REPORT

Tonkin+Taylor

Baseline Coastal Assessment

Shelly Bay Road Upgrades

Prepared for
Wellington City Council

Prepared by
Tonkin & Taylor Ltd

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Executive summary

Wellington City Council (WCC) have engaged Tonkin and Taylor (T+T) to undertake a high-level coastal assessment to assist with the planning of the upgrade of Shelly Bay Road. This is to better align with Waka Kotahi NZ Transport Agency (Waka Kotahi) guidance and the vision for the Great Harbour Way. Shelly Bay Road is located on the western side of the Miramar peninsula. The extent of the project site extends approximately 2.3 km between Miramar Avenue and Shelly Bay. The road is approximately 6 m wide-ranging in elevation from 2.1 to 4.1 m NZVD2016 with an average level of approximately 3.3 m NZVD2016. The road is constrained along the length of the site with a coastal escarpment featuring along its length between 1 and 2m from the landward edge of the road and the coastal margin a similar distance away from the seaward edge.

Wave climate and wave levels have been considered for 3 horizons: present day (2020), 2070 and 2120 based on an RCP8.5 emissions scenario. Extreme storm tide (1%AEP) water levels along the site are currently 1.0 m NZVD2016 increasing by 0.4 m and 1.0 m sea-level rise increments to 2070 and 2120 respectively. SWAN wave modelling undertaken in Wellington Harbour indicates an extreme (1%AEP) significant wave height of 1.0-1.2 m offshore of the headlands along the project site, reducing to less than 1.0 m further into the larger bays.

The extreme static water levels considered are lower than the existing road elevation for the present-day scenario, however, as sea levels rise the road freeboard reduces to around 0 m at the lowest exiting elevation when considering the 2120 horizon. However, the dynamic effect of waves results in overtopping flows above these levels which can result in health and safety risk to road users and damage to the backshore and road surface.

High level overtopping analysis shows that at the lowest road elevations there is likely to be flow in excess of safe levels for road users in present-day 1%AEP storm conditions with damage to locations of unprotected berm edge likely in this event. These flows increase as sea levels rise to levels which will likely cause damage to the pavement by 2120 in extreme events.

A high-level assessment of the condition of the coastal defences along Shelly Bay Road was undertaken in comparison with available baseline data. The key observations from the assessment are listed below:

- There are five locations where the condition of the wall differs from the baseline data. Much of the damage to the coastal defences observed is due to undermining and end-scour/outflanking of the existing walls.
- There are notable areas of erosion of unprotected slopes, the location of which has been recorded.
- Five seawalls were not included within the 2016 data, these have likely been constructed post-2016.

1 Introduction

Tonkin & Taylor Ltd (T+T) have been engaged by Wellington City Council (WCC) to explore options for upgrading Shelly Bay Road. The objective of the upgrade will be to provide an environment on Shelly Bay Road that better aligns with Waka Kotahi NZ Transport Agency guidance and the Great Harbour Way plan to provide a safer and more inviting setting for pedestrians, cyclists, and other road users along the Wellington coast. The extent of the assessment site is approximately 2.3 km, extending from Miramar Avenue to the south end of Shelly Bay, as shown in **Figure 1-1**.

To assist with the assessment of the options for upgrades, T+T has been engaged to undertake a high-level coastal assessment along this section of Shelly Bay Road. The results of the coastal assessment are outlined in this report. The assessment is to inform the coastal implications of the options, including effects on consenting, the environment, feasibility, and cost. The assessment is high-level only; a detailed coastal assessment should be undertaken at a later stage in the project to inform detailed design.

Figure 1-1: Physical scope of work (extent of the project scope (study area) shown in red; coastal areas outside of scope highlighted in yellow)

1.1 Background information

The following background information has been utilised for this assessment:

- WCC GIS database seawalls location shapefiles and 2016 condition assessment summary information.
- Site visit observations and photos from two T+T engineers on 8 June 2020.
- Bathymetric data from the Land Information New Zealand (LINZ) online data service hydrographic charts.
- GIS information publicly available including historical aerials (Retrolens) and topographical maps (LINZ data service).

1.2 Scope of work

This report provides the results of the high-level coastal assessment of the study area. The key tasks undertaken as part of this assessment are in line with T+T's Offer of Service, dated 22 May 2020, as follows:

- A desktop study of available information, including available sea level and storm tide data, historic aerial photographs to determine shoreline trends over time, Land Information New Zealand (LINZ) Wellington LIDAR survey (2013) to identify current levels and seawall structure profiles, and available bathymetric data, including New Zealand Nautical Charts.
- A high-level coastal process assessment, including location-specific wave assessment, and long-term shoreline and development trends based on available aerial imagery to indicate erosion risk.
- A high-level inundation assessment of the current road, both with present-day and future sea levels to determine risk and input into the long list assessment and shortlist considerations. This will include preparation of figures to show the extent of inundation under various sea-level rise scenarios and timeframes.
- A high-level assessment of the condition of the existing coastal protection structures along the length of the project site.

2 Physical setting

The study area is within the Wellington Harbour, along the eastern extent of Evans Bay on the Miramar Peninsula (**Figure 2-1**). Wellington Harbour is a large natural basin with an approximate surface area of 85 km^2, maximum width of 11 km, maximum depth of 31 m and an average depth of 14 m. The Harbour is connected to Cook Strait via the narrow harbour entrance passage located between Palmer and Pencarrow Heads.

The site is adjacent to Shelly Bay Road and is approximately 2.5 km in length along the eastern shoreline of Evans Bay (**Figure 2-1**). The site is accessible along the roadside and by various carparks and access ways along the length of Shelly Bay Road.

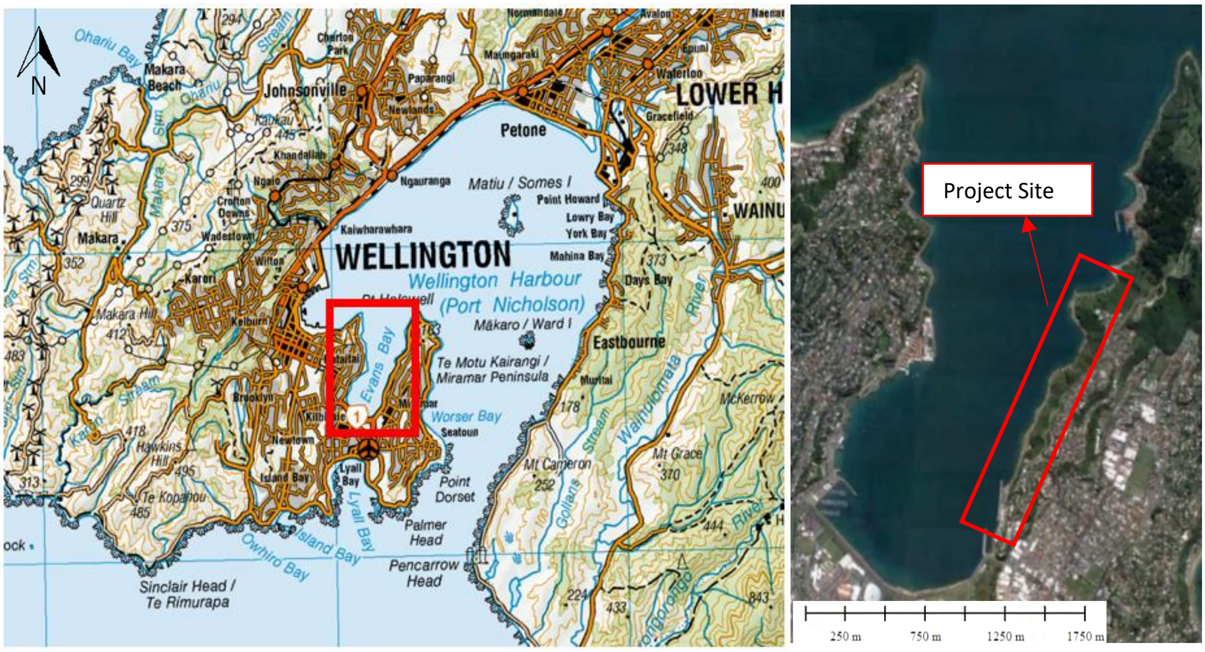


Figure 2-1: Site Location (LINZ (2019), Google Earth (2018))

2.1 Bathymetry

The LINZ (2012) hydrographic chart of Evans Bay (**Figure 2-2**) indicates the seabed shallowing gradually from the entrance of Evans Bay to approximately 14 m below chart datum approximately 100 m offshore from the road edge. Within 100 m of shore along Shelly Bay Road this chart indicates the seabed dipping at an approximate grades of between 1V:5H and 1V:10H along the length of the project site.

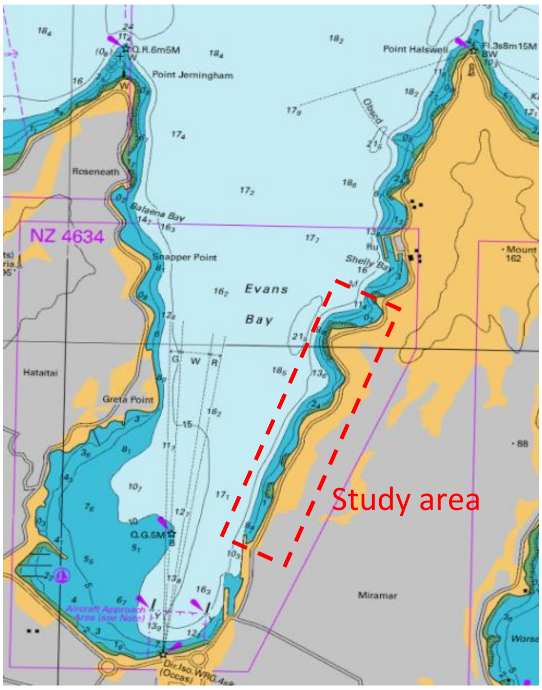


Figure 2-2: LINZ Hydrographic Chart of Evans Bay (LINZ, 2012)

2.2 Topography

Levels are reported in terms of the New Zealand Vertical Datum 2016 (NZVD2016). 2013 LiDAR and bathymetric information (**Figure 2-3**) for Wellington has been sourced from the LINZ online data service for this assessment.

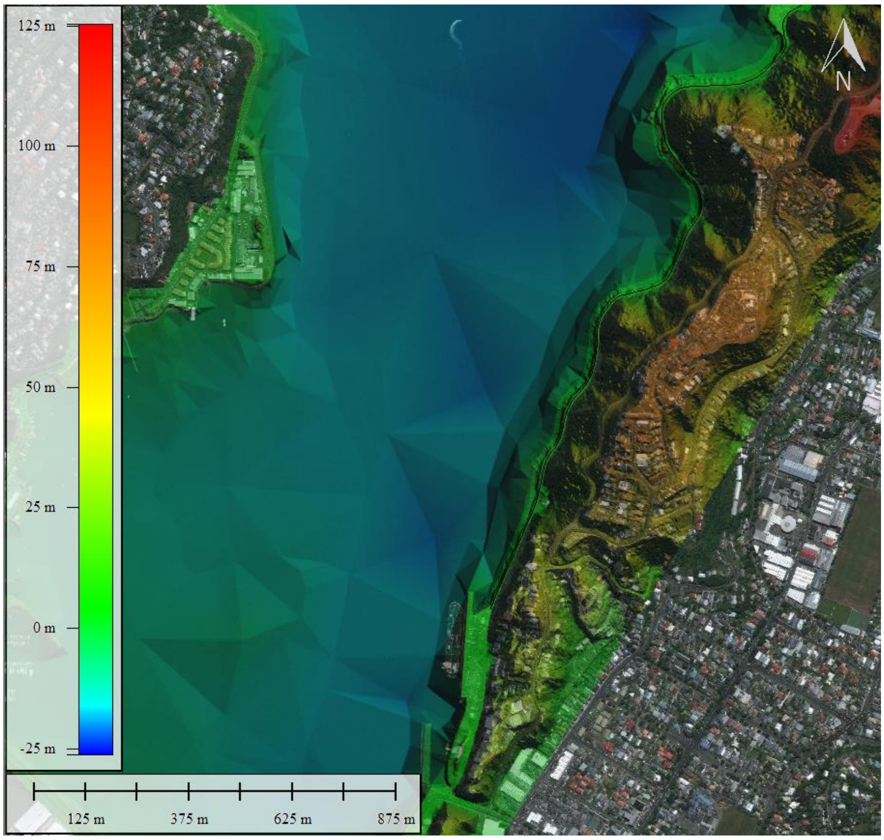


Figure 2-3: LINZ bathymetry and topography for the study area

The predominate topographic profile along the study consists of a gradually sloped beach face and berm or greywacke rock outcrop ranging from 0 m and 0.5 m NZVD2016 followed by an approximate 2 m vertical natural slope or seawall that leads to Shelly Bay Road. Shelly Bay Road itself is approximately 6 m wide and ranging in elevation from 2.1 to 4.1 m NZVD2016. The landward edge of the road features a coastal escarpment with a steep base (40 to 60 degrees) typically between 20 to 40 m high followed by a less steep upper slope (20 to 30 degrees). The road is generally located within 1 to 2 m from the seaward slope or seawall edge and less than 1 m from the base of the landward escarpment.

