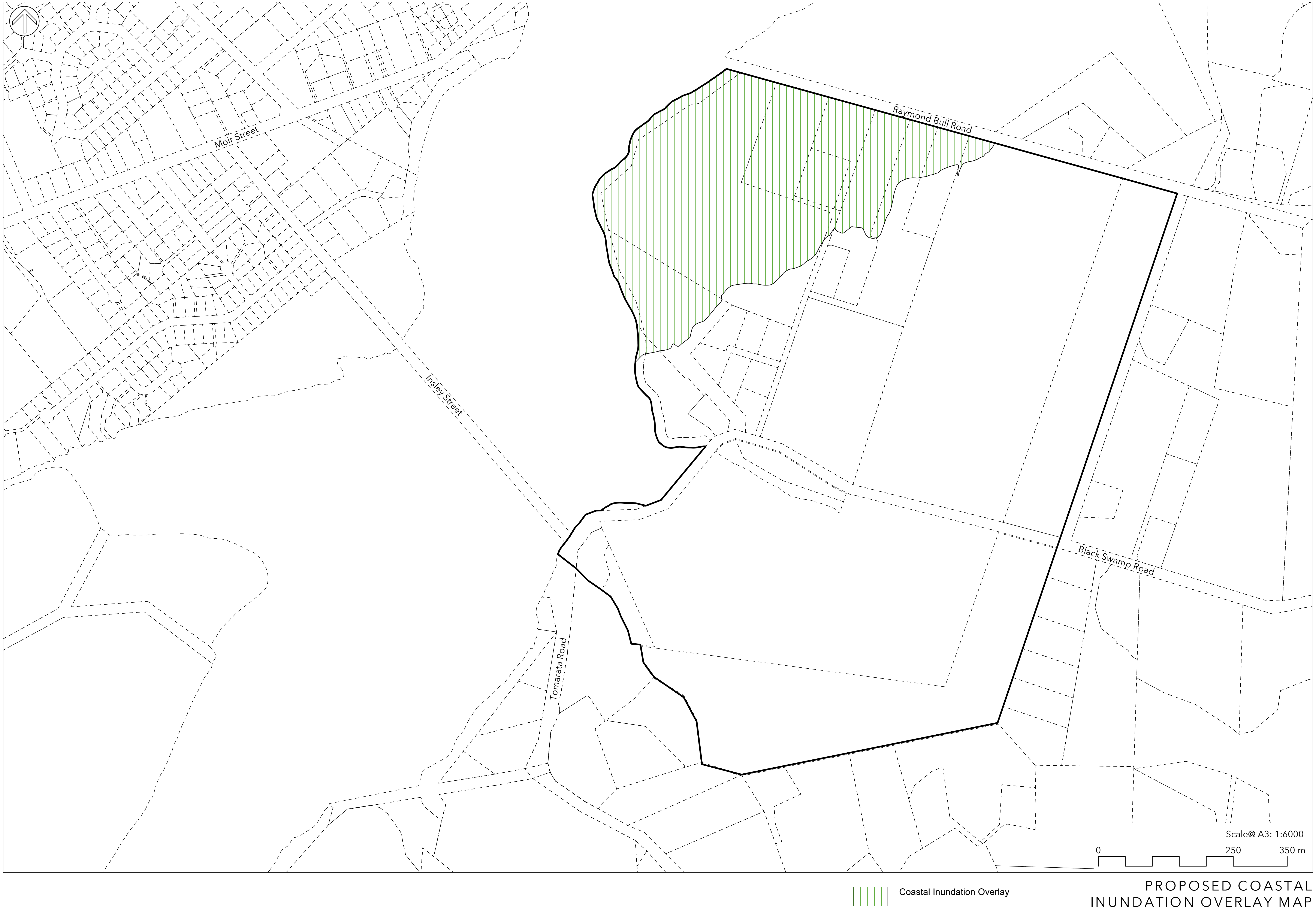
Appendix B
Proposed Planning Maps



Develpment Area - Mangawhai East

DEVELOPMENT
AREA

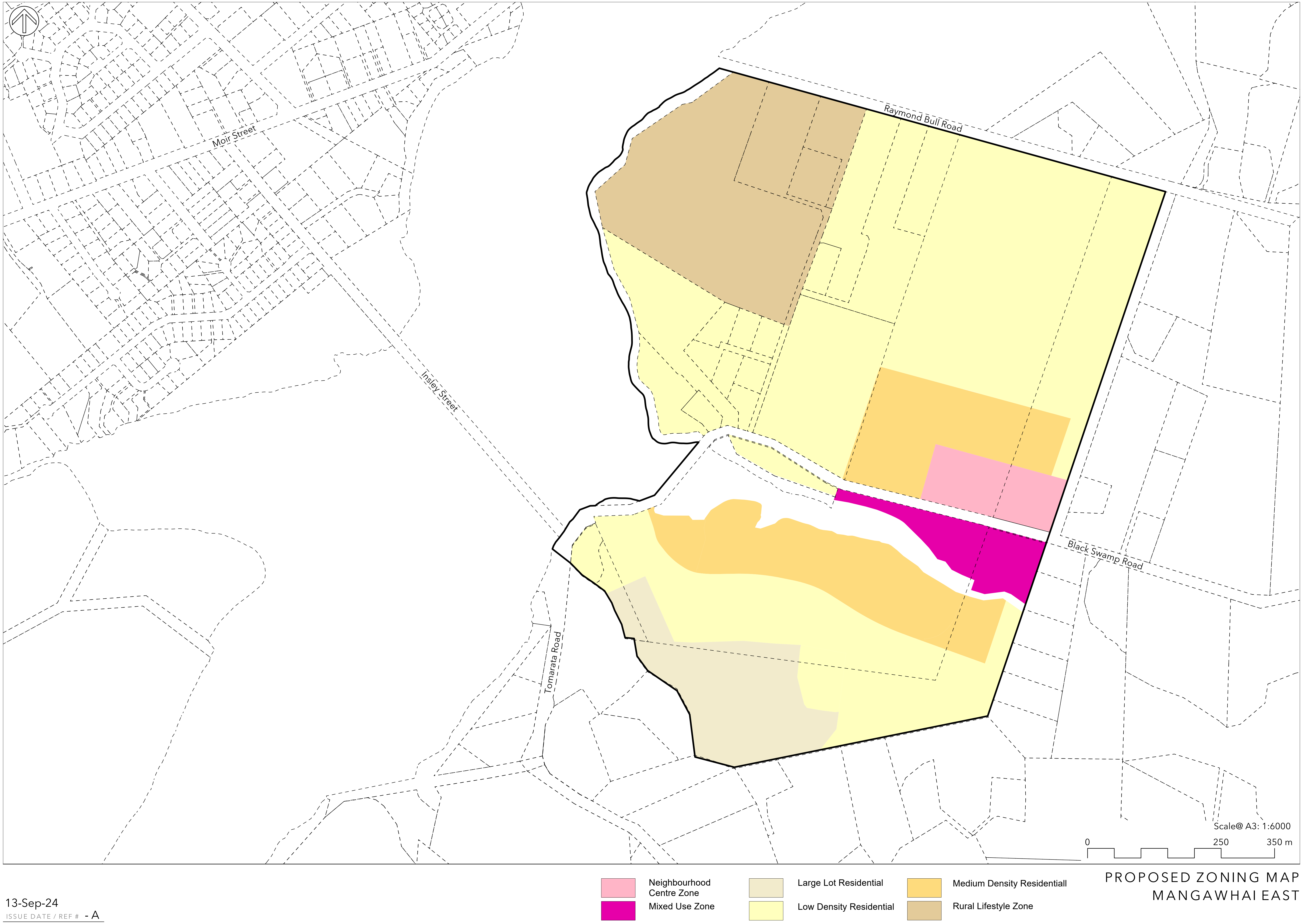
13-Sep-24
ISSUE DATE / REF # - A



PROPOSED COASTAL INUNDATION OVERLAY MAP

13-Sep-24

ISSUE DATE / REF # - A



PROPOSED ZONING MAP
MANGAWHAI EAST

13-Sep-24

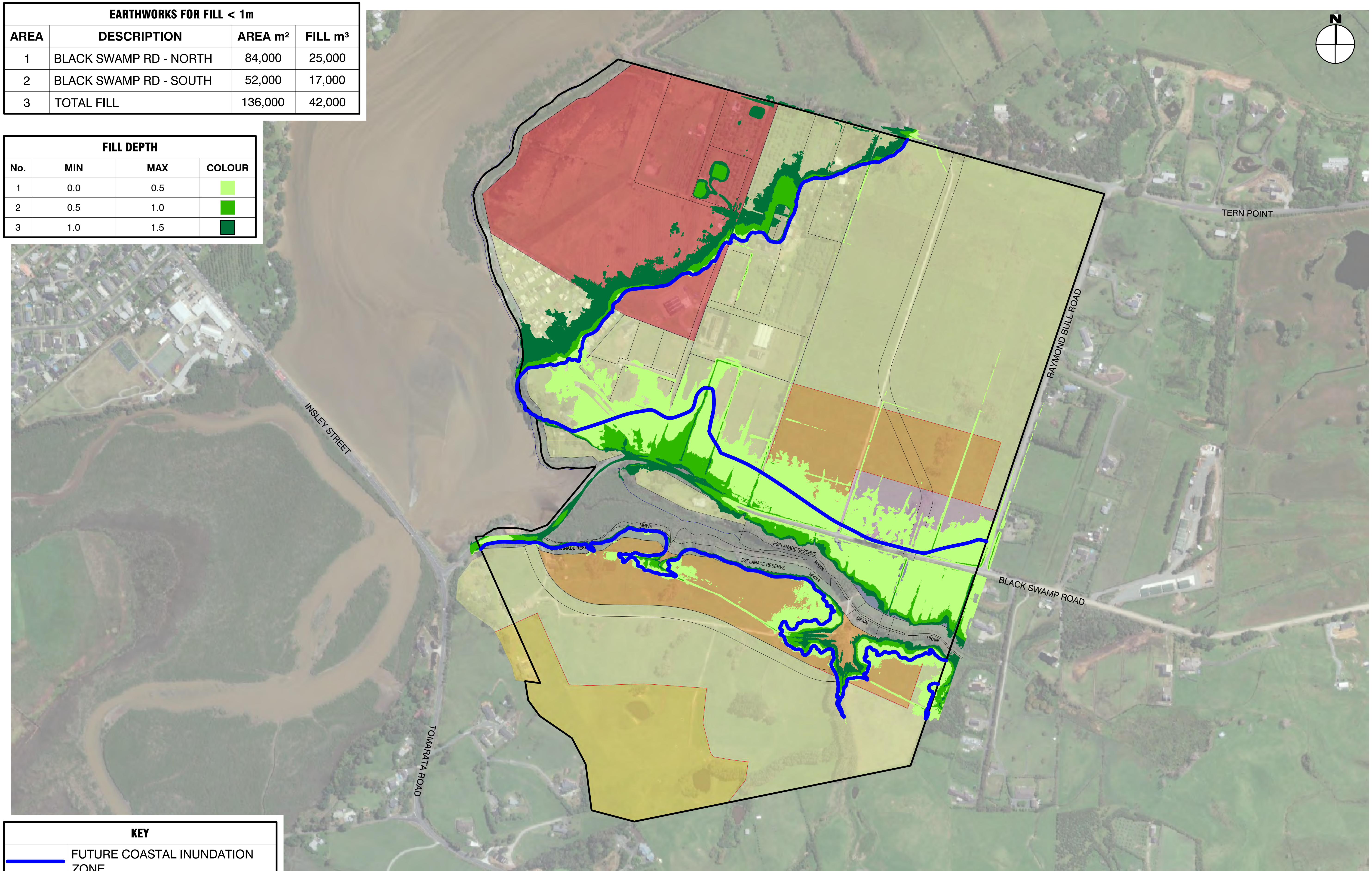
ISSUE DATE / REF # - A

Appendix C

Fill Assessment – Not Proposed

EARTHWORKS FOR FILL < 1m			
AREA	DESCRIPTION	AREA m²	FILL m³
1	BLACK SWAMP RD - NORTH	84,000	25,000
2	BLACK SWAMP RD - SOUTH	52,000	17,000
3	TOTAL FILL	136,000	42,000

FILL DEPTH			
No.	MIN	MAX	COLOUR
1	0.0	0.5	light green
2	0.5	1.0	green
3	1.0	1.5	dark green



KEY	
(blue line)	FUTURE COASTAL INUNDATION ZONE

P01 OVERALL PLAN

24022-01 CABRA MANGAWHAI PLAN CHANGE

SCALE 1:6000

DATE: 27.09.24

REV: B

DAVIS COASTAL CONSULTANTS

Z:\Projects\24022 Cabra Mangawhai Plan Change\Drawings\Dwg\24022-01 Preliminary\24022-01 Cabra Mangawhai Plan Change

