REPORT

Tonkin+Taylor

Eastern Bays Shared Path Project

Consent Level Beach Nourishment Design and Effects Assessment

Prepared for
Hutt City Council

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Tonkin & Taylor Ltd

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Executive summary

Hutt City Council (HCC) commissioned Tonkin + Taylor (T+T) to carry out consent level design for the proposed beach nourishment that forms part of the shared path application along the Eastern Bays. The beach nourishment is proposed to be used as a strategy to mitigate loss of beach area available for beach amenity by nourishing the beaches with imported beach-compatible fill, with a secondary benefit of improved coastal protection.

An analysis of the existing beaches show that the beaches are narrow, steep, mixed sand-gravel intertidal beaches, with increasing sand content from York to Point Howard Beach. There are no fines smaller than 0.09 mm (90 microns) on the beach faces, with the absences of these fines being a result of the wave sorting processes acting on the beach face. The colour of both the sand and gravels tends to be light and browner than the darker grey sand and gravels that are migrating along the foreshore from the harbour entrance to Days Bay. This suggests that within the embayments north of Days Bay the cobbles, gravels and sand are likely to originate from the local catchments within each embayment.

A range of sources for nourishment were investigated at a high level, including from dredging of the Hutt River, winning sand from beaches to the south that have experienced extensive accumulation, from dredging of the CentrePort Channel and from quarries outside the Wellington Region. The Hutt River source is likely to be the most practical source for initial placement in terms of being a currently consented source and the ability to match grain size. It is noted that the colour of this source will mean a possible change in the visual characteristics of the beach, with greyer rather than brown sediments.

1 Introduction

1.1 Purpose

Hutt City Council (HCC) commissioned Tonkin + Taylor (T+T) to carry out consent level design for the proposed beach nourishment that forms part of the shared path application along the Eastern Bays. The beach nourishment is proposed to be used as a strategy to mitigate loss of beach area available for beach amenity by nourishing the beaches with imported beach-compatible fill, with a secondary benefit of improved coastal protection.

1.2 Scope of works

The objective is to develop nourishment design sufficient for consent submission for the priority beaches: Point Howard, Lowry Bay and York Bay. This report sets out the design parameters and the requirements for any additional control structures for beaches likely to require structures (if any).

Specific tasks include the following for HCC Project Controls Group:

- Sand source study to:
  - Identify potential sources, sediment properties and anticipated stable beach angle
  - Identify high level costs and delivery options for sand nourishment, and
  - Develop cost per bay of initial nourishment and for top up nourishment (and expected frequency).
- Assess effects arising from proposed nourishment at a level suitable for consenting, such as:
  - Sediment deposition thickness and footprint arising from nourishment activities
  - Extent and concentration of sediment plumes arising from construction
  - Develop preliminary construction methodology
  - Develop consent conditions including recommended monitoring conditions.

2 Design objectives and requirements

The overall project is focussed on improving safety for pedestrians and cyclists on Marine Drive, Eastbourne between:

- Point Howard and the northern end of Days Bay
- The southern end of Days Bay (Windy Point) to Eastbourne (Muritai Road/Marine Parade Intersection).

The road and shoulder width varies significantly over this corridor and additional width is required to achieve the design objectives and a widening of the road on the seaward side has been considered the most practicable option (Stantec, 2018). Where widening is required, the seaward edge will be a combination of concrete curved seawalls and rock armour revetment.

Beach nourishment is proposed at Point Howard, Lowry Bay and York Bay as a strategy to mitigate loss of beach area available for beach amenity. Nourishing the beaches with imported beach-compatible fill, has a secondary benefit of improved coastal protection.

A preliminary assessment of the nourishment design was done by Dr M. Allis of NIWA and has been reviewed by T+T. This assessment is included in Appendix A. The key objectives for the nourishment were to:

- Augment the existing beach areas to provide the same area of beach that is expected to be occupied by the seawall works where they extend beyond the existing seawall toe
- As far as possible to be within the existing beach footprint and not to increase the beach areas beyond the existing areas (except for temporarily during construction or to offset increased sediment loss rates after construction) so to avoid unnecessary adverse effects on intertidal and subtidal ecology and avifauna.
- It is noted that nourishment may also be used in the future to enhance "resilience" of Marine Drive and implemented as an adaptive managed option throughout the medium to long-term. i.e. the purpose is to maintain existing beach area/amenity and not to create new beach area/amenity.

3 Existing beach sand properties

This section provides a brief description of the existing sand properties and beach profile. The assessment is based on site observations made during a site visit on 3 December 2018 and information contained in reports by NIWA (2018) and GHD (2015). Sand samples were obtained at Lowry Bay and York Bay and augmented the earlier sampling carried out by GHD (2015). Subtidal sand samples were also undertaken to characterise the nearshore sediment characteristics in each bay. The locations of the samples and particle size distribution curves for the beach and nearshore samples are included in Appendix B. Appendix B also includes photographs of the dried subtidal samples.

A general observation of the beach sediment is that the beaches comprise mixed sands and gravels, with increasing sand content from York to Point Howard Beach. Generally the beaches comprise around 80% gravels, ranging from fine to coarse and the remaining 20% comprises generally medium to fine sands. There are no fines smaller than 0.09 mm (90 microns) on the beach faces, with the absences of these fines is a result of the wave processes acting on the beach face. The colour of both the sand and gravels tends to be light and browner than the darker grey sand and gravels that are migrating along the foreshore from the harbour entrance to Days Bay. This suggests that the gravels and sand is likely to originate from the local catchments within each embayment.

The nearshore sediment off Point Howard Beach and York Bay generally comprise 30-50% of gravels and the remaining portion comprising very fine sands with small (less than 2% silts). The seabed off Lowry Bay is generally sandy with no significant proportion of shells.

3.1 Point Howard Beach

Point Howard Beach extends along some 120 m of the shoreline and is a predominantly brown gravely sand beach with traces of shell (visually more than 90 of sediment is sand with the remainder gravels and shell with sizes up to 20 mm) (see Figure 3-1). Due to their shape and behaviour during the wave breaking process, gravels are typically located on the upper beach area with finer sediments or mixed sediment gradings along the intertidal beach area and finer sands on the sub-tidal area. The intertidal slope is around 1(V):12.5(H). While no beach sample was taken for Point Howard, based on visual comparison with Lowry Bay, the D_{50} for the sand faction is around 0.3 mm (300 microns). The beach is covered with wood debris and seaweed. Anecdotal comments from a local resident during the site investigation is that the volume of drift wood has increased since the improvement works on the Hutt River.

The nearshore sample shows around 50 percent coarse with fine sands. The photographs in Appendix B show a mix of whole shells and gravels comprise the coarser factions.