While the slope beach profile and topography vary slightly along the project site, an indicative topography profile compared against the Mean High-Water Springs (MHWS) is in shown in **Figure 2-4**.

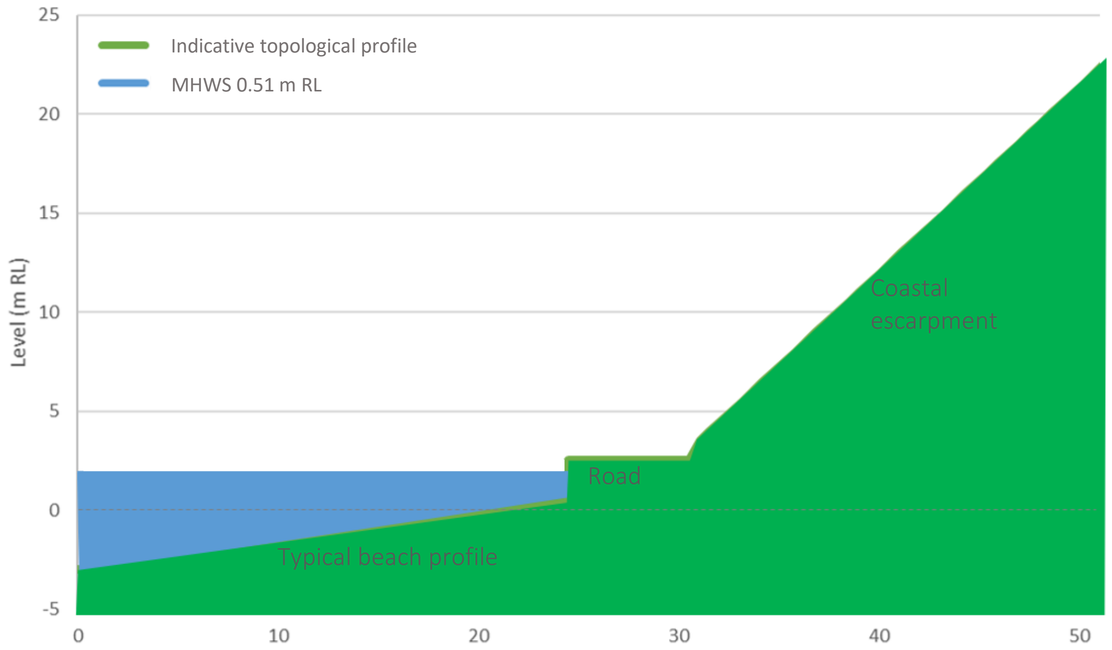


Figure 2-4: Indicative topographic profile for Shelly Bay Road

2.3 Geology and sediments

The geological setting map[1] shown in **Figure 2-5** shows Shelly Bay Road in the context of the regional geology. The map indicates that the slopes of the coastal escarpment are comprised mainly of steeply bedded, alternating sandstone / mudstone. The coastal escarpment has formed by the persistent erosion at the toe of the slope by the sea, in conjunction with the progressive tectonic uplift and tilting of the Miramar Peninsula.

A more detailed analysis of the terrain and geology can be found in T+T Preliminary Slope Hazard Assessment Shelly Bay Road report dated 26 June 2020.

[1] Begg, J.G., Mazengarb, C., 1996. Geology of the Wellington area, scale 1:50 000. Institute of Geological & Nuclear Sciences geological map 22. 1 sheet + 128 p. Lower Hutt, New Zealand. Institute of Geological & Nuclear Sciences Limited.

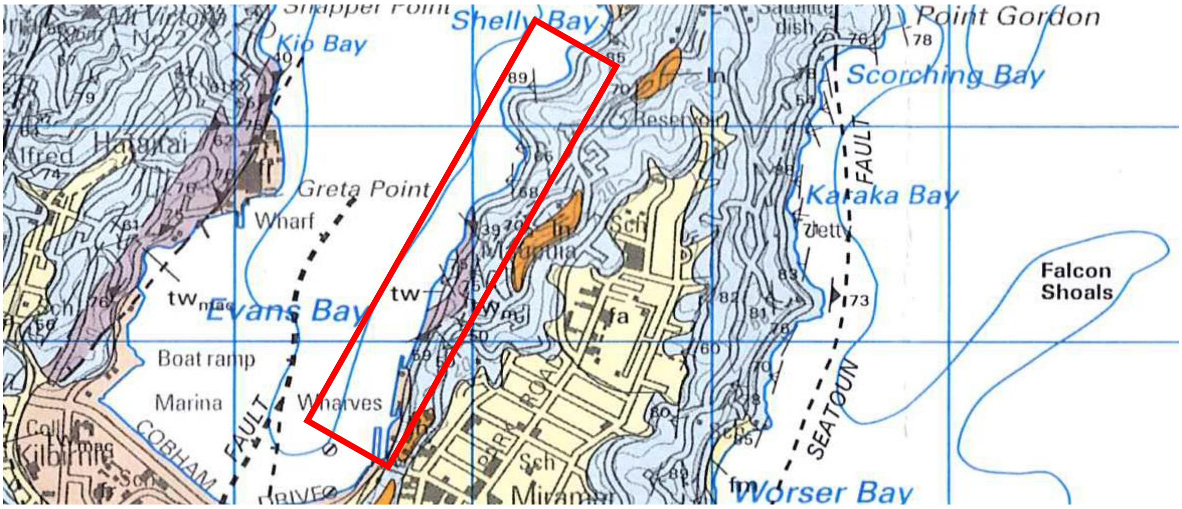


Figure 2-5: Geological setting and extent of study (red line). Note that this map only describes the general geology of the area and does not provide site specific detail

The coastline itself consists of gravel beaches and greywacke rock outcrops. There are pocket beaches located along the project site located between greywacke rock outcrops. These beaches predominately consist of mixed gravel and cobble. The less exposed pockets generally consist of a build-up of poorly sorted, angular and coarse erosion products. Whereas within the more exposed beach pockets the gravel has passed through continual erosion leading to well-rounded and graded shingle (Van der Linden 1967). These beaches have a natural sediment grade occurring from coarser to finer gravels from the lower to the upper beach. Formation of a finer gravel berm above the high tide mark is also a notable feature (refer **Figure 2-6**).

Figure 2-6: Naturally graded beach with finer sediments increasing towards the upper beach and greywacke rocky outcrop in the background

2.4 Land development

The coastline and Shelly Bay roadside are largely natural with some locations of minor reclaimed land and hillside excavation to provide short sections of reclamation fill for the road platform. The most significant area of reclamation is located at the southern end of the project site between the escarpment and the Miramar Wharf.

Due to the steep topographic profile along Shelly Bay Road the area has remained largely undeveloped. Except for within Shelly Bay itself (just north of the project site), where, in the late 19th century the area was occupied by an anti-submarine mining base (Te, M. 2020). In the early to mid-20th century this land was used Royal New Zealand Navy and Royal New Zealand Airforce for the development of the World War II naval base and armament depot. The base was closed in 1995 (Te, M. 2020). Currently, the previously used defence base buildings are rented out for industrial or hospitality purposes.

At the southern end of the project site, the Miramar Wharf is 171 m long and 18 m wide and was constructed in 1901 and predominantly used for transporting coal to the city gas works. The wharf was closed in 2015 due to public safety concerns (NatLib, 2020).

Figure 2-7: Aerial view of Miramar Peninsula 30 September 1931. Evans Bay is in the foreground, with the Miramar and Burnham (right) wharves. Shelly Bay Road runs alongside. (Alexander Turnbull Library Ref: 1/2-061244-F).

Figure 2-8: Shelly Bay Airforce Base 1948 (Alexander Turnbull Library Ref: 1/2-046266-G).

Figure 2-9: Aerial view of Watts Peninsula, Miramar, Wellington March 1966. (Alexander Turnbull Library Ref: EP/1966/1339-F).

3 Coastal processes

3.1 Water levels

The water level at any location varies across a range of timescales. Key components that determine water level are:

- Astronomical tides.
- Barometric and wind effects, generally referred to as storm surge.
- Medium-term fluctuations, including El Nino-Southern Oscillation (ENSO) and Interdecadal Pacific Oscillation (IPO) effects.
- Long-term changes in relative sea level due to climatic or geological changes.
- Nearshore wave effects (wave set-up or run-up).

These components combined either form a static extreme water level, which typically includes storm tide and wave set-up, or dynamic extreme water level, which typically include storm tide and wave run-up. **Figure 3-1** shows a schematisation of the water level components.

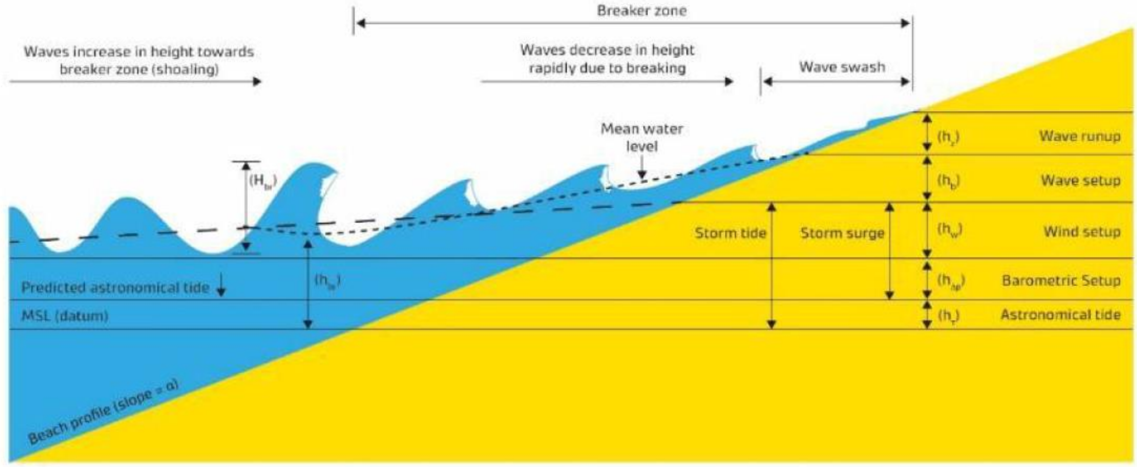


Figure 3-1: Schematisation of water level components (source: T+T 2017).

3.1.1 Astronomic tide

Standard Port Tidal Levels given by LINZ (2019) are based on the average predicted values over the 18.6-year astronomical tidal cycle. When tidal information is used as part of a MHWS determination for cadastral surveys these values should be used (LINZ, 2019). Tidal levels available for the Port of Wellington and are shown in **Table 3-1**.

Table 3-1: Tidal levels for Port of Wellington

Tidal level	Chart Datum CD (m)	WVD53 (m)	NZVD2016 (m)
Highest Astronomical Tide (HAT)	1.87	0.96	0.61
Mean High Water Spring (MHWS)	1.77	0.86	0.51
Mean High Water Neap (MHWN)	1.45	0.54	0.19
Mean Sea Level (MSL)	1.13	0.22	-0.13
Mean Low Water Neap (MLWN)	0.70	-0.21	-0.56
Mean Low Water Spring (MLWS)	0.45	-0.46	-0.81
Lowest Astronomical Tide (LAT)	0.38	-0.53	-0.88

3.1.2 Storm surge

Storm surge results from the combination of barometric setup from low atmospheric pressure and wind stress from winds blowing along or onshore which elevates the water level above the predicted tide. The combination of the mean level of the sea, astronomical tide and storm surge is known as storm tide.

Stephens et al. (2009) assessed annual maxima sea level at Queens Wharf, Wellington (dates of data not specified) and derived a range of extreme values presented in **Table 3-2**. A 1% AEP (equivalent to a 100 year return period or average recurrence interval event) storm tide level of 0.97 m NZVD2016 was derived, approximately 0.46 m above the LINZ MHWS level. It should be noted that the Stephens et al. (2009) assessment included a simulated storm tide of 0.98 m NZVD2016 on 2 February 1936.