Appendix D

Dune Migration S92 Response

938 Whangaparaoa Road
Manly
P: 09 428 0040
M: 021 203 3664
E: coastal@daviscoastal.co.nz

7th March 2025

Katherine Overwater
Planning and Policy Manager
Kaipara District Council

Our Ref: 24022

By email: council@kaipara.govt.nz

Dear Katherine,

Cabra Mangawhai Plan Change
Sand Dune Migration Risk Assessment

This letter is to address the Section 92 queries in Section **C. Geology**, raised in your letter dated 29th January 2025.

C. Geology:
The other matters that appear to be missing from application are references to the threats of sand drift and a better explanation of the effects of sea level rise.

1. **"In the early 1970s, the top blew off a large sand dune, causing sand to bury a section of Richard Bull's farm, in places to a depth of a metre or more. While the dune is currently stable and rebuilding following the 1978 breaching of the sandspit, it is a mobile system and will come and go, depending on wind and tidal fluctuations, sea level and to the availability of sand to sustain this natural buffer between the sea and the land."**

   Provide a risk assessment of a risk of the dune eroding and burying residential development on this PPC85 land.

Barrier Spits and Geological History Mangawhai Sandspit

Barrier spits are elongated coastal landforms, formed by the interaction of waves, currents and tides along a shoreline. They typically extend from the shoreline into open water, and are attached to the mainland at one end, with the unfixed or distal end projecting into a bay, lagoon, or estuary. The formation of barrier spits is driven by longshore drift, which transports sediment parallel to the coastline. Over time, depositional processes build the spit, while wave and tidal action shape its structure. A continuous cycle of sediment deposition and redistribution ultimately contributes to the formation and evolution of the barrier spit.