Figure 3-1: Point Howard Beach

3.2 Lowry Bay

Lowry Bay beach extends along some 450 m of Lowry Bay and comprises sandy fine to coarse gravel with minor broken shell (see Figure 3-2). Due to their shape and behaviour during the wave breaking process, gravels are typically located on the upper beach area with finer sediments or mixed sediment gradings along the intertidal beach area and finer sands on the sub-tidal area. The intertidal slope is around 1(V):14(H), although the upper beach tends to be steeper. Particle grading curves for the high tide and low tide are included in Appendix B. Similar to Point Howard beach, the D_{50} for the sand faction is around 0.3 mm (300 microns), but sand make up some 30 percent of the upper beach with larger gravels comprising the remaining volume. At the lower beach there is a greater proportion of sand (around 70%).

The nearshore sediment is generally fine sand, although one of the samples also included a significant quantity of whole shells.

Figure 3-2: Lowry Beach upper beach area

3.3 York Bay

York Bay beach extends along some 150 m of York Bay and comprises predominantly coarse gravel with minor broken shell (see Figure 3-2). The intertidal slope is around 1(V):12(H), although the upper beach tends to be steeper. Particle grading curves for the high tide is included in Appendix B. The high tide beach comprises some 80% gravels with the remaining portion comprising medium sands.

The nearshore subtidal area also comprises mixed sand gravel at the south fining to more sandy substrates to the north (Appendix B).

Figure 3-3: York Bay beach

4 Sand sources

Design guidance for imported beach nourishment recommends use of a similar to slightly coarser sediment than the native sediment as this will provide a similar slope, look and feel to the existing beach. Colour of sediment is another consideration for visual consistency. Possible sand sources are discussed in the sections below. Ensuring low fines is also important to reduce risks of increased turbidity with fines washing out into the Coastal Marine Area. Sourcing sand from marine areas subject to reasonable wave and tidal flows can assist in ensuring lower levels of fines in the borrow material.

4.1 Sand from accumulation areas of the foreshore south of Eastbourne

As documented in the NIWA (2018) report based on Olson (2009) there has been significant accumulation along the eastern shoreline from Pencarrow Head to Eastbourne since the 1853 earthquake that provided significant volumes of gravels from the Orongoronga River. Visual inspections were made of areas south of Eastbourne (Figure 4-1) and sediment samples were taken (refer Appendix B) along mid and lower beach. Much of the beach sediments in the intertidal area comprise grey fine gravels, but there are also areas of brown sand and lighter gravels on the upper intertidal area before transitioning into finer gravels in the backshore.

Figure 4-1: Areas of sediment accumulation south of Eastbourne

Processing of the sediment would be required for Point Howard beach nourishment to provide a greater proportion of sand. However, the gravel sand combination is of a similar proportion to Lowry and York Beaches.

In terms of coastal processes, this source could be seen as speeding up the natural process of sand/gravel migration up the Eastern edge of the Harbour, although it is possible that this natural migration might not ever extend as far as Point Howard Beach.

To our knowledge there are no consents in place to take beach sediment for beach nourishment and consents would need to be obtained for this source. However, in terms of haulage and access, is the closest source of similar sand to the priority areas.

4.2 Hutt River

GWRC actively manage the aggradation in the lower Hutt River by dredging, with processed sand sold for construction. This means that there are already consents in place for the activity of extraction. Particle grading curves including in Appendix B show that this sediment would need to be processed to derive an appropriate grading for the different beach areas, but that there is sufficient sediment for the project. The main requirement for the grading is removing the finer factions and retaining the sand and gravel. It is noted that the colour of the sand and gravel is darker than the existing native beach sediments along the priority beaches. The Hutt River sand tends to be greyer as indicated by the beach sands along the Petone foreshore (refer Figure 4-2).

There is currently a processing area adjacent to the river entrance and a relatively short haulage distance to the priority beaches.

Figure 4-2: Petone Beach showing fine dark grey sand

4.3 Dredging from Wellington Harbour

CentrePort Ltd have existing consents to dredge the shallow parts of the main channel that were obtained in 2005. Based on studies carried out at the time, there is a wide range of sediment types along the harbour entrance, with sediment ranging from gravels to silt. In the more active parts of the channel the sediment is predominantly free of silts, but there are locations with significant silts (refer the four representative gradings included in Appendix B). The colour of these sediment are typically black to dark grey, similar to the Hutt River sediment properties.

There is currently no dredging proposed by CentrePort, but a channel deepening application is being considered in the next few years. This means that to obtain this sand there would need to be dredging activity and possibly processing to obtain the right grading of sediment for the beaches.

Due to the shallow depths adjacent to the beach, these sands would need to be barged to an appropriate location, unloaded, transported to a site for processing before being trucked to site, involving significant handling. Alternative options, such as slurry pumping are unlikely to be economic due to the size of the material, the relatively small volumes and the lack of space on the foreshore to discharge.

4.4 External sources

Existing quarries can also be considered for processed sand. As part of the Oriental Bay re-nourishment (T+T, 2007) a range of alternative options were investigated including Ferny Hill (Mosgiel) and Black Head Quarries (Cameron Pit). These sands and gravels are quartz that was selected to match the existing sand at Oriental Bay and sample gradings for these sites are also included in Appendix B. It is noted that sand would need to be processed and trained in containers to the port for unloading and trucking to site.

While processing is likely to provide a good match for the in-situ sediment, alternative quarry locations would need to be investigated for a closer colour match to the priority beaches, but it is likely that lighter cobbles and gravels with similar greywacke composition could be sourced.

4.5 Summary

The Hutt River source is likely to be the most practical source for initial placement in terms of being able to match grain size, but it is noted that the colour of this source will mean a change in the visual characteristics of the beach, with greyer rather than brown sediments.

Investigating winning sand from areas where there has been ongoing accumulation along the southern ends of the eastern shoreline of Wellington Harbour may be a lower cost, with sand/gravel grading that closely matches the in situ sediment and sand colour that is also more closely matching the in situ sediments of the priority beaches.

There are many other sources that might be suitable from Wellington Harbour (such as from dredging of the CentrePort channel) and quarry sites outside the Wellington Region, but all these options are likely to have higher transport costs compared to the two options identified above and may require more processing to match grading requirements.

5 Beach nourishment design

A full description of the Project, including its components and construction, is contained in the resource consent application for the Project. This guidance memo is based on the Preliminary Design Plans (Revision J, Appendix N of consent application), and the Design Features and Construction Methodology report (Stantec 2018, Appendix J of the Resource Consent Application).

The beach nourishment is proposed only along those parts of the shoreline where there are existing high tide beaches at York Bay, Lowry Bay and Point Howard. The beach nourishment design includes the selection of the sediment properties, an evaluation of beach volume requirements and the plan form extent of the proposed work.

5.1 Sediment properties

It is assumed that all imported sediment would be of a marine source of processed to remove fines, so only comprise minor portions of silt (typical beach sediments can have 2-3% of silt which is defined at being less than 63 microns (van Rijn, 2014), but in this instance we recommend no more than 2% passing 150 microns to more closely match the in situ sediment properties. Grading out the sand size factions (say below 300 micron) would provide a slightly steeper grading.

It is noted that these conditions are met with the samples obtained from the Hutt River and southern beach sources and were also met by the processed sand from Otago quarries (refer Appendix B).