During extreme storm tide events, wave processes are expected to further increase the mean water level at the shoreline through wave setup. Lane et al. (2012) estimated the 1%AEP joint probability of extreme sea level including wave setup (i.e. storm tide + wave setup) for Evans Bay of 1.12 m NZVD-16 indicating wave setup may contribute an additional **0.15 m** to total sea level during this event.

Table 3-2: Storm tide elevations

Annual Exceedance Probability (AEP)	Average Recurrence Interval (ARI)	Extreme Sea Level (m WVD53)	Extreme Sea Level (m NZVD2016)
0.2	5 year	1.20	0.85
0.1	10 year	1.23	0.88
0.05	20 year	1.26	0.91
0.02	50 year	1.30	0.95
0.01	100 year	1.32	0.97

3.1.3 Medium-term sea-level fluctuations

The mean sea level can fluctuate on time scales ranging from months to decades due to atmospheric factors such as season, ENSO and IPO. The combined effect of these fluctuations may cause variation in the local water level by up to 0.25 m (Bell, 2012). This effect has not been included in the water levels considered as part of this assessment.

3.1.4 Long term sea levels

Historic sea level rise for the Wellington region has averaged 2.2 ± 0.1 mm/year (Hannah and Bell, 2012). Climate change is predicted to accelerate this rate of sea-level rise into the future. The New Zealand Coastal Policy Statement (NZCPS, 2010) requires that the identification of coastal hazards includes consideration of sea-level rise over at least a 100-year planning period. For these assessments, a planning horizon of 2120 has been used as a practical minimum and a planning horizon of 2070 has been used as an intermediate time frame.

We have used four sea-level rise Representative Concentration Pathway (RCP) scenarios derived from those presented in MfE (2017). These are the median projections of the RCP2.6, RCP4.5 and RCP8.5 scenarios, and an RCP8.5+ projection representing the 83rd percentile of the RCP8.5 scenario. The projections of the potential future scenarios adjusted to the New Zealand regional scale are presented in **Table 3-3** below for the two planning horizons.

Table 3-3: Sea level rise projections adjusted to 2009 sea levels from the 1986-2005 baseline for the four emission scenarios

Year	RCP 2.6 M1	RCP 4.5 M	RCP 8.5M	RCP 83rd %
2070	0.28 m	0.32 m	0.40 m	0.55 m
2120	0.51 m	0.63 m	1.01 m	1.30 m

1 - M = median

For this assessment, we will consider the RCP8.5 scenario as shown in **Table 3-4** below.

Table 3-4: Extreme sea-level predictions including the sea level rise component associated with the RCP 8.5M emission scenario

AEP	ARI (years)	Extreme Sea Level (m NZVD2016)		
		Present Day	RCP 8.5M 2070	RCP 8.5M 2120
0.2	5	0.85	1.25	1.86
0.1	10	0.88	1.28	1.89
0.05	20	0.91	1.31	1.92
0.02	50	0.95	1.35	1.96
0.01	100	0.97	1.37	1.98

3.2 Wind and wave climate

Located within Evans Bay inside Wellington Harbour protects the coastline along Shelly Bay Road from open coast swell. The north-south alignment of Evans Bay also serves to limit exposure to wind waves generated from directions other than the north and south.

National Institute of Water and Atmospheric Research (NIWA) have published a wind rose based on wind data collected at the Wellington Airport. The wind data used was collected at hourly intervals from December 1959 to March 2011. Although not explicitly stated these measurements are taken to be 10-minute mean wind speeds. The wind rose in **Figure 3-2** shows annual wind frequency of surface wind speed and direction.

This wind rose shows a bimodal wind distribution with winds from either the north or the south, with more frequent and higher wind speeds from the north.

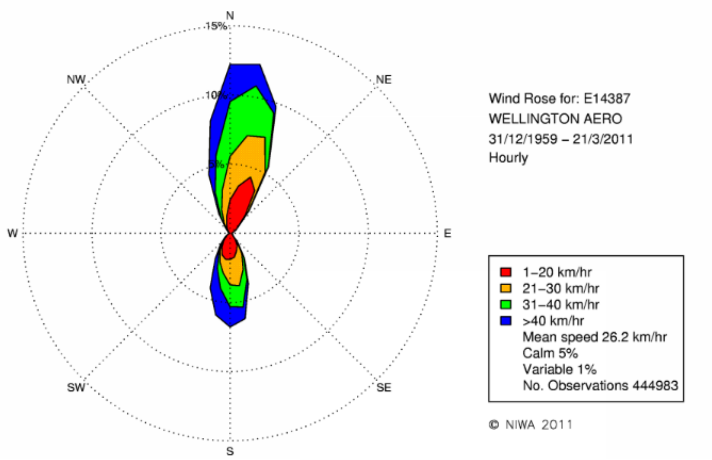


Figure 3-2: Wind rose and monthly mean wind speed for Wellington Aero (NIWA, 2011)

Design wind speeds calculated using AS/NZS 1170.2 and modified for a one-hour duration, indicates a 100-year return period wind speed of 112 km/hr (31 m/s).

3.2.1 Wind waves

Simulated Waves Nearshore (SWAN) wave modelling undertaken by T+T (2019) assesses extreme wave climate in the study area including the sheltering effects of Evans Bay on wave generation. SWAN is a third-generation wave model that computes random, short-crested wind-generated waves in coastal regions and inland waters by solving the spectral action balance equation without any restrictions on the wave spectrum evolution during growth or transformation.

A design water level of 0.92 m NZVD2016 was adopted for this model which is in between the 20- and 50-year ARI. Design wind speeds of 31 m/s corresponding to a 100-year return period event was applied throughout the model domain.

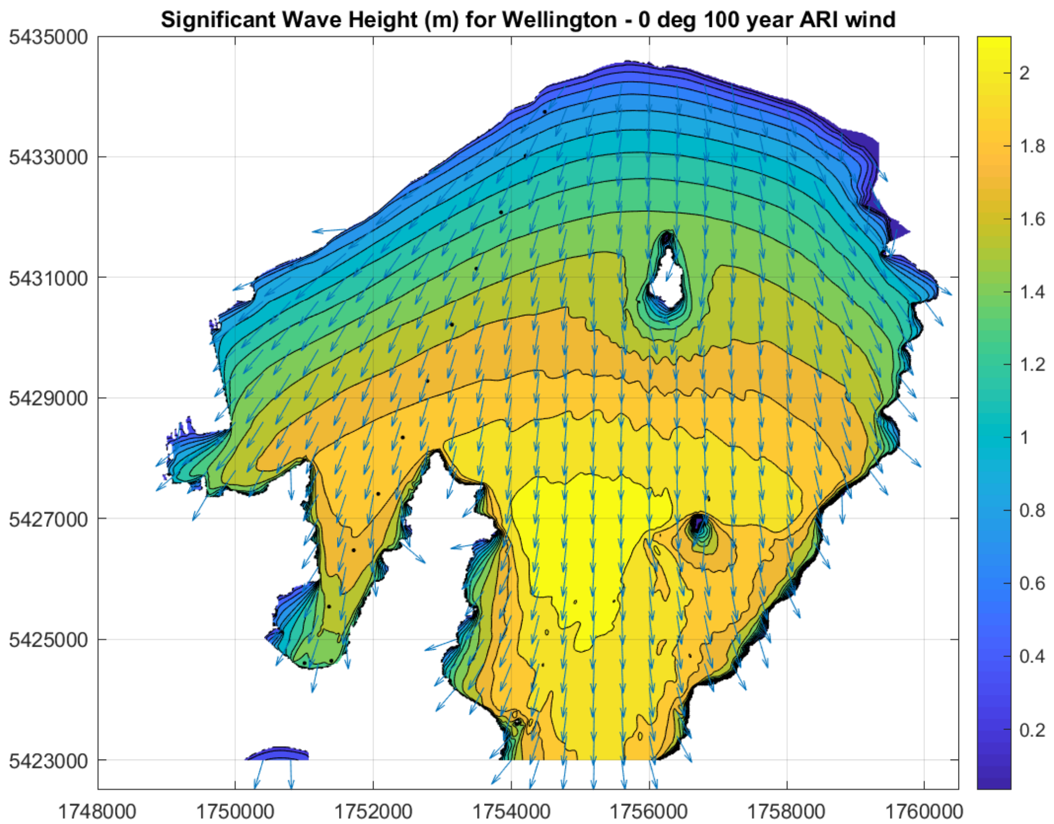


Figure 3-3: Model domain

The 100-year design wind speed was applied between 315 degrees and 30 degrees (with respect to 0 degrees North). The modelling indicates greatest wave heights at 0 degrees North (**Figure 3-4**) as this allowed for the greatest fetch relative to the coastline along the study area. This model indicates a significant wave height offshore of headlands along the site of approximately 1.0-1.2 m with a mean period of approximately 3 seconds and a peak wave period of approximately 3.8 seconds. Wave heights reduce due to refraction and shoaling effects to less than 1.0 m further into some of the larger bays (refer **Figure 3-4**). These waves can super-elevate the mean water level (i.e. storm tide level) during the breaking process (wave set-up).

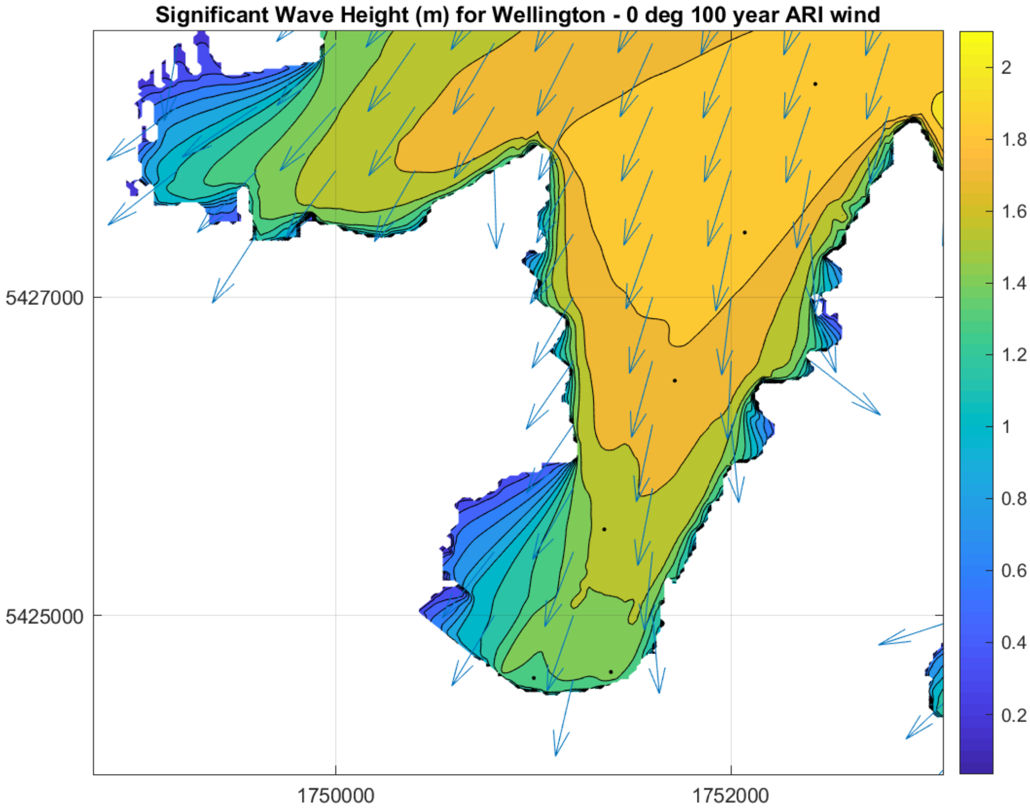


Figure 3-4: SWAN output wave height model results

3.3 Harbour sediment transport

High-level sediment transport processes with Wellington Harbour are shown in **Figure 3-5**. Within Evans Bay, available literature suggests that the source of existing sediment is largely from the Hutt River that has entered the bay through tidal dispersion (**Figure 3-6**) (Brodie 1958). The source of the larger shingle and pebbles is likely from local sources such as the greywacke rock outcrops and adjacent escarpments (Dahm 2009, Olson 2012) which have eroded over time (K. B. Lewis & D.C. Mildenhall 1985).

The funnel-like topography surrounding Evan's Bay is subject to strong southerly and northerly winds entering the bay. These strong winds can generate local seas as discussed in **Section 3.2** and define the localised sediment transport processes along the study area in the form of longshore drift (Van der Linden 1967). As the study area is within a confined bay tide effects on longshore drift are likely to be negligible due to the small tidal range.

Within the study area the wind generated waves can cause substantial localised erosion of the shoreline where it is unprotected. During less stormy periods', equilibrium is re-established by redistribution and accretion of sediment (Van der Linden 1967). Aerial and site analysis of beach planform orientations do not indicate predominant longshore drift direction. This suggests bimodal sediment transport along the study area that is reliant on the wind direction and intensity.