The Mangawhai Spit is a barrier sandspit at the mouth of the harbour, with the harbour mouth adjacent to the northern end of the spit, against Mangawhai Heads. The spit has developed since sea-level stabilised following Holocene sea-level rise, approximately 7000 years ago.

Sands for the beach and dune system were derived from onshore migration of sands from the adjacent continental shelf (Dahm & Bergin, 2016). The barrier forms a near complete barrier for the estuary to ocean swells and processes. It is understood the dunes of the spit were originally forested '*with various species including totara, marie, matai and titoki; but this mixed podocarp-coastal forest was destroyed by fire associated with early human settlement around 800 years B.P* (Enright & Anderson, 1988). As a result of this removal of vegetation cover, consequent wind erosion and dune instability was widespread, and there is little evidence of natural revegetation of the dunes since this original disturbance through fire (Enright & Anderson, 1988). The dune ecosystem is significantly altered and degraded, and the existing state of generally bare and mobile sand (Photograph 1.0), with only limited vegetation, is largely anthropogenic in origin (Dahm & Bergin, 2016).

Photograph 1.0: Mangawhai Sandspit, 1949, Whites Aviation

Mangawhai Sandspit – Recent History

The high level of mobility of the dune sands comprising the spit, have led to a number of issues over the past 50 years. This is succinctly described below, quoted from a report commissioned by Northland Regional Council (J. Dahm & D.O. Bergin, 2016), which outlines the recent history of the spit and the actions taken to manage its stability:

> *"In its natural state, erosion on the outside of the main channel significantly eroded and narrowed Mangawhai Spit in the lower estuary near the harbour entrance… The wind erosion of the dunes also lowered the frontal foredune in this area increasing susceptibility to wave overtopping during major coastal storms. Consequently, in a major coastal storm of July 1978 the spit was breached at its narrowest point developing a dual inlet configuration (Flood et al., 1993).* (Photograph 2.0). *It is probable that similar inlet breaching has occurred in or near this area in the past (McCabe et al., 1985).*
>
> *By the early 1990's, the dual inlet configuration had caused significant deterioration of the harbour in several important respects and was considerably impacting on human*

use, particularly boating (Flood et al., 1993). Government agencies decided against intervention despite community requests because it was considered that the expensive restoration work may not be successful (Flood et al., 1993). This led to community action to address the issue through the Mangawhai Harbour Society (now Mangawhai Harbour Restoration Society – MHRS); with successful closure of the breach and restoration of the main entrance achieved in 1996.

The MHRS has continued channel dredging work to realign the channel along the landward margin in an effort to reduce erosion along this shoreline. A wide, high dune/bund (Figure 1.0) *has also been established along this margin with the deposition of dredged sand and shell and use of sand-trapping fences."*

Photograph 2.0: Breach through dune spit, 1978, Mangawhai Museum

Figure 1.0: 1995 Aerial image showing location of bund wall

Wider Geological Setting and Geology of PPC Area

The 1:50,000 Geological Map 'Geology of the Auckland Urban Area' (Figure 2.0), published by IGNS, indicates the area is classed as Holocene active dune deposits of the Karioitahi group, being *"loose sand in mobile dunes"*.

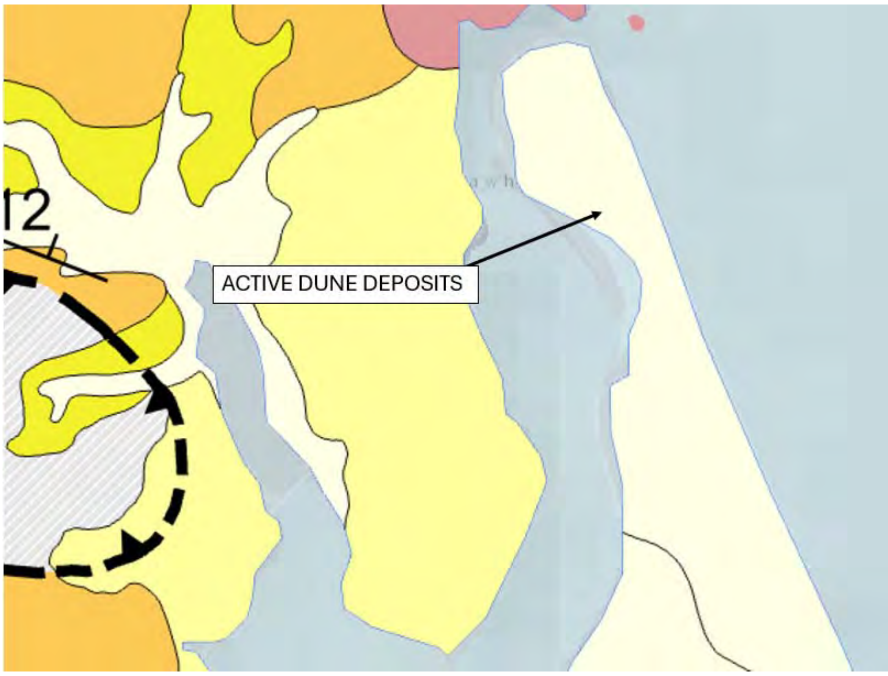


Figure 2.0: Geology of Mangawhai sandspit ex. IGNS

In relation to the PPC area, the Geotechnical Report produced by Initia (2024) reviews published information on the underlying geology of the plan change site (Figure 3.0). This site is some distance south-west of the spit, approximately 1.5km from the landward end of the feature. The report states:

> *"Based on review of the published geological map and our general knowledge of ground conditions in the area, the site is mapped as being underlain by Late Pleistocene River deposits (OIS5), which are typically described as poorly consolidated mud, sand, gravel and peat deposits of alluvial, swamp and estuarine origins. Holocene River deposits are mapped to the north of the subject site, which is typically described as unconsolidated to poorly consolidated mud, sand, gravel and peat deposits of alluvial, colluvial and lacustrine origins."*

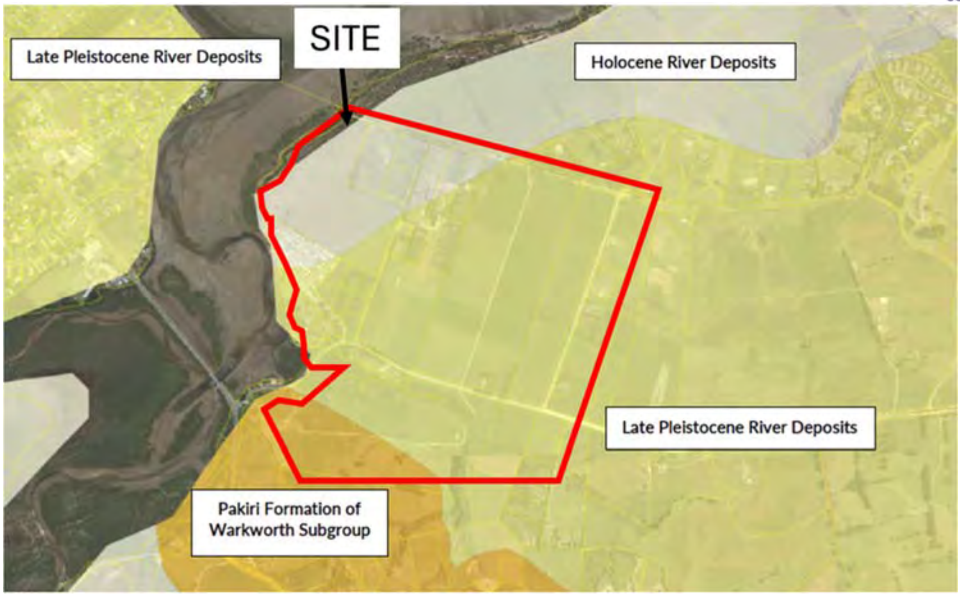


Figure 3.0: Mangawhai Geological Map ex. Initia Geotech Report

This reporting undertook extensive soil investigation, involving test pits and cone penetration tests. The results of these tests confirmed the site is underlain by Late Pleistocene River Deposits comprising *"organic sandy SILT/fibrous PEAT between 200-1200mm thick"* and below this was a *"strongly cemented hardpan SAND layer"* between 100-800mm thick. It would be expected that a much deeper sand layer would be present if the underlying material had at some point been a beach dune system.

The underlying geology indicates the PPC area is not underlain by beach sand deposits, and any sand deposits within the soil layers is of estuarine/alluvial origin rather than material derived offshore from the continental shelf, as is the case of the spit.

Site Morphology

The PPC area is significantly landward of the general shoreline, approximately 2.4km. The morphology of the PPC area north of Black Swamp Road is, as noted in the Coastal Hazard Assessment, an elevated, relatively flat plateau at approximately RL 4 and above, and an extensive low-lying area to the north-west, typically at and below RL 2. This morphology is not consistent with an area that has historically been a beach dune environment, where relic dune ridges running approximately shore parallel would be expected.

A typical example of this environment is shown below (Figure 4.0), in Whitianga, where a progressively prograding beach face due to an excess of sediment supply from the continental shelf resulted in relic dune ridges present in the backshore. This is evidence of a historic shoreline position.

Similarly, historic sand inundation is likely to be represented in the morphology as hummocky topography with low rounded ridges with possibly a parabolic or curved plan form. This is inconsistent with the subject area suggesting it has not been inundated by sand.

The morphology of the PPC area and the area between there and the Tern Point subdivision is generally planar. This is more consistent with alluvial deposition and modification, rather than an area previously occupied by beach dune formations.