5.2 Beach volume requirements

The beach volume that is required to offset the occupation of the shared path was initially estimated by Dr Allis (refer Appendix A) and reviewed by T+T.

The volume was derived from the area of the foreshore occupied by the shared path over the effective length of the beach and the depth of the beach system. It was assumed that the proposed beach would have a similar slope to the in situ beach area. The proposed volume was then reduced by taking into account the retention of existing beach sediment from the footprint of the proposed shared path on the beach seaward of the proposed shared path.

Table 5-1 shows the effective beach length and the minimum proposed nourished length. This nourishment length is less than the effective beach length to provide a shorter area where the beach sediment can be placed, with the expectation that coastal processes will assist in redistributing the sediments within the embayment. Therefore it is expected that the placed sediment will move and adjust from the post construction placement.

It is noted that this table includes a rounded total and includes for bulking (i.e. this is the volume to be imported with an expectation of a smaller volume being retained on the foreshore due to settlement of the placed sediment. Around 6,000 m^3 of sediment will need to be imported, but will rapidly consolidate to around 4,600 m^3 when place. Our experience with Oriental Bay beach nourishment is that tidal action and construction trafficking enables consolidation to occur over periods of days to weeks.

This table shows that between 11.5 to 15.4 m^3 per linear of metre could be placed, but with redistribution along the effective beach length, the volumes reduce to around 5.5 to 10.3 m^3 per linear metre.

Table 5-1: Beach extents and imported sand volumes

Beach	Effective beach length (m)	Linear length nourished (m)	Volume imported[1] (incl. 1.3 x overfill) m^3	Placed volume with linear placement after consolidation (m^3/lin.m)	Expected Average volume (m^3/lin.m)
Point Howard	120	80	1,600	15.4	10.3
Lowry Bay	450	160	3,200	15.4	5.5
York Bay	150	80	1,200	11.5	6.2
Totals	720	320	6,000	-	
1 volumes rounded up to nearest 100 m^3 from calculations by Allis M. (email 29/11/2018)					

5.3 Planform

Over time it is anticipated that the proposed beach area will be the same as the present day effective beach length shown in Table 5-1 and will follow the contours of the existing upper beach. However, a shorter and wider beach is proposed for the initial placement and the constructed beach planform based on the nourishment area are shown in Appendix D for the three bays. These placement areas are situated at the widest area of beach with the most substantial high tide area and the extents are designed not to extend across significant stormwater outlets. However, over time the imported material will be re-distributed along each bay and will respond to the incident wave energy and direction in a similar way to the existing beach sediment.

6 Construction

General construction approaches are set out in general terms in the Design Features Report (Stantec, 2018), while recognising that the construction planning will be done by the Contractor awarded to deliver the project. This section provides more detailed assessment specific to the beach nourishment process based on our assessment of the likely construction processes.

6.1 Preparation of existing beach

In terms of beach nourishment design it is anticipated that the existing beach sediment that are present both within the proposed footprint and immediately seaward of the construction area will be moved down the beach face prior to the construction of the shared path structure rather than removing and stockpiling. This is enable foundations to be formed and to retain the material on the foreshore to provide a buffer against coastal processes. It is the same method proposed to provide a bench for the beach nourishment.

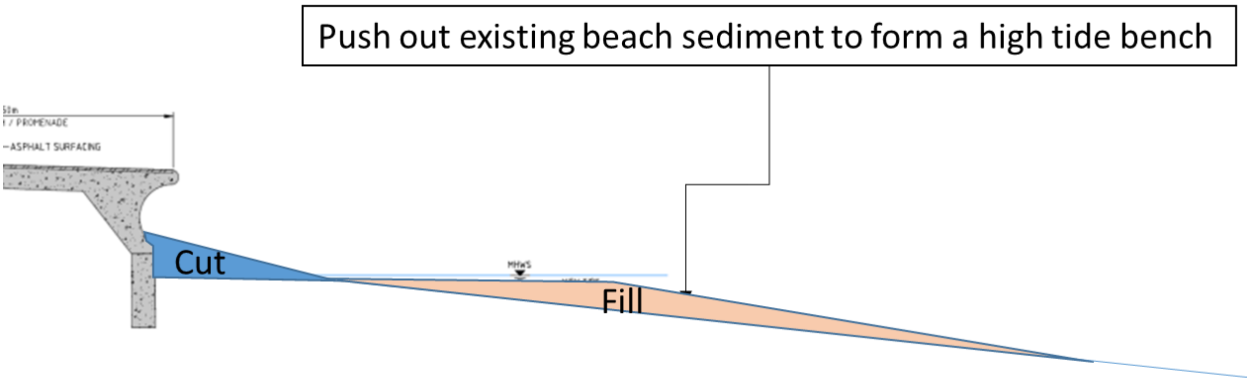

Figure 6-1 Sketch showing initial high tide bench formation moving existing beach material from the upper beach to the lower beach

Forming the bench likely to initially be done by a hydraulic excavator operating along the crest of the existing wall, although once the bench is formed, it could be carried out with machinery working along the upper part of the beach adjacent to the existing seawall during low tide periods (i.e. when two hours either side of low water). During the construction of the shared path it will be limited to the immediate area of the works planned for that period plus a transition zone of around 20 m either side of the work area.

The existing sediment will be pushed immediately seaward of the proposed wall, but it is expected to be largely above the existing beach footprint, creating an over-steepened upper intertidal beach face within the existing footprint of the beach (typically with a seaward slope of 1(V):5 to 1(V):4(H) depending on the reach of the excavator). Over the construction process this sediment will be transported down and along the beach face depending on the incident wave conditions, with the next result being a slight increase in levels along the beach area. It is noted that this activity may need to be done several times during the construction of the path and immediately prior to importing beach sediment, as wave action is likely to move the material back up the beach face.

For the placement of imported beach sediments it is assumed that the sediment will be transported to site by truck or be brought to site by barge.

6.1.1 Truck placement

For truck placement, sediment could either be:

- unloaded from the truck to a discrete location and transferring along the beach seaward of the shared path
- end tipped along the extent of the proposed beach.

It is anticipated that a single deposition location will be preferable within each bay and the nourishment material would be placed on the foreshore on the formed high tide bench. The sediment would then be transferred along the bench during low tides to form a beach berm, or crest around 0.6 m above MHWS and a seaward slope of around 1(V):4(H). Sketches of the expected occupation of the constructed beach nourishment for Point Howard, Lowry Bay and York Bay Beaches are included in Appendix D.

An alternative to a single deposition location would be to progressively end tip to the formed high tide bench along the extent of placement, with the profile shaped with hydraulic excavators to achieve the post construction profile. In both cases there will be the requirement to form the high tide bench (see Figure 6-1 for the sketch of bench formation) and the resulting as constructed beach would be the same.

Where it is proposed to place at one location, the supply of sediment would be balanced with the rate of sediment able to be moved along the bench by hydraulic excavators working along the bench, to avoid placing too large a volume on the upper beach bench. The initial placement area will be selected to avoid stormwater outlets (no closer than 10 m) as well as being as distant as possible from areas of sea grass.