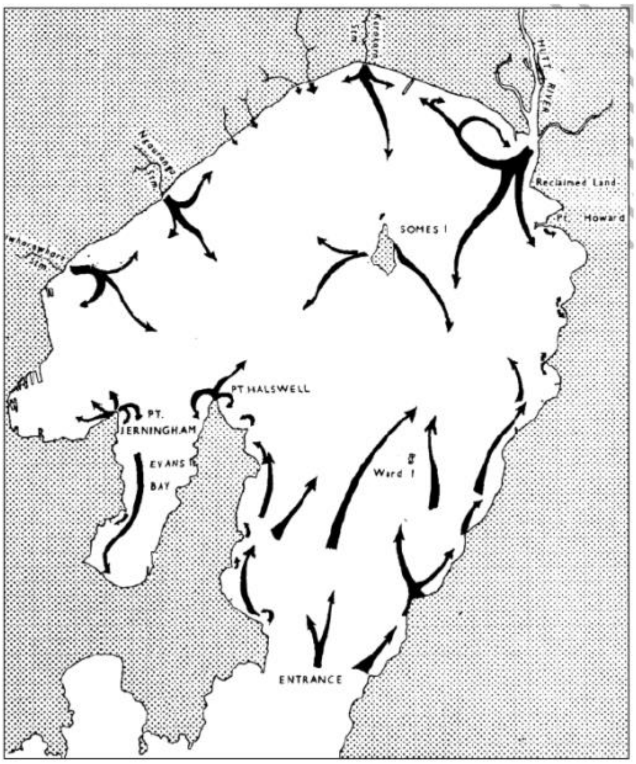


Figure 3-5: Sediment transport processes within Wellington Harbour [Source: Van der Linden (1967)].

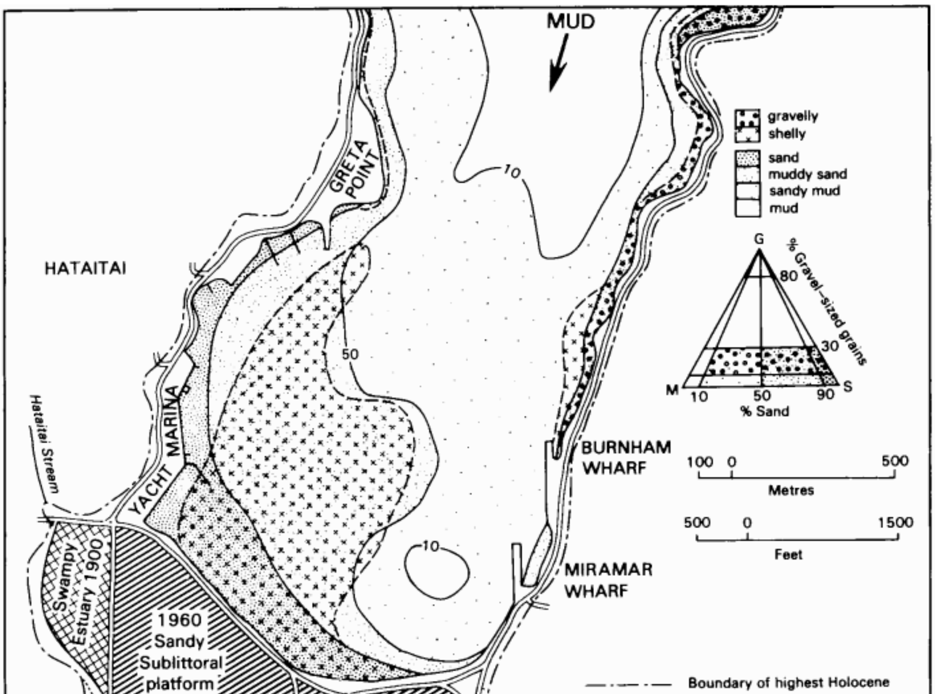


Figure 3-6: Sediments in Evans Bay showing mud derived mainly from the Hutt River (K. B. Lewis & D.C. Mildenhall (1985) adapted from Lewis and Carter (1976).

4 Coastal hazards

Coastal hazards arise when coastal processes adversely affect human assets and infrastructure. Coastal hazards which may affect Shelly Bay Road include:

- Coastal inundation.
- Wave overtopping.
- Coastal erosion and shoreline recession.

4.1 Coastal inundation hazard

Coastal inundation occurs when the seawater level rises above that which is typically considered normal fluctuation, potentially resulting in flooding of land, infrastructure and buildings.

A high-level inundation assessment was undertaken along the project site based on the existing road levels and extreme 1% AEP static storm tide levels to indicate the increased risk of coastal flooding along the road heading into the future.

The inundation levels assessed are outlined in **Table 4-1**, are based on static water levels, i.e. 1% AEP storm tide water levels + wave setup for both present sea levels and future sea-level scenarios. For this high-level assessment, a wave setup component of 0.15 m has been included as derived by Lane et al. (2012).

Table 4-1: 1% AEP static water levels (including wave setup) assessed for inundation risk along the project site

Extreme Sea Level (m NZVD2016)		
Present Day	**RCP 8.5M 2070**	**RCP 8.5M 2120**
1.1	1.5	2.1

Figure 4-1 shows a long section profile along the seaward edge of Shelly Bay Road within the project site. It can be seen that the road ranges in elevation from 2.1 to 4.1 m NZVD2016.

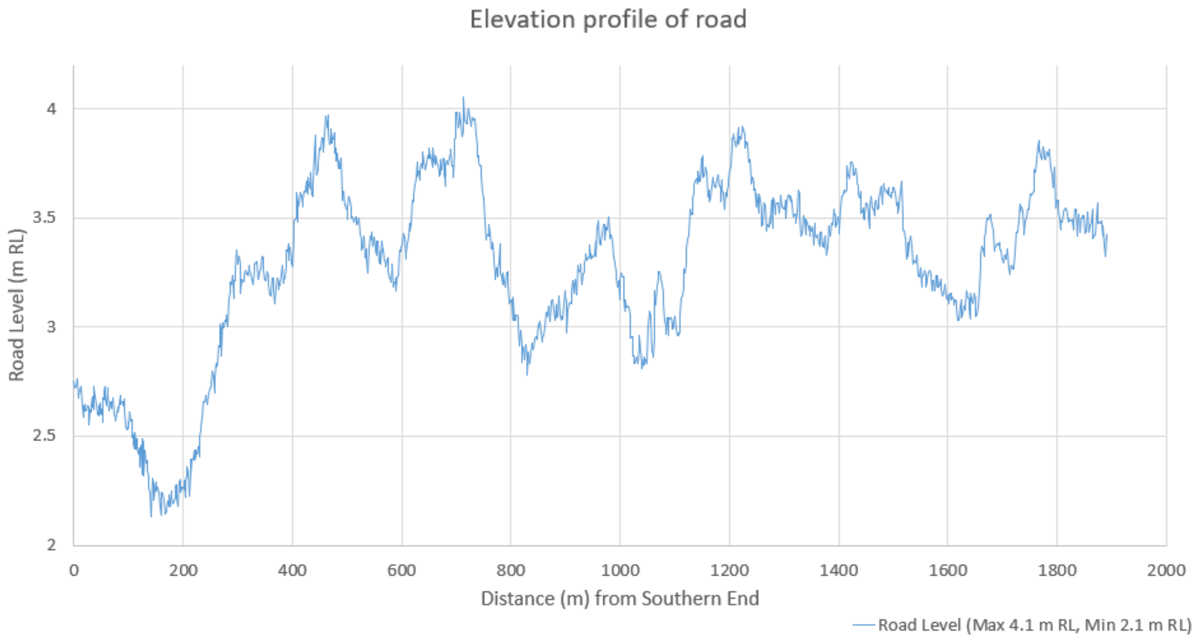


Figure 4-1: Elevation profile of Shelly Bay Road along seaward white line

These static water levels have been included on project site maps in **Appendix A** for reference of how these vary in plan along the project site.

Static water levels are unlikely to result in flooding of the road at current levels until the 2120 horizon where these levels reach the point of lowest road elevation. However, the dynamic effect of waves resulting in overtopping flows can result in health and safety risk to road users and damage to the road surface. This is assessed in **Section 4.2**.

4.2 Wave runup and overtopping

Wave overtopping occurs when the crest of a seawall is not sufficiently high to allow for wave run-up as the waves wash up the seawall face or natural berm edge. Overtopping is usually a white-water splash and/or wind-driven spray, but it can also be a flowing seawater surge that can cause localised inundation. Overtopping is affected by the seawall or berm face angle, crest height and permeability of materials in the seawall. A seawall structure with a vertical face will generally result in larger overtopping volumes than a structure with a sloping permeable face that is laid back against the slope. This is because the latter wall type dissipates the wave energy more than vertical walls. Wave overtopping is an important design criterion to consider for safety and backshore damage.

4.2.1 Limits of overtopping hazard for users

International literature contains various recommendations for various acceptable limits for wave overtopping of seawalls. Safe limits for pedestrians and vehicles using the footpath based on the EurOtop (2018) are included in **Table 4 2**. These mean overtopping values can appear conservative (low) as they are periodic flows averaged over time and are not representative of higher flows from individual waves.

Table 4-2: Limits for overtopping for people and vehicles (EurOtop Manual, 2018)

Hazard type and reason	Mean discharge q (l/s per m)	Max volume V_{max} (l per m)
People at structures with possible violent overtopping, mostly vertical structures	No access for any predicted overtopping	No access for any predicted overtopping
People at seawall / dike crest. Clear view of the sea.		
H_{m0} = 3 m	0.3	600
H_{m0} = 2 m	1	600
H_{m0} = 1 m	10-20	600
H_{m0} < 0.5 m	No limit	No limit
Cars on seawall / dike crest, or railway close behind crest		
H_{m0} = 3 m	<5	2000
H_{m0} = 2 m	10-20	2000
H_{m0} = 1 m	<75	2000
Highways and roads, fast traffic	Close before debris in spray becomes dangerous	Close before debris in spray becomes dangerous

USACE (2006) gives critical values of average overtopping for backshore damage and structural safety including:

- Grass backslopes: start of damage between 1-10 l/s/m.
- Unprotected seawall backslopes: damage >20 l/s/m.
- Pavement behind seawalls: damage >200 l/s/m.

4.2.2 Overtopping assessment

Overtopping of the road edge will increase as sea levels rise into the future. A high level overtopping assessment has been undertaken based on EurOtop (2016) empirical formula to estimate average overtopping flows during the 100-year return period storm conditions, for both extreme current sea level and the predicted future sea levels scenarios (refer to water levels in **Table 3-4**). Three road edge elevations were assessed, 2.0 m, 3.5 m, 4.0 m NZVD2016 corresponding to the approximate minimum, mean and highest current road elevations respectively. Given the proximity of the road edge to seawalls (refer **Figure 4-2**) and berm crest we have ignored any road setback as part of this high-level assessment.

Figure 4-2: Shows the coast proximately of Shelly Bay Road to the coastline

We note that nearshore effects on wave height and the spatial variation of this along the project site have not been considered as part of this high-level assessment. As such the flows are likely to be an overestimate on actual flows. However, these provide an indicative estimate and can be refined at a later stage. The results of this assessment are summarised in **Table 4-3**.

Table 4-3: Overtopping volume calculations

Scenario	Mean overtopping (l/s/m)				
	Crest level = 2.0 m NZVD2016	Crest level = 2.5 m NZVD2016	Crest level = 3.0 m NZVD2016	Crest level = 3.5 m NZVD2016	Crest level = 4.0 m NZVD2016
2020 1%AEP storm	30	10	5	3	2
2120 1%AEP storm	200	70	25	10	4

This assessment shows that at the lowest road elevations are likely to result in overtopping flows in excess of safe levels for road users in 1%AEP storm conditions with damage to the unprotected berm edge likely. Overtopping flows increase to volumes that are likely to damage the pavement by 2120 with a high-end sea-level scenario.

At a crest level of 3.5 m, a 1%AEP storm will likely result in overtopping flows in line with the upper end of those considered safe for pedestrians with this increasing to likely damaging levels for unprotected backshore at the 2120 horizon. When considering road setback from the coastal edge and nearshore wave breaking effects it is likely a minimum seawall crest level or road edge in the order of 3.5 m NZVD2016 will be adequate to mitigate overtopping risk over a 100-year planning consideration. Currently, there is approximately 1250 m of road that is below 3.5 m RL and 440 m below 3 m RL.

4.3 Coastal erosion hazard

The extents of land threatened by erosion hazard is influenced by short-term storm erosion, the stability of slopes above any erosion scarp, long-term recession trends and additional recession due to future sea-level rise.