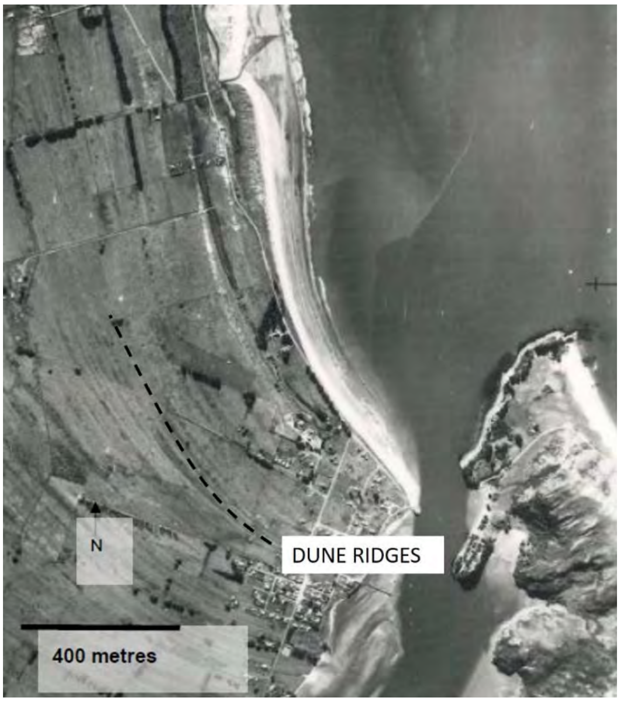


Figure 4.0: Historic aerial image showing relic dune ridges, Environment Waikato, 2006

Extent of Sand Dune Migration

The potential for the spit to alter in form over time, and pose a risk to development, is most clearly highlighted by the southern spit area, and the Tern Point subdivision (Figure 5.0). The southern spit area comprises actively migrating sand dunes, and includes one very high dune approximately central to the spit. Due to the lack of a well vegetated foredune, the dunes are progressively migrating landwards and appear to be slowly encroaching on the Tern Point subdivision.

Figure 5.0: Southern spit area, Tern Point subdivision and PPC area to south-west

This risk is noted in Dahm & Bergin (2016), who state:

> *"The landward migrating dunes pose a significant long term threat to more seaward properties in the Tern Point subdivision. Accurate assessment of the average rate of sand advance and encroachment over time would require analysis of data extending over decades. Indicative results from analysis of shorter term data (aerial photographs from 2006 and 2014) suggest the average rate of landward migration probably ranges from 1-3m/yr. However, residents of Tern Point estimated this drift to be 5 metres per year on average, based on the rate of burial of a boundary fence put in place during the initial Tern Point development"*

This report gives a short-term rate of advance of 1-3m/yr, anecdotally as much as 5m/yr. This is a short term record, and does not capture any longer term (decadal scale) variation in dune planform, which could be driven by variations in trends of wind-driven sand transport.

To quantify the historic sand migration, historic images were obtained from 1966 (Figure 6.0), 1983, 1995 and a recent image from 2025. The length of time between subsequent images limits interpretation of short term change, but does allow assessment of historic dune positions and any long-term trends. Common repeated features between images (such as corners of rooves on dwellings) used to geo-rectify and align the images. The geo-rectified images with dune delineations are attached as Appendix A.

Figure 6.0: Historic aerial – 1966, dune area delineated

The most advanced position of the unvegetated dune is the oldest, with the dune extents in 1966 covering much of what is now the Tern Point subdivision. The dune extents have changed by 1983, however they extend a similar distance to the south-west as those of 1966 (Figure 7.0). Work to stabilise the dune sands through planting of marram grass and lupin, to enable development of pine forestry, can be seen in the conversion of an extensive area south of the spit between 1966 and 1983. This is the area that is now Tara Iti Golf Course. However, this land-use change terminates south of the widest and most mobile dune area.

The 1995 image shows a regression in the dune extents, with what appears to be the stabilisation of the land, with vegetation, around what is now Tern Point. It is understood that the Tern Point Recreation and Conservation Society have been planting on the dunes at the southern end of the spit since 1999, primarily with pīngao, although in more recent years spinifex has also been added. Between 1995 and 2025, the primary change is the re-burying of the area previously covered in vegetation, by mobile sands. The width of this area is approximately 200m, which assuming it was progressively buried through migration of the dune over the 30 year period, would give a drift rate of 7m/yr, which is of a similar order to the anecdotal rate noted previously by residents of Tern Point. However, the most recent form is still significantly reduced from that originally present in 1966 and 1983, where the dune covered a much larger area to the south-west, approximately 500m from its current position.