6.1.2 Barge placement

Barge placement is an alternative to trucking and would bring in the sediment by sea. This is likely to need relatively shallow draft barges coming into the bay and landing on the beach at high tide, with unloading of the barge by hydraulic excavator. The remainder of the process of distributing sediment along the beach area would be similar to the approach discussed in the section above.

6.2 Anticipated movement of placed sediment

With the linear placement the sediment on a formed bench, it is expected that initially the cross-shore transport is main transport process, with sediment moving down the beach face during periods where wave action is sufficient to generate waves during the upper stages of the tide (typically during mid tide and higher tide levels). This would result in the landward retreat of the beach crest and a seaward movement of the beach toe. This process is expected to result in a beach face slope similar to the existing beach profile slope and sorting will occur with sands and gravels moving to their preferred location on the beach profile (refer Figure 6-2 and the sketches in Appendix D).

There will also be alongshore transport that will act to distribute the placed sediment wider within the embayment. The speed of this process will depend on the persistency of waves that are generated that break at an angle to the shoreline creating alongshore velocity vectors. It is likely that this will result in movement both to the south and north of the placed sediment. And this will result in a retreat of the placed sediment profile, with gains in the adjacent beach profile. In all instances of sediment transport, it will only be at the rate that the natural processes of waves, tide and wind allow. Due to the shape of the bays there is not anticipated to be any alongshore loss from the bay where the sediment is placed.

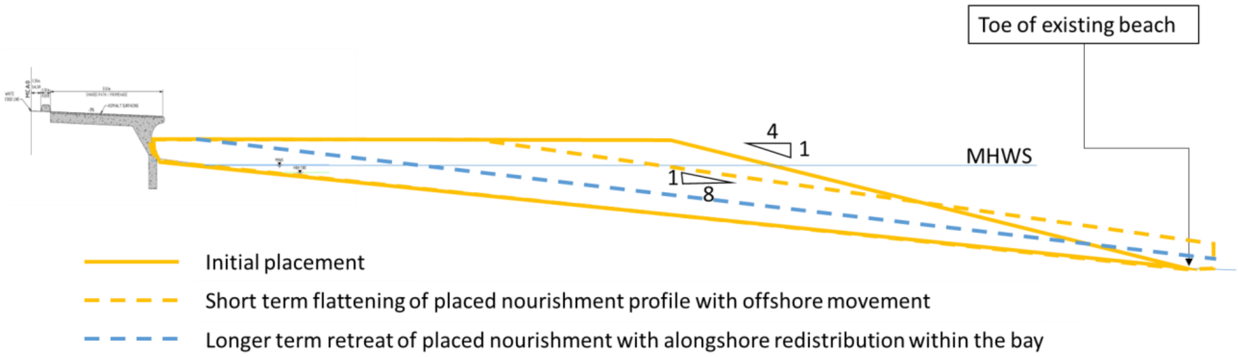

Figure 6-2: Illustration of sand nourishment placement and expected cross shore redistribution and landward retreat of the placed profile due to the alongshore processes

6.3 Control structures

Additional control structures are not proposed for these priority beaches. The priority beach areas appear to be largely headland controlled or within embayed areas so limited loss of the nourishment sediment from the embayed areas is expected, although there may be significant movement of the nourished sediment within the embayment following similar sediment transport processes as currently occur.

6.4 Ongoing re-nourishment

No on-going re-nourishment is proposed as part of this project. The nourishment volumes indicated in Table 5-1 provide a direct mitigation for the occupation of the shared path structure, but there is no enhancement, or betterment, of the existing beach area and no provision for the ongoing effect of sea level rise. This approach provides a balance with other values and concerns such as the potential risk to sea grass adjacent to the beach at Lowry Bay and the risk of increased stormwater blocking at the various outlets that discharge through the beach that may have potential effects on low flow flooding and migration of native fish species.

However, Council may wish to maintain volumes along the upper beach with losses associated with sediment redistribution (both alongshore and cross-shore). If this were required we recommend the same deposition process as describe for the initial construction works.

To determine the changes to the upper beach system and to confirm any sediment loss pathways, we recommend regular monitoring of the beaches to assess the performance of the placed sand and consideration of additional top-ups or structures depending on the outcome of the monitoring.

7 Coastal processes effects assessment

The potential effects of the beach nourishment on the coastal physical processes include both during the construction phase and over the longer term include:

Potential positive effects

- Retaining beach area seaward of the shared path where beaches are currently present.

Potential negative effects

- Burial of adjacent seagrass features and marine ecology along seaward edge of beach nourishment during construction (Lowry Beach is the only bay where there are stands of seagrass identified)
- Turbidity in the CMA during placement of the nourishment material (sediment plumes)
- Burial of adjacent seagrass features and marine ecology along seaward edge of beach nourishment due to profile flattening over time
- Blocking stormwater outlets.

These potential effects are assessed in the sections below.

7.1 Burial of seabed adjacent to the nourishment during construction

The risk of burial during construction of the subtidal seabed and any ecology that may be present relates to the seaward movement of the existing beach toe and the movement and depth of sand that might rapidly occupy the adjacent seabed. The potential risk of burial of important marine species that may be present along the toe of the existing beach during construction is mitigated by a construction process that:

- Carrying out the beach nourishment over the winter months where sea grass beds are not growing significantly
- Selecting sand/gravel gradings that match or are coarser than the in situ sediment which encourages onshore movement of sediment, rather than offshore
- Forming the high tide construction bench with a slightly over-steepened profile
- Only depositing as much sediment on the bench as can be transferred along the placement area in the day of placement
- Forming and shaping a steeper profile within the existing beach footprint (refer Figure 6-2)
- Placing imported beach sediment along the entire designated placement area rather than in one discrete location.

With these proposed actions, the risk of extending the seaward toe of the existing beach during the placement of the imported sand is considered low.

7.2 Turbidity in the CMA during construction

The release of fines from the imported beach nourishment is a potential risk to the flora and fauna present on the seabed adjacent to the work area and also may be visually unattractive. It is noted that there is an ambient, or existing background, level of suspended sediment that exists within the bays due to the finer sediment within the subtidal area and the wind generated waves that can occur. From the experience of nourishment at Oriental Bay with imported land-based processed sand, indicates a very small fringe of turbidity at the water level/beach interface was noticed, but rapidly (hours) dissipated after placement. For this project the potential risk of the generation of suspended sediment clouds that might add to the existing turbidity within the nearshore area is mitigated by:

- Selecting sand/gravel from a marine source that limits the potential release of minerals and fines typical of land based sources
- Selecting sand/gravel gradings that match or are coarser than the in situ sediment and restrict the proportion of finer material
- Forming the high tide construction bench with a slightly over-steepened profile so that the existing beach sediment are more exposed to typical wind and wave action
- Only transferring and shaping the beach profile during lower tide levels.

With these proposed actions, the risk of turbidity in excess of the ambient turbidity that can be experienced during wave conditions is considered low.