4.3.1 Short term erosional trends

There is evidence along the length of the project site that this area is subject to ongoing erosion due to wave attack. The presence of significant lengths of seawall along Shelly Bay Road indicates vulnerable areas that have been repaired over the lifetime of the road. There are also areas of recent erosion and during the site walkover evidence of damage to the backshore and some seawalls was observed reflecting this ongoing erosional trend (refer **Figure 4-3**).

Figure 4-3: Erosion trends along the coastal line of Shelly Bay Road

4.3.2 Long term shoreline trends

Long term shoreline[2] trends are unlikely along the project site due to the significant lengths of greywacke rock outcrop (which is more subject to erosion trends of geological timeframes as opposed to those relevant for this assessment) and seawalls. There been localised erosion and overtime of more vulnerable lengths of escarpment toe and road berm and coastal defence

[2] The 'shoreline' is typically represented by the MHWS location, however for historic aerial analysis coastal margin features such as berms dune and scarp alignments are considered as indicative representations of the shoreline

structures have been constructed in these areas to mitigate further erosion and road damage. This effectively holds the shoreline at the seawall location mitigating future shoreline retreat.

Historic aerial photographs between 1939 and 2018 are available in **Appendix B**. Analysis of these aerials show there are few notable long-term shoreline trends within the project site. Shelly Bay Road was constructed before 1939 and the rocky outcrops and beaches very similar to present-day can be seen in the photographs. Digitizing the 1939 shoreline shows that in locations along the more exposed shorelines within the study area there has been shoreline regression of up to 0.07 m/y. This indicates where the shoreline is unprotected or stabilised with rock outcrops, there is a general erosional trend. However, the shoreline along the majority of study area appears unchanged over this period.

4.3.3 Future shoreline response

The project site (not including seawall locations) is generally representative of a consolidated shoreline, including hard cliffs and soft estuarine banks. These respond differently to coastal processes than beaches and are not able to rebuild following periods of erosion. Cliff erosion typically has two components; a gradual retreat caused by weathering, marine and bio-erosion processes, and episodic failures due to cliff lithology and geologic structure. If cliff toe erosion is halted through either natural (i.e. establishment of a beach) or artificial (i.e. rock or seawall protection), then the above cliff will continue to retreat until a stable angle of response is reached and vegetation becomes established.

As sea levels rise into the future, the typical anticipated response of a consolidated shoreline is for the toe erosion due to the increased susceptibility to coastal processes to result in increased cliff instability and an increased regression rate from that experiences in the past.

However, considering the presence of the road and seawall structures along the project site, the shoreline is likely to be held at its current location unless these structures are removed sometime in the future to allow naturalisation of the coastal edge. As such we have not undertaken a future shoreline response analysis as part of this high-level assessment.

5 Existing structures

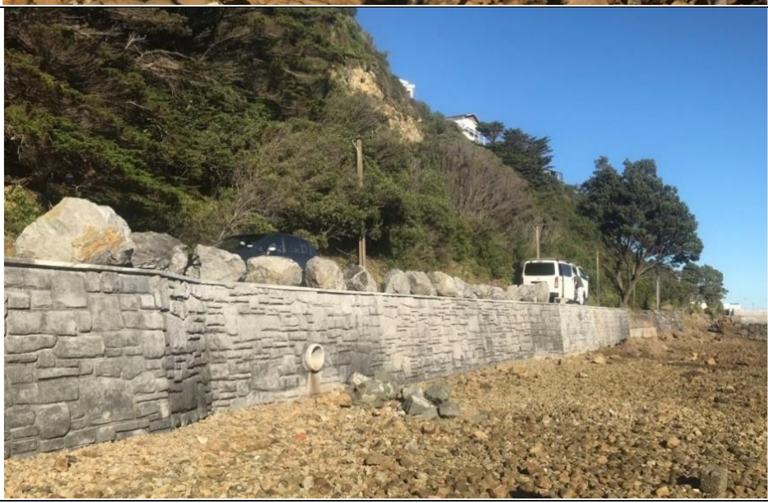
5.1 Baseline data and walkover

There are numerous existing coastal structures along the coastline of the Shelly Bay Road study area that reflect the longstanding attempts to manage the shoreline and erosion hazards. The majority being seawalls with varied design and age but generally have been in place since the 1960s with some sections older or newer than this date. The general different types of seawalls in place along the study area are shown in **Table 5-1** and the approximate total length of these coastal defences are summarised in **Table 5-2**.

T+T undertook a site walkover on 8 June 2020 to gain a high-level understanding of the project site, note any areas of erosion or where seawall condition has changed since the baseline dataset provided. Plans showing existing seawall locations and site notes are included in **Appendix A**.

The baseline for our assessment is the 2016 condition assessment summary supplied by WCC (refer Appendix C) and the 2013 T+T report 'Preliminary Assessment of Storm Damage Rev A'. This section will include a summary of noted changes in the seawall and coastal edge condition since these reports based on our site walkover on 8 June 2020.

Table 5-1: Types of coastal structures along the study area

Coastal structure	Example Image
Revetment (riprap rock or concrete blocks)	
Vertical wall (sloping, mortared rock or concrete)	

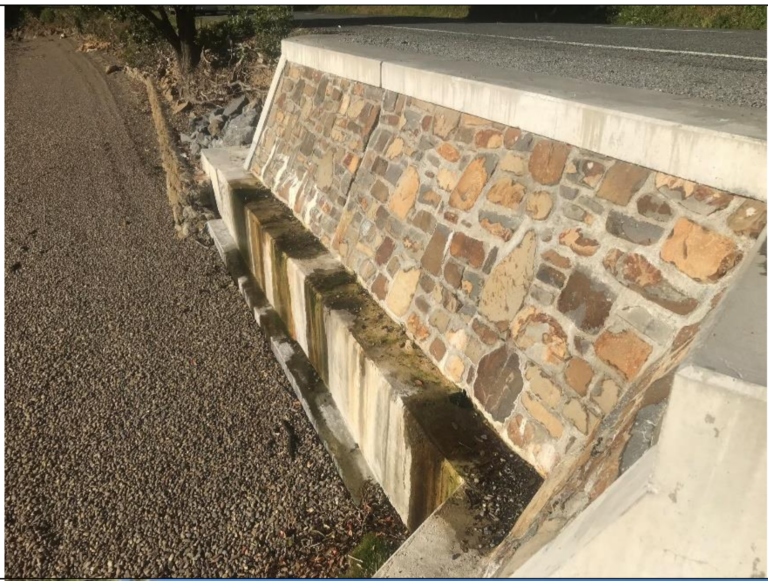
Stepped vertical wall (mortared rock or concrete)	
No coastal defence (rock outcrop, plantations, bare soil)	

Table 5-2: Summary of coastal structure lengths (2016 WCC seawall condition assessment)

Existing coastal structure	Approximate Length (m)
Revetment (riprap rock or concrete blocks)	54
Vertical wall (sloping, mortared rock or concrete)	103
Stepped vertical wall (mortared rock or concrete)	393
No coastal defence (rock outcrop, plantations, bare soil)	1342

5.2 Condition assessment summary

The key observations from the site assessment are:

- There are five main areas noted where the condition of the wall differs from the 2016 baseline data. The majority of the damage to the coastal defences observed in our inspections due to undermining and end-scour/outflanking of the existing walls.

- **Table** 5-4 summarises the change in the condition noted, refer to **Appendix A** for the corresponding locations.
- There are notable areas of erosion of unprotected slopes which have been recorded on the site walkover notes in **Appendix A**.
- Five seawalls were not included within the 2016 data, these have likely been constructed post-2016. These locations are shown in **Appendix A**.

The condition of the coastal defences has previously been assessed with a rating (refer Table 5-3) from excellent to very poor. We have recorded where we consider the existing rating of these structures has changed since the 2016 assessment. There are approximately 220m of coastal defence structures that are rated very poor or poor, refer to Appendix A for the locations of these seawalls. Note that the condition assessment only includes a visual assessment, no post walkover analysis has been undertaken, i.e. specific overtopping assessments.

Table 5-3: Condition assessment criteria (Wellington City Council)

Condition rating	Description
Excellent	Sound structure well designed. Well maintained. Intervene in 50+ years.
Good	As previous condition showing wear and tear and minor deterioration of surfaces. Some spalling but with no corrosion staining; needs to be inspected in the medium term. Deterioration causing minimal influence on performance. Intervene in 25 to 50 years.
Average	Staining and vegetation growth. Deterioration beginning to be reflected in adjacent carriageway. Intervene in 10 to 25 years.
Poor	Structure functioning but with problems due to significant cracking, spalling, loss of stability, deformation and corrosion. Likely to cause a marked deterioration in performance in the medium term. Some asset rehabilitation needed within the medium term. Intervene in 3 to 10 years.
Very poor	Structure has serious problems and has failed or is about to fail in the near future resulting in unacceptable performance. Minimal life expectancy, requiring urgent replacement or rehabilitation. Intervene in 0 to years.

Table 5-4: Seawall condition update summary

<table>
<tr><th>Asset ID</th><th>Changes noted since 2016 condition assessment and image</th></tr>
<tr><td>14555
Vertical wall
Mortared rock</td><td>2016 condition: Poor
Present Day condition: Very poor
• Overtopping and undermining of wall
• Scour of crest
• Damage to face
</td></tr>
<tr><td>14740
Vertical wall
Mortared rock</td><td>2016 condition: Poor
Present Day condition: Very poor
• Overtopping and undermining of wall
• Scour of crest
• The seawall isn’t protecting the bank behind
• Damage to face
• End-scour of wall
• Higher seawall likely needed such as the one adjacent
</td></tr>
<tr><td>11205
Stepped vertical wall
Mortared rock</td><td>2016 condition: Average
Present Day condition: Poor
• Localised undermining of wall
• Localised significant damage to face</td></tr>
</table>

	• End-scour of wall (particularly at the southern end)  
14581 Vertical wall Mortared rock	2016 condition: Average Present Day condition: Poor • Localised undermining of wall • Damage to face • End/outflanking scour (more significant at the southern end) • At the end of a wall there are large concrete blocks that may have been put there to prevent erosion, but they have since been displaced  
14584 Vertical Wall Mortared rock	2016 condition: Average Present Day condition: Very poor • Void behind wall caused by undermining failure • Damage to face • End-scour of wall  
NW04	This wall was not included in the 2016 assessment and has likely been installed post-2016.

Revetment Rip rap rock	Present Day condition: Poor-Average • It can be seen in the image that several rocks have been plucked from this revetment and are located on the beach. This is likely due to the revetment being constructed too steep for the size of rock used. It is anticipated this plucking will continue to occur in future storm events. 

6 Coastal considerations for road upgrades

The following coastal implications should be considered through the options assessment process for future road design:

- There is evidence of erosion along the edge of the current road alignment, particularly where the road edge is unprotected along the seaward edge by natural features such as rocky outcrops (refer Figure 6-1 for high level erosion summary along the site). This indicates a general erosional trend which will increase into the future as sea levels rise. There are locations where seawall repairs and construction of new seawalls will need to be considered if the road corridor alignment remains the same width. Extending the road corridor seaward will increase this risk and will require new seawall construction along significant lengths, particularly where present day MHWS is within 5m of the road edge (refer Table 6-1).
- Inundation risk from static sea levels along this length of road are negligible for the present day. However subject to sea level rise into the future, this may become more problematic for low lying sections of the road. Even so, this risk is considered to be minor and overtopping of the road edge is a more important design consideration.
- Overtopping of the road edge during extreme storm events is an important consideration when assessing design road elevation, particularly where a seawall is required to support this road edge (refer Figure 6-2 for high level overtopping summary along the project site). High levels of overtopping can result in hazardous conditions for road users and cause damage to the backshore and road surface. Overtopping flows will increase if the road corridor shifts seaward and will also increase into the future as sea levels rise. Particular attention should be given to lengths of the road with lowest elevations, where current seawalls are present or where the road edge is within 5m of the present day MHWS. It is recommended that a minimum road/seawall crest elevation of at least 3.5m RL be considered in these locations. Where this is not feasible, alternate mitigation measures may be required in the future such as road closures during large storm events.
- The coastal hazard for the project site is expected to be similar to other sheltered, low lying inner harbour roads that follow the coastal edge, including Oriental Parade, Evans Bay Road and Massey Road. However, these roads are predominantly protected by seawalls. The sheltered nature of this location differs from more northerly and easterly harbour roads as it is not vulnerable to open coast southerly swells entering the harbour mouth, i.e. Marine Drive and Karaka Bay Road.
- Reclamation seaward to widen the road corridor will require the application for resource consent where this would extend seaward of the present day MHWS location (i.e. into the CMA). In locations where works will not reach present day MHWS but are potentially located below future MHWS levels during the 100 year planning horizon, it is recommended the consenting implications be discussed with GWRC. Table 6-1 shows the road lengths relative to 1.5m, 3.5m and 8m of present day and future CMA levels. These distances are approximately those being considered for road widening as part of the long list options selection process.
- As part of any resource consent application, consideration of coastal hazard risk to the development over the next ‘at least 100 years’ will be required under the MfE (2017) guidelines with general policy direction away from development in areas subject to coastal hazard risk over in this timeframe.
- An option specific coastal effects assessment will be required for the preferred option to support any resource consent application.