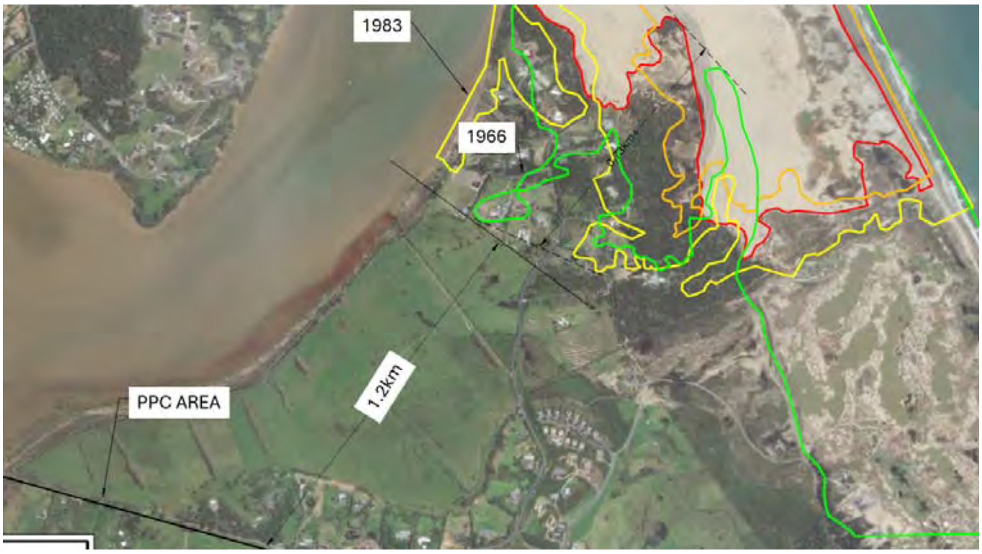


Figure 7.0: Comparison between 1966 and 1983 dune extents

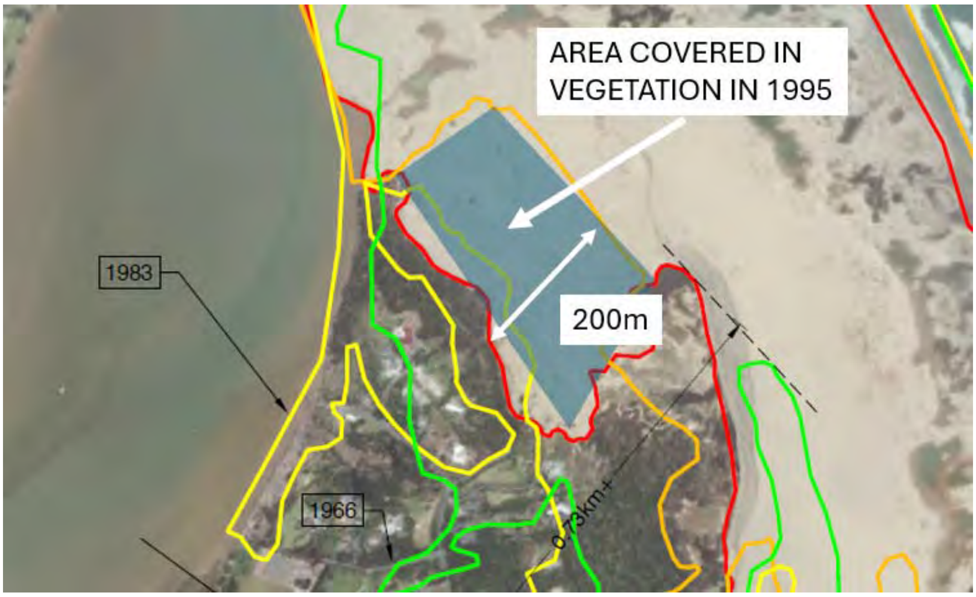


Figure 8.0: Area covered in vegetation in 1995 re-buried by dune in 2025

Risk of Future Sand Dune Migration

The PPC area is approximately 1.2km away from the closest historic dune position, as per the historic aerial photographic record. However, it is approximately 1.7km away from the current dune position.

Research indicates the inner continental shelf has 'run out' of beach grade sediment (Hilton, 1995) and it is unlikely there is any significant onshore net supply of sand to the Mangawhai-Pākiri beach system, allowing significant growth of the dune sands area.

With distance from the coastline the lack of sand supply and decrease in ground level wind speed and frequency make aeolian sand transport increasingly more difficult.

As set out above there is:

No morphological evidence at the PPC site that indicates the dune line has impacted even close to the site historically.

No geological evidence underlying the site that indicates the dune line has been here historically.

Over the last 30 years, based on aerial photography the active dune line has not become any closer to the PPC site.

It is therefore, considered highly unlikely, from a geomorphological point of view, that the dune will continue to migrate inland to the point that it reaches the PPC area.

However, irrespective of the above, if the dune was to migrate continually towards the PPC area, the maximum observed drift rate is 7m/yr. Based on this rate, for the dune to migrate the 1.7km between the closest dune point and the closest part of the PPC area, it would take nearly 250 years.

Given that this highly unlikely chance of occurrence and the significantly long time before it could occur affect the site even assuming the maximum drift rate, it is considered the PPC area is not at risk of the dune eroding and burying residential development.