The main area potentially at risk is within Lowry Bay, where seagrass beds are in close proximity to the toe of the existing beach. The measures described above should be sufficient to limit the risk to these beds during placement of the nourishment. Additional measures to reduce the likelihood of turbidity include silt curtains on the landward side of areas of value (such as the sea grass). However, we do not recommend due to the likely disturbance during the installation and ongoing maintenance of these structures.

7.3 Burial of seabed adjacent to the placement area during beach profile adjustments

The movement of the beach profile to flatten its slope after the construction placement is likely to result in the seaward movement of sand and some encroachment seaward of the existing beach toe (refer Figure 6-2 and sketches in Appendix A), with the beach toe being defined as the location where the steeper intertidal beach face intersects with the shallower subtidal bathymetry. This process is expected to occur over a period of weeks to months largely during higher energy onshore events (storms).

In addition to the cross-shore movement, there is also the likelihood of the beach areas adjacent to the placement areas increasing in sediment depth due to along shore drift and this may also manifest as the seaward movement of the beach in these areas, while there is likely to be an associated reduction in beach volume from the constructed placement area. This process is likely to occur over a period of months to years.

The potential risk of burial of important marine species resulting from profile adjustments after construction has been completed is reduced by:

- Selecting sand/gravel gradings that are slightly coarser than the in situ sediment and a reasonable proportion of gravels results in a slightly steep natural beach slope for the same wave conditions and also encourages smaller rates of offshore movement of sediment (e.g. 10% coarse gravels, 70% medium gravels, and 20% sands and fine gravels ± 2 to 3%).
- Placing imported beach sediment along the entire designated placement area rather than in one discrete location.

The existing beaches comprise composite sediments ranging from medium/fine sands to cobbles and the slopes vary from 1(V):12(H) to 1(V):14(H), with generally steeper upper slopes comprising the more gravelly and cobble sediments and flatter lower slopes with more sandy compositions. The profile will move as a result of onshore wave action similar to the existing beach profiles dynamics. During storms it is likely that the finer sediments will move offshore and the coarse gravels will move more seaward. During calmer periods onshore movement of the coarser sediments can be expected.

To calculate the theoretical maximum increase in height of the beach at the toe of the existing beach, a volumetric assessment has been done based on the expected maximum increase in beach width assuming the same slope as the existing beach. The active height of the beach is around 2.5 m.

With a maximum volume of 15.4 m^3/m placed (refer Table 5-1) at Lowry Bay and Pt Howard beach, this results in a maximum net seaward shift of the beach profile by around 6 m (15.5 m^3/m divided by 2.5 m). The increase in beach height at the existing toe of the beach is up to 0.6 m tapering to 0 m at a distance of 6 m seaward of the existing toe based on the new beach matching the existing beach slope of 1(V):12(H). It is noted that a steeper slope, such as the initial adjustment expectation of around 1(V):8(H) will result in smaller depths of burial at the toe.

Due to the smaller volumes proposed to be placed at York Bay, the same process results in a maximum net seaward shift of 4.6 m (11.5 m^3/m divided by 2.5 m) and the increase in beach height at the existing toe being 0.36 m (3.6 m divided by 10 m) and tapering to 0 m at a distance 4.6 m seaward from the existing beach toe.

These dimensions are the theoretical maximum net extent of additional burial in addition to the natural processes that occur over a period of weeks to months after the beach nourishment has been completed. Longshore distribution is likely to reduce the actual volume as placed sediment will be distributed along a longer extent of the coastline, and the timing of the seaward movement of the profile will be dependent on onshore storm and higher wave energy events that enable the sediment to be moved. It is anticipated that the adjustment process would occur over weeks to months.

An alternative treatment to reduce the rate of burial would be to reduce the volume of placed gravels over two or three campaigns, and this would act to reduce the initial volume introduced, enabling the first placed volume to settle into the natural setting prior to placing the remaining volumes.

There is no risk to coastal processes with this activity, with the beach adjusting to the natural profile. Any potential effects on the adjacent seabed and ecological values would need to be assessed by the marine ecologist.

7.4 Blocking of stormwater outlets

During construction there is the potential for blocking of the stormwater. The potential risk of additional blocking is limited by

- Selecting sand/gravel gradings that match or are coarser than the in situ sediment which encourages onshore movement of sediment, rather than offshore
- Avoiding the initial placement from being within 10 m of an existing stormwater outlet.
- Only placing relatively small volumes of imported material, matched to the existing foot print loss
- Only depositing as much sediment on the bench as can be transferred along the placement area in the day of placement
- Placing imported beach sediment along the entire designated placement area rather than in one discrete location.

During the construction period the existing outfalls should be inspected and kept clear of gravels and sand.

The beach nourishment volumes proposed are to replace the existing beach area lost as a result of the shared path occupation on the upper beach. As there is no net increase in existing beach area it is anticipated over the longer term that there should be no net change to the existing processes of sediment transport along the beach areas.

7.5 Potential spill-over to rock platforms and reefs

The imported material is proposed to be placed on existing beach environments, but there are adjacent rocky outcrops and intertidal reefs. There is a potential risk that the alongshore transport of the placed sediment may smother some of these features.

We note the proposal does not aim to add any significant increase in beach area than exists within the existing system and the proposed borrow material will be similar to, or slightly coarser than the in situ, so coastal processes, such as the movement of sediment onto and off the rock shelves and reef areas is likely to be similar to that currently experienced.

It is noted that rock reef environments are typically at the edges of the more embayed beaches and are more exposed to energetic wave conditions. The sediment transport processes, including wave reflection of the adjacent seawalls, are likely to retain the placed sediment within the existing embayments. By their very nature, the rocky platforms create more turbulence and tend to retain sediment in suspension, meaning that there is little settlement of suspended sediment on these forms, further reducing the likelihood of smothering.

The potential effects of the distribution and spread of the placed sediment is low and no actions are proposed to restrict the natural coastal processes that will occur with the placed sediment.

8 Monitoring conditions

The following monitoring conditions are proposed:

8.1 Final design

A final beach nourishment design report and plans should be prepared and submitted 20 days prior to seeking tenders for the proposed work. The report should describe the selected source, a specification of the borrow material including median grain size, grading envelope and colours and extent of placement in general accordance with the sketches provided in the consent level beach nourishment design report and submitted to the consent authority for review and approval. The plans and details should be based on the latest survey information and the final shared path alignment. The surveys of the beach and seabed area should extend seaward to at least 3 m below Chart Datum and should include the nourished area and the foreshore at the base of the seawall extending at least 60 m along the seawall at both edges of the nourished area at York Bay and Pt Howard beach and 60 m to the south and 240 m to the north of the nourishment at Lowry Bay. The survey resolution should be of sufficient detail to identify significant changes in grade and the presence of key features such as reefs, stormwater outlets, stairs and access ways.

8.2 Construction

The consent holder shall submit a Construction Management Plan that included the beach nourishment work. The CMP should be submitted 20 days prior to the pre start meeting for the works. The purpose of the Construction Management Plan is to confirm the final project details and to ensure that all works are implemented and undertaken in a manner that avoids, remedies or mitigates potential adverse effects during the construction works.