Table 6-1: MWHS location relative to the existing road edge[1,2]

Sea level scenario	Length of road within 1.5m of the CMA	Length of road within 3.5m of the CMA	Length of road within 8m of the CMA
Present day MHWS (0.51m NZVD2016)	0	5	1050
2070 RCP8.5 MHWS (0.91m NZVD2016)	0	150	1250
2120 RCP8.5 MHWS (1.52m NZVD2016)	5	500	1550

[1] Future MHWS location is based only on sea level rise component, no future shoreline response has been included. Where no seawalls or rock outcrops are present, future shoreline response to sea level rise will likely result in greater lengths of road within these offsets than those outlined above (refer Section 4.3.3).
[2] Based on 2013 LiDAR

Figure 6-1: High level erosion summary along the project site based on site observations

Figure 6-2: High level overtopping summary along the project site for present day (left) and 2120 (RCP8.5) (right) sea levels during a 1%AEP storm event

7 Applicability

This report has been prepared for the exclusive use of our client Wellington City Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that this report will be used by Wellington City Council in undertaking its regulatory functions in connection with erosion protection works.

Tonkin & Taylor Ltd

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Coastal Engineer

Report prepared by:

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Civil Engineer

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Tom Shand

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Appendix A: Site plans

LEGEND

- EXISTING KERB
- 25 GROUND CONTOURS (25.0m)
- GROUND CONTOURS (5.0m)
- ASSET ID SEA WALL LOCATIONS

1% AEP STORM TIDE STATIC INUNDATION LEVELS

- 1.1m RL (2020)
- 1.5m RL (2070 RCP 8.5)
- 2.1m RL (2120 RCP 8.5)
- MHWS (0.5m NZVD2016)

- Site walkover 8.6.20 notes
- Very poor and poor condition

NOTES:
1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. AERIAL PHOTO SOURCED FROM WELLINGTON 0.10m URBAN AERIAL PHOTOS (2017), LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
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4. SEAWALL DATA SOURCED FROM WELLINGTON CITY COUNCIL GIS DATA BASE.
5. COORDINATE DATUM: NZGD2000, NEW ZEALAND TRANSVERSE MERCATOR (NZTM2000). VERTICAL DATUM: NEW ZEALAND VERTICAL DATUM (NZVD2016).

A3 SCALE 1:500
0 5 10 15 20 25 (m)

ORIGINAL IN COLOUR

PROJECT No.	1014113	
DESIGNED	JASZ	Jun.20
DRAWN	JASZ	Jun.20
CHECKED		
APPROVED	DATE	

CLIENT	WELLINGTON CITY COUNCIL
PROJECT	SHELLY BAY ROAD, MAUPUIA
TITLE	COASTAL ASSESSMENT SITE PLAN - SHEET 1 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F100
REV	1

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NOTES:
1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
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4. SEAWALL DATA SOURCED FROM WELLINGTON CITY COUNCIL GIS DATA BASE.
5. COORDINATE DATUM: NZGD2000, NEW ZEALAND TRANSVERSE MERCATOR (NZTM2000). VERTICAL DATUM: NEW ZEALAND VERTICAL DATUM (NZVD2016).

A3 SCALE 1:500
0 5 10 15 20 25 (m)

ORIGINAL IN COLOUR

PROJECT No.	1014113		
DESIGNED	JASZ	Jun.20	
DRAWN	JASZ	Jun.20	
CHECKED			
APPROVED		DATE	

CLIENT	WELLINGTON CITY COUNCIL
PROJECT	SHELLY BAY ROAD, MAUPUIA
TITLE	COASTAL ASSESSMENT SITE PLAN - SHEET 2 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F101
REV	1

UNDER REVISION

T:\Wellington\TT Projects\1014113\WorkingMaterial\CAD\FIG\1014113-F100_F112.dwg 2020-Jun-25 7:35:05 PM Plotted By: JANINE SZIKLASI

NOTES:
1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
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4. SEAWALL DATA SOURCED FROM WELLINGTON CITY COUNCIL GIS DATA BASE.
5. COORDINATE DATUM: NZGD2000, NEW ZEALAND TRANSVERSE MERCATOR (NZTM2000).
VERTICAL DATUM: NEW ZEALAND VERTICAL DATUM (NZVD2016).

A3 SCALE 1:500
0 5 10 15 20 25 (m)

ORIGINAL IN COLOUR

PROJECT No.	1014113		
DESIGNED	JASZ	Jun.20	
DRAWN	JASZ	Jun.20	
CHECKED			
APPROVED		DATE	

CLIENT	WELLINGTON CITY COUNCIL
PROJECT	SHELLY BAY ROAD, MAUPUIA
TITLE	COASTAL ASSESSMENT SITE PLAN - SHEET 3 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F102
REV	1

UNDER REVISION

LEGEND

EXISTING KERB
GROUND CONTOURS (25.0m)
GROUND CONTOURS (5.0m)
ASSET ID — SEA WALL LOCATIONS

1% AEP STORM TIDE STATIC INUNDATION LEVELS
1.1m RL (2020)
1.5m RL (2070 RCP 8.5)
2.1m RL (2120 RCP 8.5)
MHWS (0.5m NZVD2016)

Site walkover 8.6.20 notes
Very poor and poor condition

Erosion noted

Void behind seawall - undermining failure

NOTES:
1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. AERIAL PHOTO SOURCED FROM WELLINGTON 0.10m URBAN AERIAL PHOTOS (2017), LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
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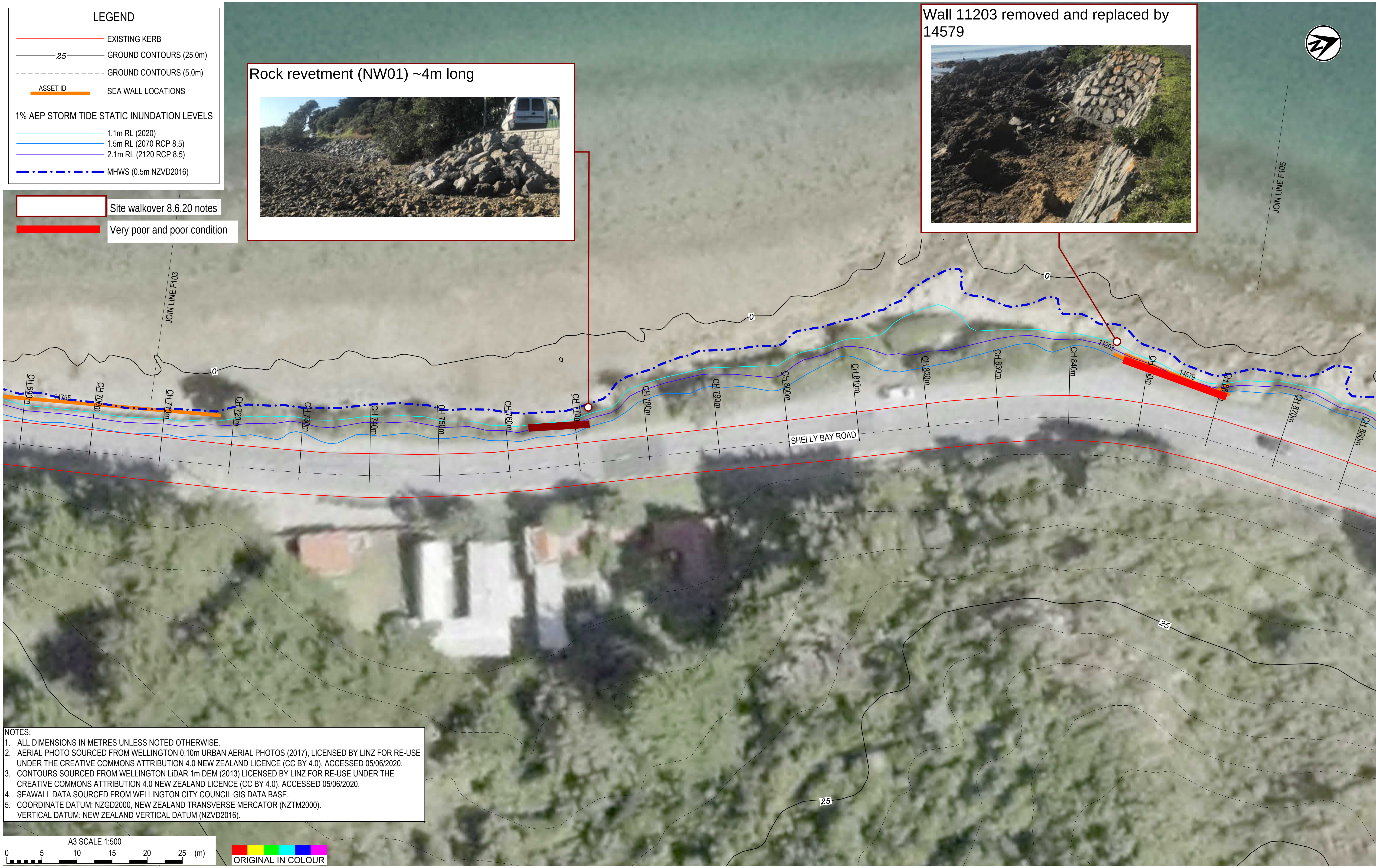
A3 SCALE 1:500
0 5 10 15 20 25 (m)

ORIGINAL IN COLOUR

PROJECT No.	1014113		
DESIGNED	JASZ	Jun.20	
DRAWN	JASZ	Jun.20	
CHECKED			
APPROVED		DATE	

CLIENT WELLINGTON CITY COUNCIL
PROJECT SHELLY BAY ROAD, MAUPUIA
TITLE COASTAL ASSESSMENT
SITE PLAN - SHEET 4 OF 13
UNDER REVISION
SCALE (A3) 1:500 FIG No. 1014113-F103 REV 1



LEGEND

- EXISTING KERB
- 25 GROUND CONTOURS (25.0m)
- GROUND CONTOURS (5.0m)
- ASSET ID SEA WALL LOCATIONS

1% AEP STORM TIDE STATIC INUNDATION LEVELS

- 1.1m RL (2020)
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- Very poor and poor condition

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A3 SCALE 1:500
0 5 10 15 20 25 (m)

ORIGINAL IN COLOUR

PROJECT No.	1014113		
DESIGNED	JASZ	Jun.20	
DRAWN	JASZ	Jun.20	
CHECKED			
APPROVED		DATE	

CLIENT	WELLINGTON CITY COUNCIL
PROJECT	SHELLY BAY ROAD, MAUPUIA
TITLE	COASTAL ASSESSMENT SITE PLAN - SHEET 5 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F104
REV	1

UNDER REVISION

LEGEND

- EXISTING KERB
- 25 GROUND CONTOURS (25.0m)
- GROUND CONTOURS (5.0m)
- ASSET ID — SEA WALL LOCATIONS

1% AEP STORM TIDE STATIC INUNDATION LEVELS

- 1.1m RL (2020)
- 1.5m RL (2070 RCP 8.5)
- 2.1m RL (2120 RCP 8.5)
- MHWS (0.5m NZVD2016)

- Site walkover 8.6.20 notes
- Very poor and poor condition

NOTES:
1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. AERIAL PHOTO SOURCED FROM WELLINGTON 0.10m URBAN AERIAL PHOTOS (2017), LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
3. CONTOURS SOURCED FROM WELLINGTON LiDAR 1m DEM (2013) LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
4. SEAWALL DATA SOURCED FROM WELLINGTON CITY COUNCIL GIS DATA BASE.
5. COORDINATE DATUM: NZGD2000, NEW ZEALAND TRANSVERSE MERCATOR (NZTM2000). VERTICAL DATUM: NEW ZEALAND VERTICAL DATUM (NZVD2016).