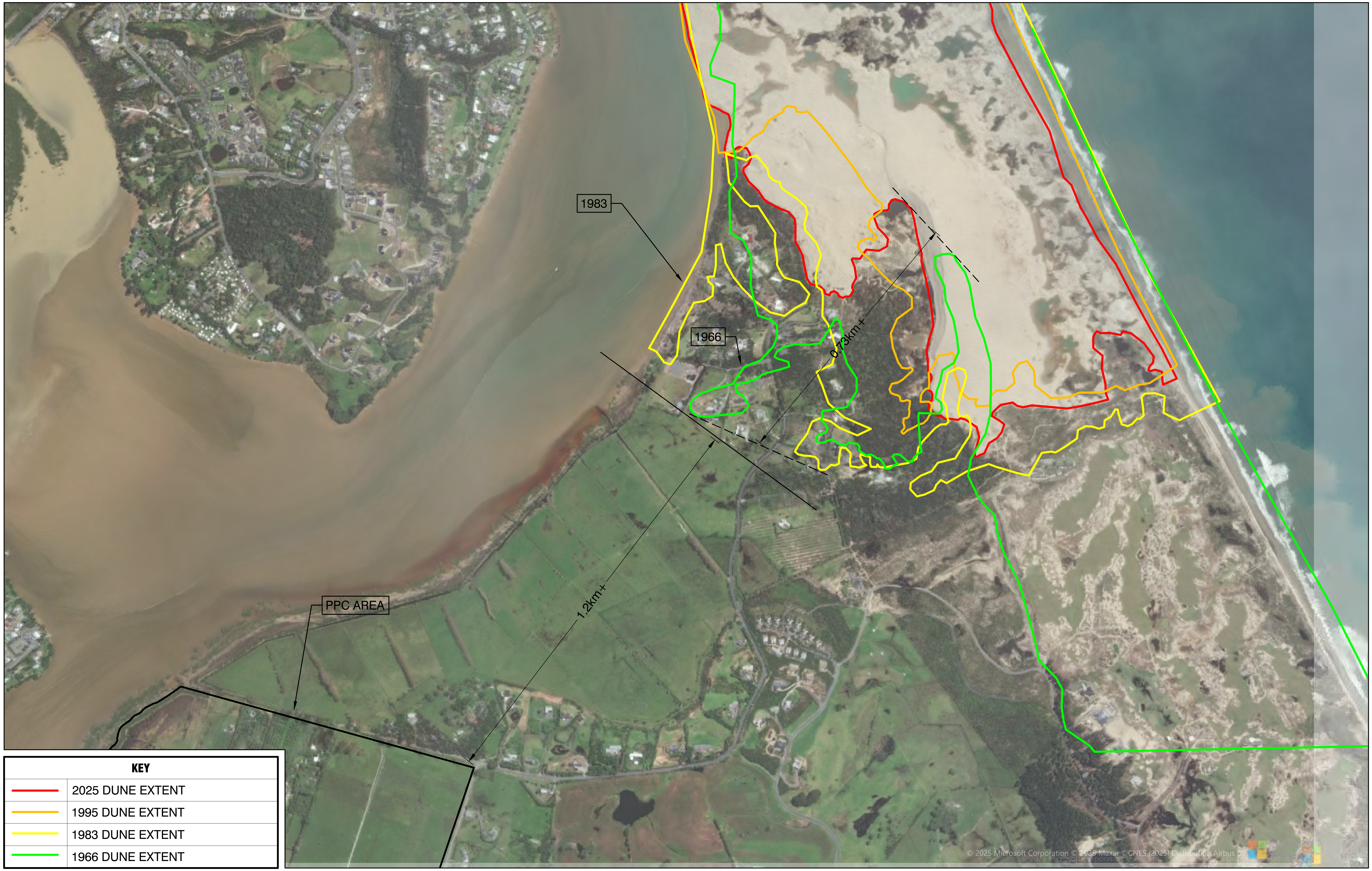
We trust this addresses the issues raised.

Kind regards,

Sam Scott-Kelly
Senior Coastal Engineer

Appendix A

Delineated Dune Extents



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DUNE EXTENTS

24022 - GR CABRA MANGAWHAI PLAN CHANGE

SCALE 1:10000

DATE: 19.02.2025

REV: -

\\DAVISCOASTAL\Davis Coastal\Projects\24022 Cabra Mangawhai Plan Change\Georeferencing\AutoCAD Dwg\24022 - GR Cabra Mangawhai Plan Change

1966 DUNE EXTENT

24022 - GR CABRA MANGAWHAI PLAN CHANGE

SCALE 1:10000

DATE: 19.02.2025

REV: -

DAVIS COASTAL CONSULTANTS

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1983 DUNE EXTENT

24022 - GR CABRA MANGAWHAI PLAN CHANGE

SCALE 1:10000

DATE: 19.02.2025

REV: -

DAVIS COASTAL CONSULTANTS

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1995 DUNE EXTENT

24022 - GR CABRA MANGAWHAI PLAN CHANGE

SCALE 1:10000

DATE: 19.02.2025

REV: -

DAVIS COASTAL CONSULTANTS

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2025 DUNE EXTENT

24022 - GR CABRA MANGAWHAI PLAN CHANGE

SCALE 1:10000

DATE: 19.02.2025

REV: -

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