8.3 Post construction

A monitoring plan should be prepared and submitted to GWRC for approval. Monitoring of the beach nourishment should be carried out and include surveys (topographic and bathymetric) of the completed work within one week of the beach nourishment being completed within each embayment. The surveys should include the nourished area and the foreshore at the base of the seawall extending at least 60 m along the seawall at both edges of the nourished area at York Bay and Pt Howard beach and 60 m to the south and 240 m to the north of the nourishment at Lowry Bay. Monitoring should be carried out every 6 months for a period of 2 years with a report completed after the 2 year period to assess the changes and make recommendations on the requirement for ongoing monitoring, or if the monitoring could cease.

9 Applicability

This report has been prepared for the exclusive use of our client Hutt 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.

Tonkin & Taylor Ltd

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
	p.p.
....	....
Richard Reinen-Hamill Technical Director – Coastal Engineering	Grant Pearce Project Director

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Appendix A: Preliminary assessment of the nourishment design

- **Memo and calculations dated 29/11/2018 by Dr M. Allis of NIWA**

This memo provides the preliminary design method proposed by NIWA and reviewed by T+T. Volumes relate to earlier designs and are not to be relied on and have been updated in the T+T report.

NIWA
Taihoro Nukurangi

Memo

From	**Michael Allis**
To	Simon Cager (HCC)
CC	Jamie Povall (Stantec) Caroline van Halderen (Stantec)
Date	24 August 2018
Subject	Eastern Bays Shared Path: Beach nourishment volume estimates
File path *(right click to update)*	*O:\HCC18201\Working\Nourishment design\HCC_EasternBaysSharedPath_Nourishment memo_v1.docx*

1. Introduction

The proposed Eastern Bays Shared Path is a Hutt City Council (HCC) Project focused on improving the safety for pedestrians and cyclists along 4.4 km of Marine Drive between Point Howard and Eastbourne (excluding Days Bay).

A full description of the Project, including its components and construction, is contained in the resource consent application for the Project. This guidance memo is based on the Preliminary Design Plans (Revision F[1], Appendix N of consent application), and the Design Features and Construction Methodology report (Stantec 2018b, Appendix J of the Resource Consent Application).

For the purposes of this memo, the Project can be described as the construction of a shared path by replacing seawalls alongside Marine Drive with the new seawalls extending beyond the existing seawall toe in most places. The overall shape of this encroachment is a thin rectangle alongside Marine Drive with 1.57 m average seaward encroachment over the 4.4 km length of the project. The net loss of coastal zone[2] from the new works is an area of 6954 m^2 (+/- 11) m^2 over both rock platforms and beach areas (Preliminary Design Plans, Revision F). Within that combined area, of particular interest is the loss of beach area available as a public amenity, which is an important consideration for mitigation of effects from the works and consenting. The sub-total area of beach loss over all bays is about 1,000 m^2 and varies by +/- 100 m^2 as the beach planform area changes with tidal elevation (Urban Design Report, Burns 2018).

This memo addresses beach nourishment as a strategy to mitigate loss of beach area available for beach amenity by nourishing the beaches with imported beach-compatible fill, with a secondary benefit of improved coastal protection.

Here we provide indicative volumes required for nourishment, possible construction methodology, and suggested monitoring and consent conditions for the Eastern Bays Shared Path project. The volumes required are only indicative estimates for the purposes of decision making. They are based on several assumptions and will require further refinement as more information becomes available, as the detailed Project design plans are updated and nourishment requirements evolve.

For a thorough review of beach nourishment concepts, refer to the Coastal Engineering Manual (2008, Part V Chapter 4: Beach Fill Design).

[1] All metrics which will may change with future design changes are highlighted throughout.

[2] Along the Eastern Bays the effective “coastal zone” encompasses all areas of subtidal (below lowest low tide), intertidal and supratidal (above MHWS but within wave runup, splashing and wind-affected areas) by assuming an average width of 200 m (approximately to the 5 m depth contour at 1:40 bed slope) (Allis, 2018).

2. Summary

A conceptual schematic of beach nourishment volume calculations is shown in Figure 1. Note that the beach width *W* is equal to the loss of beach width *W* by seawall encroachment at each tidal elevation only. No allowance is made for additional beach material to further widen or enhance the beach.

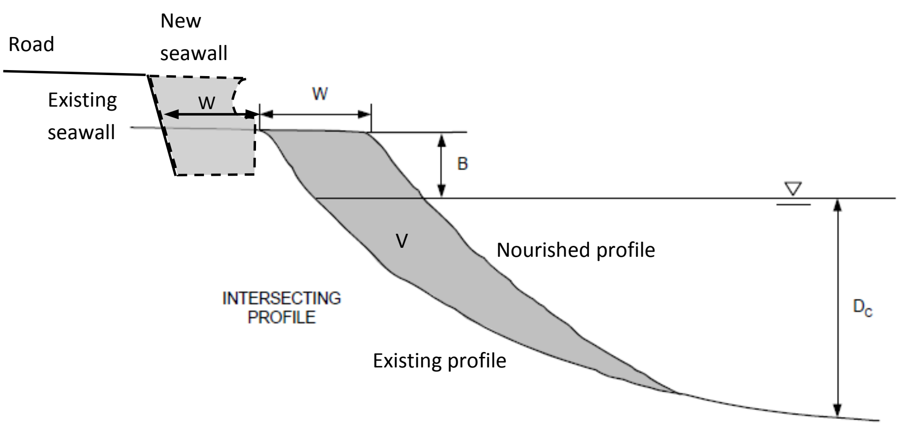

Figure 1 Schematic of beach nourishment as cross section through beach [not to scale]

The total volume of material required to mitigate the loss of beach area per bay is indicated in Table 1. In these calculations the beach width loss due to path encroachment is generally less than 1 m and will require updating if the encroachment area of components of the project change.

Table 1 Summary of nourishment volumes for each bay

Bay	Nourished beach length (m)	Beach width lost at high tide (m)	Total volume required including overfill (m^3)	Volume nourished by-proxy (m^3)	Volume required to import (m^3)
Point Howard Beach	120	0.75	356	90	266
Sorrento Bay Beach	40	0.00	163	24	139
Lowry Bay	450*	1.01	1785	453	1332
York Bay	150	1.05	848	158	690
Mahina Bay	225	0.56	500	127	373
Sunshine Bay	250	0.34	339	86	253

* Lowry Bay beach length at present day is 450 m historically (1958) it was approximately 530 m.

The following calculations establish that the general pattern across all Eastern Bays beaches is that for each 1 metre of beach width *W* lost (per length of beach) a volume *V* of 3 to 6 m^3 (per length of beach) of material needs to be deposited to allow for infilling down to the subtidal beach (see Figure 1).

At the time of writing (Aug 2018) we understand nourishment is proposed for three of the beaches with the timing of nourishment staged according to the multi-year construction schedule (See Design Features Report, Stantec 2018).