A3 SCALE 1:500
0 5 10 15 20 25 (m)

ORIGINAL IN COLOUR

PROJECT No.	1014113	
DESIGNED	JASZ	Jun.20
DRAWN	JASZ	Jun.20
CHECKED		
APPROVED	DATE	

CLIENT	WELLINGTON CITY COUNCIL
PROJECT	SHELLY BAY ROAD, MAUPUIA
TITLE	COASTAL ASSESSMENT SITE PLAN - SHEET 6 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F105
REV	1

UNDER REVISION

NOTES:
1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. AERIAL PHOTO SOURCED FROM WELLINGTON 0.10m URBAN AERIAL PHOTOS (2017), LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
3. CONTOURS SOURCED FROM WELLINGTON LiDAR 1m DEM (2013) LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
4. SEAWALL DATA SOURCED FROM WELLINGTON CITY COUNCIL GIS DATA BASE.
5. COORDINATE DATUM: NZGD2000, NEW ZEALAND TRANSVERSE MERCATOR (NZTM2000). VERTICAL DATUM: NEW ZEALAND VERTICAL DATUM (NZVD2016).

PROJECT No.	1014113		
DESIGNED	JASZ	Jun.20	
DRAWN	JASZ	Jun.20	
CHECKED			
APPROVED		DATE	

CLIENT	WELLINGTON CITY COUNCIL
PROJECT	SHELLY BAY ROAD, MAUPUIA
TITLE	COASTAL ASSESSMENT SITE PLAN - SHEET 7 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F106
REV	1

UNDER REVISION

LEGEND

- EXISTING KERB
- 25 GROUND CONTOURS (25.0m)
- GROUND CONTOURS (5.0m)
- ASSET ID SEA WALL LOCATIONS

1% AEP STORM TIDE STATIC INUNDATION LEVELS

- 1.1m RL (2020)
- 1.5m RL (2070 RCP 8.5)
- 2.1m RL (2120 RCP 8.5)
- MHWS (0.5m NZVD2016)

- Site walkover 8.6.20 notes
- Very poor and poor condition

NOTES:
1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. AERIAL PHOTO SOURCED FROM WELLINGTON 0.10m URBAN AERIAL PHOTOS (2017), LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
3. CONTOURS SOURCED FROM WELLINGTON LiDAR 1m DEM (2013) LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
4. SEAWALL DATA SOURCED FROM WELLINGTON CITY COUNCIL GIS DATA BASE.
5. COORDINATE DATUM: NZGD2000, NEW ZEALAND TRANSVERSE MERCATOR (NZTM2000). VERTICAL DATUM: NEW ZEALAND VERTICAL DATUM (NZVD2016).

A3 SCALE 1:500
0 5 10 15 20 25 (m)

ORIGINAL IN COLOUR

PROJECT No.	1014113	
DESIGNED	JASZ	Jun.20
DRAWN	JASZ	Jun.20
CHECKED		
APPROVED	DATE	

CLIENT	WELLINGTON CITY COUNCIL
PROJECT	SHELLY BAY ROAD, MAUPUIA
TITLE	COASTAL ASSESSMENT SITE PLAN - SHEET 8 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F107
REV	1

UNDER REVISION

LEGEND

- EXISTING KERB
- 25 GROUND CONTOURS (25.0m)
- GROUND CONTOURS (5.0m)
- ASSET ID SEA WALL LOCATIONS

1% AEP STORM TIDE STATIC INUNDATION LEVELS

- 1.1m RL (2020)
- 1.5m RL (2070 RCP 8.5)
- 2.1m RL (2120 RCP 8.5)
- MHWS (0.5m NZVD2016)

Site walkover 8.6.20 notes

Very poor and poor condition

NOTES:

1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. AERIAL PHOTO SOURCED FROM WELLINGTON 0.10m URBAN AERIAL PHOTOS (2017), LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
3. CONTOURS SOURCED FROM WELLINGTON LiDAR 1m DEM (2013) LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
4. SEAWALL DATA SOURCED FROM WELLINGTON CITY COUNCIL GIS DATA BASE.
5. COORDINATE DATUM: NZGD2000, NEW ZEALAND TRANSVERSE MERCATOR (NZTM2000). VERTICAL DATUM: NEW ZEALAND VERTICAL DATUM (NZVD2016).

A3 SCALE 1:500

0 5 10 15 20 25 (m)

ORIGINAL IN COLOUR

PROJECT No.	1014113		
DESIGNED	JASZ	Jun.20	
DRAWN	JASZ	Jun.20	
CHECKED			
APPROVED		DATE	

CLIENT	**WELLINGTON CITY COUNCIL**
PROJECT	**SHELLY BAY ROAD, MAUPUIA**
TITLE	COASTAL ASSESSMENT SITE PLAN - SHEET 9 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F108
REV	1

UNDER REVISION

LEGEND

- EXISTING KERB
- GROUND CONTOURS (25.0m)
- GROUND CONTOURS (5.0m)
- ASSET ID — SEA WALL LOCATIONS

1% AEP STORM TIDE STATIC INUNDATION LEVELS

- 1.1m RL (2020)
- 1.5m RL (2070 RCP 8.5)
- 2.1m RL (2120 RCP 8.5)
- MHWS (0.5m NZVD2016)

- Site walkover 8.6.20 notes
- Very poor and poor condition

NOTES:
1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. AERIAL PHOTO SOURCED FROM WELLINGTON 0.10m URBAN AERIAL PHOTOS (2017), LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
3. CONTOURS SOURCED FROM WELLINGTON LiDAR 1m DEM (2013) LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
4. SEAWALL DATA SOURCED FROM WELLINGTON CITY COUNCIL GIS DATA BASE.
5. COORDINATE DATUM: NZGD2000, NEW ZEALAND TRANSVERSE MERCATOR (NZTM2000). VERTICAL DATUM: NEW ZEALAND VERTICAL DATUM (NZVD2016).

A3 SCALE 1:500
0 5 10 15 20 25 (m)

ORIGINAL IN COLOUR

PROJECT No.	1014113		
DESIGNED	JASZ	Jun.20	
DRAWN	JASZ	Jun.20	
CHECKED			
APPROVED		DATE	

CLIENT	WELLINGTON CITY COUNCIL
PROJECT	SHELLY BAY ROAD, MAUPUIA
TITLE	COASTAL ASSESSMENT SITE PLAN - SHEET 10 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F109
REV	1

UNDER REVISION

LEGEND

- EXISTING KERB
- 25 GROUND CONTOURS (25.0m)
- GROUND CONTOURS (5.0m)
- ASSET ID SEA WALL LOCATIONS

1% AEP STORM TIDE STATIC INUNDATION LEVELS

- 1.1m RL (2020)
- 1.5m RL (2070 RCP 8.5)
- 2.1m RL (2120 RCP 8.5)
- MHWS (0.5m NZVD2016)

- Site walkover 8.6.20 notes
- Very poor and poor condition

NOTES:
1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. AERIAL PHOTO SOURCED FROM WELLINGTON 0.10m URBAN AERIAL PHOTOS (2017), LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
3. CONTOURS SOURCED FROM WELLINGTON LiDAR 1m DEM (2013) LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
4. SEAWALL DATA SOURCED FROM WELLINGTON CITY COUNCIL GIS DATA BASE.
5. COORDINATE DATUM: NZGD2000, NEW ZEALAND TRANSVERSE MERCATOR (NZTM2000). VERTICAL DATUM: NEW ZEALAND VERTICAL DATUM (NZVD2016).

A3 SCALE 1:500
0 5 10 15 20 25 (m)

ORIGINAL IN COLOUR

PROJECT No.	1014113		
DESIGNED	JASZ	Jun.20	
DRAWN	JASZ	Jun.20	
CHECKED			
APPROVED		DATE	

CLIENT	WELLINGTON CITY COUNCIL
PROJECT	SHELLY BAY ROAD, MAUPUIA
TITLE	COASTAL ASSESSMENT SITE PLAN - SHEET 11 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F110
REV	1

UNDER REVISION

PROJECT No.	1014113		
DESIGNED	JASZ	Jun.20	
DRAWN	JASZ	Jun.20	
CHECKED			
APPROVED		DATE	

CLIENT WELLINGTON CITY COUNCIL
PROJECT SHELLY BAY ROAD, MAUPUIA
TITLE COASTAL ASSESSMENT
SITE PLAN - SHEET 12 OF 13
UNDER REVISION
SCALE (A3) 1:500 FIG No. 1014113-F111 REV 1

LEGEND

- EXISTING KERB
- 25 GROUND CONTOURS (25.0m)
- GROUND CONTOURS (5.0m)
- ASSET ID SEA WALL LOCATIONS

1% AEP STORM TIDE STATIC INUNDATION LEVELS

- 1.1m RL (2020)
- 1.5m RL (2070 RCP 8.5)
- 2.1m RL (2120 RCP 8.5)
- MHWS (0.5m NZVD2016)

- Site walkover 8.6.20 notes
- Very poor and poor condition

NOTES:
1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. AERIAL PHOTO SOURCED FROM WELLINGTON 0.10m URBAN AERIAL PHOTOS (2017), LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
3. CONTOURS SOURCED FROM WELLINGTON LiDAR 1m DEM (2013) LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
4. SEAWALL DATA SOURCED FROM WELLINGTON CITY COUNCIL GIS DATA BASE.
5. COORDINATE DATUM: NZGD2000, NEW ZEALAND TRANSVERSE MERCATOR (NZTM2000). VERTICAL DATUM: NEW ZEALAND VERTICAL DATUM (NZVD2016).

A3 SCALE 1:500
0 5 10 15 20 25 (m)

ORIGINAL IN COLOUR

PROJECT No.	1014113	
DESIGNED	JASZ	Jun.20
DRAWN	JASZ	Jun.20
CHECKED		
APPROVED	DATE	

CLIENT WELLINGTON CITY COUNCIL
PROJECT SHELLY BAY ROAD, MAUPUIA
TITLE COASTAL ASSESSMENT
SITE PLAN - SHEET 13 OF 13

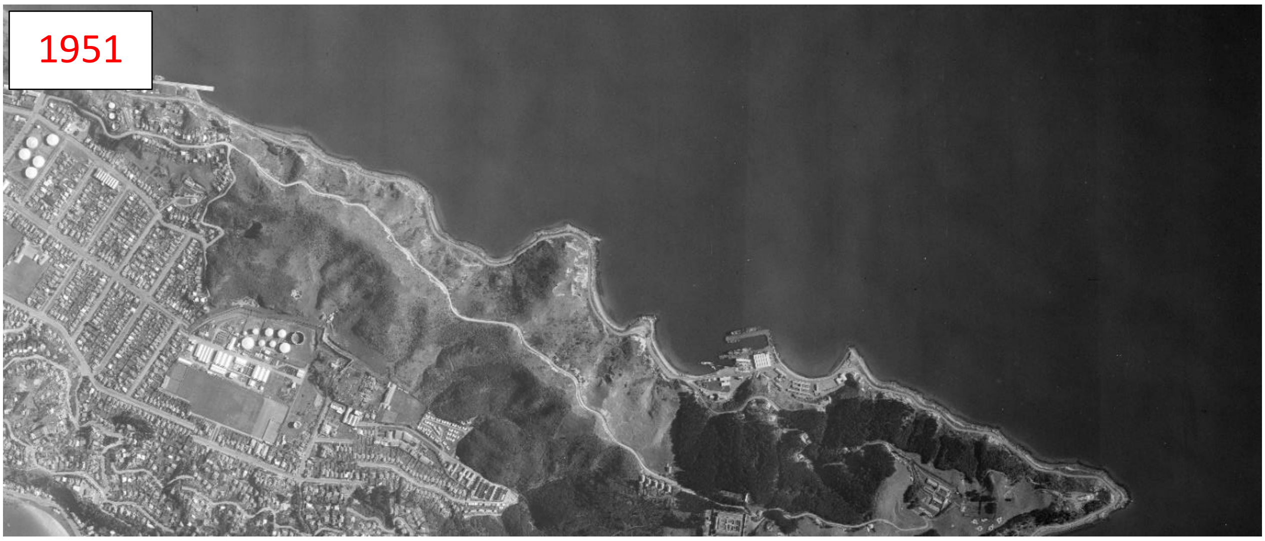
UNDER REVISION

SCALE (A3) 1:500 FIG No. 1014113-F112 REV 1

Appendix B: Historic Aerial Photographs

Note: Historic aerial photographs for 1939, 1951, 1961 and 1887 have been sourced from Retrolens.


1939


1951


1961


1987


2002


2018

Appendix C: 2016 WCC Condition Assessment

2016 WCC Condition Assessment

Infomation in table provided by Wellington City Council

Asset ID	Date Assessed	Condition	Cracking - C/B/R only: Extent17	Spalling - C/B only :Cond23	Spalling - C/B only :Extent25	Loss of Mortar/Binding: Cond	Loss of Mortar/Binding: Extent	Undermining (Condition)
14588	25/11/2016	Good	Moderate	2 - Good	Localised	2 - Good	Localised	3 - Average
14587	25/11/2016	Good	Localised	2 - Good	Localised	2 - Good	Localised	2 - Good
14586	25/11/2016	Poor	Moderate	4 - Poor	Widespread	4 - Poor	Widespread	5 - Very Poor
14585	25/11/2016	Good	Localised	1- Excellent	As new / No defect	2 - Good	Localised	2 - Good
14584	25/11/2016	Average	Localised	4 - Poor	Widespread	4 - Poor	Widespread	3 - Average
14582	25/11/2016	Good	Localised	1- Excellent	As new / No defect	2 - Good	Localised	2 - Good
14581	25/11/2016	Average	Localised	2 - Good	Localised	3 - Average	Moderate	2 - Good
14579	25/11/2016	Poor	Not Applicable	2 - Good	Localised	5 - Very Poor	Localised	3 - Average
11203	30/11/2016	Good	Localised	2 - Good	Localised	3 - Average	Moderate	2 - Good
14577	30/11/2016	Excellent	Localised	2 - Good	Localised	2 - Good	Localised	2 - Good
12278	30/11/2016	Good	Localised	2 - Good	Localised	2 - Good	Localised	3 - Average
11204	30/11/2016	Excellent	Localised	2 - Good	Localised	1- Excellent	As new / No defect	1- Excellent
14574	30/11/2016	Excellent	Localised	2 - Good	Localised	2 - Good	Localised	3 - Average
14573	30/11/2016	Good	Moderate	2 - Good	Localised	2 - Good	Localised	3 - Average
11205	30/11/2016	Average	Localised	3 - Average	Moderate	5 - Very Poor	Widespread	2 - Good
12279	30/11/2016	Average	Localised	1- Excellent	As new / No defect	2 - Good	Localised	3 - Average
14740	30/11/2016	Poor	Widespread	4 - Poor	Moderate	5 - Very Poor	Moderate	5 - Very Poor
14567	30/11/2016	Poor	Localised	3 - Average	Moderate	3 - Average	Moderate	2 - Good
14566	30/11/2016	Excellent	As new / No defect	1- Excellent	As new / No defect	Not Applicable	Not Applicable	1- Excellent
14565	30/11/2016	Excellent	As new / No defect	2 - Good	Moderate	1- Excellent	As new / No defect	Not Applicable
14563	30/11/2016	Excellent	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
14564	30/11/2016	Excellent	As new / No defect	1- Excellent	As new / No defect	1- Excellent	As new / No defect	1- Excellent
14562	30/11/2016	Excellent	As new / No defect	1- Excellent	As new / No defect	1- Excellent	As new / No defect	1- Excellent
14561	30/11/2016	Good	Localised	2 - Good	As new / No defect	2 - Good	Localised	2 - Good
14559	30/11/2016	Average	Localised	2 - Good	As new / No defect	2 - Good	Localised	3 - Average
14558	30/11/2016	Excellent	Localised	2 - Good	As new / No defect	2 - Good	Localised	2 - Good
14557	30/11/2016	Good	As new / No defect	1- Excellent	As new / No defect	Not Applicable	Not Applicable	2 - Good
14556	30/11/2016	Good	Localised	1- Excellent	As new / No defect	2 - Good	Localised	2 - Good
14555	30/11/2016	Poor	Moderate	3 - Average	Moderate	3 - Average	Widespread	4 - Poor
14554	30/11/2016	Average	Localised	3 - Average	Localised	2 - Good	Widespread	4 - Poor
14553	30/11/2016	Average	Moderate	3 - Average	Moderate	3 - Average	Widespread	4 - Poor
14552	30/11/2016	Poor	Moderate	3 - Average	Moderate	5 - Very Poor	Widespread	3 - Average
14551	30/11/2016	Very poor	Localised	3 - Average	Localised	2 - Good	Localised	2 - Good
14550	01/12/2016	Good	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	2 - Good

2016 WCC Condition Assessment

Infomation in table provided by Wellington City Council

Asset ID	Undermining (Extent)	Lateral Movement (Condition)	Overturning (Condition)	Bulging (Condition)	Loss of Scour Protection: Cond	Loss of Scour Protection Extnt	Erosion Protection (Condition)
14588	Localised	1- Excellent	1- Excellent	1- Excellent	3 - Average	Moderate	2 - Good
14587	Localised	1- Excellent	1- Excellent	1- Excellent	1- Excellent	As new / No defect	1- Excellent
14586	Moderate	2 - Good	1- Excellent	1- Excellent	3 - Average	Localised	Not Applicable
14585	Localised	1- Excellent	1- Excellent	1- Excellent	1- Excellent	As new / No defect	2 - Good
14584	Localised	1- Excellent	1- Excellent	1- Excellent	2 - Good	Localised	2 - Good
14582	Localised	1- Excellent	1- Excellent	1- Excellent	1- Excellent	As new / No defect	1- Excellent
14581	Localised	1- Excellent	1- Excellent	1- Excellent	3 - Average	Localised	3 - Average
14579	Widespread	1- Excellent	1- Excellent	1- Excellent	3 - Average	Localised	Not Applicable
11203	Localised	1- Excellent	1- Excellent	1- Excellent	2 - Good	Localised	3 - Average
14577	Localised	1- Excellent	1- Excellent	1- Excellent	3 - Average	Moderate	3 - Average
12278	Localised	1- Excellent	1- Excellent	1- Excellent	2 - Good	Localised	2 - Good
11204	As new / No defect	1- Excellent	1- Excellent	1- Excellent	1- Excellent	As new / No defect	1- Excellent
14574	Localised	1- Excellent	1- Excellent	1- Excellent	2 - Good	Localised	2 - Good
14573	Localised	1- Excellent	1- Excellent	1- Excellent	1- Excellent	As new / No defect	1- Excellent
11205	Moderate	2 - Good	1- Excellent	1- Excellent	4 - Poor	Localised	Not Applicable
12279	Moderate	1- Excellent	1- Excellent	1- Excellent	2 - Good	Localised	2 - Good
14740	Moderate	1- Excellent	1- Excellent	1- Excellent	3 - Average	Moderate	3 - Average
14567	Localised	3 - Average	3 - Average	1- Excellent	4 - Poor	Localised	2 - Good
14566	As new / No defect	1- Excellent	1- Excellent	1- Excellent	1- Excellent	As new / No defect	1- Excellent
14565	As new / No defect	1- Excellent	1- Excellent	1- Excellent	1- Excellent	As new / No defect	1- Excellent
14563	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
14564	As new / No defect	1- Excellent	1- Excellent	1- Excellent	1- Excellent	As new / No defect	1- Excellent
14562	As new / No defect	1- Excellent	1- Excellent	1- Excellent	1- Excellent	As new / No defect	1- Excellent
14561	Localised	1- Excellent	1- Excellent	1- Excellent	2 - Good	Moderate	2 - Good
14559	Localised	1- Excellent	1- Excellent	1- Excellent	3 - Average	Localised	2 - Good
14558	Localised	1- Excellent	1- Excellent	1- Excellent	2 - Good	Localised	2 - Good
14557	Moderate	1- Excellent	1- Excellent	1- Excellent	1- Excellent	As new / No defect	1- Excellent
14556	Localised	1- Excellent	1- Excellent	1- Excellent	1- Excellent	As new / No defect	3 - Average
14555	Moderate	1- Excellent	1- Excellent	1- Excellent	4 - Poor	Moderate	Not Applicable
14554	Localised	1- Excellent	1- Excellent	1- Excellent	4 - Poor	Moderate	Not Applicable
14553	Localised	1- Excellent	1- Excellent	1- Excellent	3 - Average	Moderate	3 - Average
14552	Localised	2 - Good	1- Excellent	3 - Average	3 - Average	Moderate	3 - Average
14551	Moderate	2 - Good	2 - Good	2 - Good	2 - Good	Localised	2 - Good
14550	Localised	1- Excellent	1- Excellent	1- Excellent	2 - Good	Localised	2 - Good

2016 WCC Condition Assessment

Infomation in table provided by Wellington City Council

Asset ID	Erosion Protection (Extent)	Erosion Protection (Ext Notes	Overtopping of Waves: Cond
14588	Moderate		2 - Good
14587	As new / No defect		1- Excellent
14586	Not Applicable		5 - Very Poor
14585	Localised		1- Excellent
14584	Localised		4 - Poor
14582	As new / No defect		1- Excellent
14581	Localised		3 - Average
14579	Not Applicable	east end	1- Excellent
11203	Localised	north end,	1- Excellent
14577	Moderate	erosion at both ends of wall, 0.5m.sq at sth end	2 - Good
12278	Localised	south end maintenance required	2 - Good
11204	As new / No defect		1- Excellent
14574	Localised	nth end	1- Excellent
14573	As new / No defect		1- Excellent
11205	Not Applicable	sth end, 3m.sq removed , maintenance required	2 - Good
12279	Localised		1- Excellent
14740	Widespread	land behind wall is compromised,both ends and above	4 - Poor
14567	Localised	sth end 1m.sq	2 - Good
14566	As new / No defect		1- Excellent
14565	As new / No defect		1- Excellent
14563	Not Applicable		Not Applicable
14564	As new / No defect		1- Excellent
14562	As new / No defect		1- Excellent
14561	Moderate	east end side erosion	1- Excellent
14559	Localised	at both ends, 1m.cube of material removed.	1- Excellent
14558	Localised	east end, 2m from wall, erosion and under mining of bank. west end 1m.cube of material removed	1- Excellent
14557	As new / No defect		1- Excellent
14556	Moderate	4m of erosion at west end, beside wall	1- Excellent
14555	Not Applicable		5 - Very Poor
14554	Not Applicable		1- Excellent
14553	Severe	west end, severe 15m of undercutting bank, over road from dwelling	3 - Average
14552	Moderate		3 - Average
14551	Localised		5 - Very Poor
14550	Localised		3 - Average

2016 WCC Condition Assessment

Infomation in table provided by Wellington City Council

Asset ID	Overtopping of Waves: C Notes	Overtopping of Waves: Extnt	Overall Condition
14588		Moderate	2 - Good
14587		As new / No defect	2 - Good
14586	5m3 of material removed above wall	Moderate	4 - Poor
14585		As new / No defect	2 - Good
14584	over topping of waves causing scour along 20m section of wall	Moderate	3 - Average
14582		As new / No defect	2 - Good
14581		Localised	3 - Average
14579		As new / No defect	4 - Poor
11203		As new / No defect	2 - Good
14577		Localised	1- Excellent
12278		Localised	2 - Good
11204		As new / No defect	1- Excellent
14574		As new / No defect	1- Excellent
14573		As new / No defect	2 - Good
11205		Localised	3 - Average
12279		As new / No defect	3 - Average
14740	over topping along crest of wall and amongst bushes.	Widespread	4 - Poor
14567		Localised	4 - Poor
14566		As new / No defect	1- Excellent
14565		As new / No defect	1- Excellent
14563		Not Applicable	1- Excellent
14564		As new / No defect	1- Excellent
14562		As new / No defect	1- Excellent
14561		As new / No defect	2 - Good
14559		As new / No defect	3 - Average
14558		As new / No defect	1- Excellent
14557		As new / No defect	2 - Good
14556		As new / No defect	2 - Good
14555	over topping waves are causing the bank above to scallop and scour	Severe	4 - Poor
14554		As new / No defect	3 - Average
14553		Moderate	3 - Average
14552		Moderate	4 - Poor
14551	may not by due to over topping waves, however land above sea wall requires attention. 4x holes 2m across by upto 1m deep	Widespread	5 - Very Poor
14550		Localised	2 - Good

2016 WCC Condition Assessment

Infomation in table provided by Wellington City Council

Asset ID	Overall Condition Notes
14588	
14587	
14586	5m3 of material removed above wall. 2m section wth blocks and mortar removed below wall
14585	
14584	over topping of waves causing scour along 20m section of wall
14582	
14581	
14579	repair east end, eroded blocks and scour, 2m3
11203	
14577	
12278	
11204	
14574	
14573	
11205	sth end, 3m.sq removed , maintenance required
12279	
14740	over topping along crest of wall and amongst bushes. under mining at wst end blocks and mortar remover 1m2
14567	sth west end, 10m length, top rotating forward approx 80 degrees
14566	
14565	
14563	wall rebuilt by next wall
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14557	5 bricks along the top edge require replacement
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14555	over topping waves are causing the bank above to scallop and scour.
14554	Severe scour seen at east of wall by 5m, including under cutting of bank by 1m
14553	Local undermining seen at toe of wall.
14552	storm water pipes at sth end have blown out leaving 5x5m scarp.
14551	may not by due to over topping waves, however land above sea wall requires attention. 4x holes 2m across by upto 1m deep
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