The three beaches considered are Point Howard Beach, Lowry Bay and York Bay. At the time of writing he total volume required to offset these beach area losses for a 2.5 m shared path through the nourished sections is about 2,800 m^3. Of this volume, a moderate proportion 700 m^3 is nourished by-proxy through the re-use of native beach material removed during foundation construction; therefore the requirement for imported beach fill is approximately 2100 m^3.

This indicative volume is anticipated to change if any of the below assumptions are changed.

- Width of pathway changes (i.e. widened from 2.5 m to 3.5 m along beach sections)
- Linear beach grade from high-tide to sub-tidal depth of closure (i.e. no inclusion of beach profile curvature)
- Well matched grain size distribution of imported material and native beach material.
- Fill is evenly distributed along the beach length by mechanical placement and further smoothed by wave/wind action
- The design volumes, construction method and expected life of fill relate to the relatively small volumes anticipated (i.e. offsetting the loss of approximately 1 m beach width beach). Larger fill programmes will require further analysis and detailed design.
- Nourishment is to offset loss of beach area at low, mid and high tide elevation only with no added fill to compensate for future volume losses due to sediment leaving the bay, no allowance for increasing the beach area or beach elevation beyond reinstating the existing beach dimensions. Further, no additional volume is included to compensate for future losses if climate change alters sediment supply/demand.
- No requirement for groynes or reefs to retain sediment on the beach. Some small groynes may be needed in the future to retain sediment on the beach in localised hot spots, or if the beach is made wider than designed here. But this decision may best be assessed through an adaptive plan via a monitoring and review step.

Detailed design of the nourishment programme should include comprehensive grain size analysis of native beach material, grain size analysis of potential borrow source material, assessment of potential sediment leakage rates between bays, control structure requirements, implementing cleanfill requirements on borrow material, and assessing ecological effects.

The below sections detail the calculation of the volume requirement, and outline important matters pertaining to the construction, operation, maintenance, monitoring and consenting of beach nourishment for the Project.

The guidance should be considered preliminary design, with all measures likely to change as new information comes to hand and expectations for the project are refined.

3. **Calculation method**

<u>Beach profile shape</u>

The existing and new beach profiles are assumed to be a linear slope. The existing beach slope has curvature (e.g. Figure 1) and assuming a linear profile gives a slightly conservative (high) volume estimate. The existing beach profile can be a good indicator of the expected post nourishment beach profile provided the nourishment material has similar grain size characteristics as the native beach.

The linear beach face slopes are assumed based on site inspections and measurements from Days Bay (4 - 7.6 degrees, Olson et al., 2012). Here we assume the beach faces are generally steeper than Days Bay, with Sorrento Bay the steepest beach. The beach slope varies within an embayment, and the values here are indicative and require measurement for detailed design.

The volume calculations are insensitive to assumed slope, however the area of seabed covered by nourished fill is highly sensitive to beach slope.

The beach length refers to the length of beach affected by Shared Path construction and is generally constrained by rock outcrops. The beach length is assumed to remain unchanged after Shared Path construction and beach nourishment, however sand will spread outside these bounds.

Table 2 Bay beach details

Bay	Beach length for nourishment (m)	Beach face slope (degrees)
Point Howard Beach	120	8
Sorrento Bay Beach	40	12
Lowry Bay	450	7
York Bay	150	8
Mahina Bay	225	10
Sunshine Bay	250	10

Area of beach area lost

The loss of beach areas available for beach amenity at each tidal stage are summarised in below from the Urban Design Assessment (Burns 2018). We understand Burns (2018) calculated these values from the Preliminary Design Plans (Revision F) where the specification was for a 2.5 m path width along the beach sections.

The tidal elevations refer to mean tidal elevations and not to MHWS (+0.82 m WVD-53) or MLWS (-0.43 M WVD-53). Refer to Allis (2018) for tidal elevations.

Table 3 Beach area losses for each bay [Source: Burns 2008, Preliminary Design Plans (Revision F)]

Bay	Tide stage elevation (m WVD-53)	Tide level	Beach area existing (m^2)	New beach area (m^2)	Change to beach area (m^2)
Point Howard Beach	-0.29	Low	2059	1992	-67
	0.195	Mid	1202	1132	-70
	0.68	High	426	335.6	-90.4
Sorrento Bay Beach	-0.29	Low	487	438	-49
	0.195	Mid	203	155	-48
	0.68	High*	0	0	0
Lowry Bay	-0.29	Low	6252	5726	-526
	0.195	Mid	3517	2994	-523
	0.68	High	1798	1344.8	-453.2
York Bay	-0.29	Low	3389	3132	-257
	0.195	Mid	1418	1169	-249
	0.68	High	520	362	-158
Mahina Bay	-0.29	Low	1994	1856	-138

	0.195	Mid	1135	996	-139
	0.68	High	478	351	-127
Sunshine Bay	-0.29	Low	1654	1573	-81
	0.195	Mid	1035	950	-85
	0.68	High	653	567	-86

* Sorrento Bay has no high tide beach at present day.

Depth of closure

The depth of closure D_c refers to the depth at which wave-driven mobilisation of sands on the seabed becomes minimal and the seabed elevation does not change materially over time. It indicates the depth where there is no longer significant net sediment transport between the nearshore and the offshore deeper water.

This is the idealised depth to which imported material will settle in a nourishment programme (e.g. Figure 1) and is central to calculating beach nourishment requirements. Other geomorphic processes control the seabed elevation offshore from this point (e.g. tidal currents).

The closure depth is closely related to wave exposure. Table 4 indicates that the largest storm waves have a greater influence on closure depth than the mean annual significant wave height.

Obtaining the depth of closure from measured sub-tidal beach surveys is preferred but this requires multiple surveys over several years which are not available for the Project. However, the calculated depth of closure appears to match with the transition in seabed slope from the single-survey profiles measured by GHD (2015).

Table 4 Depth of closure for each bay. [NB an offset + 0.43 m is used to convert MLW (chart datum) into WVD-53 (Hannah and Bell, 2012)].

	Method 1: Mean annual significant wave height H_s, where D_c=8.9H_s. (Housten 1995 and Kraus et al. 1998).			Method 2: Storm waves using the 0.1% annual exceedance probability (AEP) significant wave height H_s, where $D_c=2.28H_s-68.5(H_s^2/gT^2)$ *Hallermeier (1981) and CEM (2008, Eq. III-3-9)**				
Beach name	Wave height ** (m)	Depth of closure (m below MLW)	Depth of closure elevation (m WVD-53)	Wave height *** (m)	Depth of closure (m below MLW)	Depth of closure elevation (m WVD-53)	Max depth of closure (m WVD-53)	Depth of closure for nourishment calculation (m WVD-53)
Point Howard Beach	0.2	1.78	-2.21	1.50	2.44	-2.87	-2.87	2.9
Sorrento Bay Beach	0.2	1.78	-2.21	1.50	2.44	-2.87	-2.87	2.9
Lowry Bay	0.2	1.78	-2.21	1.50	2.44	-2.87	-2.87	2.9
York Bay	0.2	1.78	-2.21	1.37	2.30	-2.73	-2.73	2.7
Mahina Bay	0.2	1.78	-2.21	1.36	2.29	-2.72	-2.72	2.7
Sunshine Bay	0.2	1.78	-2.21	1.33	2.26	-2.69	-2.69	2.7

** The 0.1% AEP (annual exceedance probability) wave height) is used instead of the 0.137% AEP "wave height exceeded for 12 consecutive hours each year" specified by CEM (2008). This assumes a wave period of T=4 s due to the relatively short wind-fetch to generate waves (refer to Coastal Processes Assessment, Allis 2018).*
***Mean annual significant wave height (m) from MSL (2016) for Centreport dredging AEE. Refer to MSL (2016) Table 5.7 and Figure 5.26).*
**** The 0.1% AEP (annual exceedance probability) wave height from NIWA modelling (see Table 4.7 Coastal Processes, Assessment (Allis 2018).*

Excavation and nourishment by-proxy

The proposed construction methodology intends to excavate for the new seawall footing, stockpile native beach material on-site and backfill beneath the new seawall with no-fines concrete. In this way, the excavated volume of beach material will exceed the backfill volume resulting in previously buried native beach sediment being returned to the active beach. This re-used beach sediment can be considered beach nourishment by-proxy and should be offset to quantify the net loss of beach area, and reduce the requirement for importing beach material.

Here the proxy nourishment volumes assume an average 1.0 m deep excavation with the width based on the loss of beach width at high tide (refer to Figure 1), over the entire beach length.

These volumes assume the construction method follows that outlined in the design features report, and assumes a large proportion of excavated beach materials are native material suitable for re-use.

Table 5 Estimated volumes to be excavated from the existing beach

Bay	Volume of 1 m deep excavation based on loss at high tide over total beach length (m^3)
Point Howard Beach	90
Sorrento Bay Beach	24*
Lowry Bay	453
York Bay	158
Mahina Bay	127
Sunshine Bay	86

* Excavation calculated at 0.5 m deep at mid-tide because Sorrento Bay has no high tide beach.

Total volumetric requirement

The total nourishment requirement is calculated as the total volume (per bay) to offset the worst-case loss of beach width for all tidal elevations (Table 6). In most cases mitigating the high tide beach width loss controls the minimum nourishment volume, however at Sorrento Bay and York Bay the mid tide beach width loss controls the minimum nourishment volume (refer to Table 6, column 6).

The volumes are calculated assuming a level beach at the tidal elevation and include no allowance for the wedge of sediment above high tide via wind and wave action (ref. Figure 1).

An overfill factor of 1.1 is included to compensate for some volume losses due to bulking/compaction, losses during placement and small mismatches between grain size distribution of native and borrow material. The overfill requirement can be predicted using standard guidance when more detailed information about the native and borrow material size distributions is available.

Table 6 Total volume requirements to offset beach area losses at each tidal elevation

Bay	Tide stage*	Average beach width lost (m/m length)	Volume V required to offset loss of beach width at tide level (m^3/m length). $V=W(D_c+Z_{tide})$. CEM (2008, Eq V-4-6)	Total volume required over total bay length (m^3)	Minimum requirement to nourish at tidal stage (m^3)	Total volume required including 1.1 overfill factor (m^3)
Point Howard Beach	low	0.56	1.46	175	324	356
	mid	0.58	1.81	217		
	high	0.75	2.70	324		

Sorrento Bay Beach	low	1.23	3.20	128	149	163
	mid	1.20	3.71	149		
	high	0.00	0.00	0		
Lowry Bay	low	1.17	3.05	1373	1622	1785
	mid	1.16	3.60	1619		
	high	1.01	3.61	1622		
York Bay	low	1.71	4.47	671	771	848
	mid	1.66	5.14	771		
	high	1.05	3.77	566		
Mahina Bay	low	0.61	1.60	360	455	500
	mid	0.62	1.91	430		
	high	0.56	2.02	455		
Sunshine Bay	low	0.32	0.85	211	308	339
	mid	0.34	1.05	263		
	high	0.34	1.23	308		

* Tide elevations in m WVD-53: low = -0.29, mid = 0.195 and high = 0.68. Note that these represent an average tidal range and do not correspond to either spring or neap tides.

Volume of imported fill required

The total volume of material required to mitigate the loss of beach area per bay is indicated in Table 1 and Table 7. In these calculations the beach width loss due to the shared-path encroachment is generally less than 1 m and will require updating if the extent of encroachment changes in the design. A portion of this required nourishment volume can be offset by the re-use of excavated beach material left over from construction, the remainder must be imported from a suitable source with similar sediment characteristics.

The result of supplying this volume of sand to the beaches is expected to re-establish a similar width beach (after completion of the shared path) to the present situation, with a similar beach slope and sediment characteristics.

These calculations are caveated on several assumptions outlined in this memo, and will require updating as new information comes to hand and as the detailed design requirements evolve and/or and expectations of objectives for the project change.

Table 7 Summary of nourishment volumes for each bay

Bay	Nourished beach length (m)	Beach width lost at high tide (m)	Total volume required including overfill (m^3)	Volume nourished by-proxy (m^3)	Volume required to import (m^3)	Offshore distance of new sand placement (m from seawall)	Average depth change (m)
Point Howard Beach	120	0.75	356	90	266	57	0.05
Sorrento Bay Beach	40	0.00	163	24	139	47	0.09
Lowry Bay	450	1.01	1785	453	1332	65	0.06
York Bay	150	1.05	848	158	690	49	0.11
Mahina Bay	225	0.56	500	127	373	45	0.05
Sunshine Bay	250	0.34	339	86	253	45	0.03

The general pattern across all Eastern Bays beaches is that for each 1 metre of beach width *W* lost (per length of beach) a volume *V* of 3-6 m^3 (per length of beach) of material needs to be deposited to allow for infilling down to subtidal depths (see Figure 1). The offshore distance where the material for the new beach will settle is approximately 45-65 m from the new seawall (Table 7) but is sensitive to assumed beach slope and offshore seabed slope (1V:40H). The average bed-level increase over this distance is 0.03-0.11 m (Table 7). We anticipate the bed level will be up to 0.4 m higher at the beach face and tapering to ~0 m change at the depth of closure (refer to Figure 1 schematic).

4. Other matters

Native sediment

There is sparse information available on the sediment properties of each beach in the project area. Results from the 5 sediment samples collected by GHD (2015) show that sediments on all beaches are mainly composed of gravelly fine to coarse sand (0.2 mm to 0.8 mm) or fine to coarse gravel (1 mm to 10 mm). The finest median diameter d_{50} of 0.2 mm was observed in the single sample from Lowry Bay. Note that their samples were from Days Bay (2), Lowry Bay, Sunshine Bay and Rona Bay with Mahina Bay, York Bay and Sorento Bay assumed to have similar sediment characteristics.

More grain size information is available from Days Bay (Olson and Kennedy 2009, Olson et al. 2012) but this beach is not part of the Project and is discounted for this analysis on the basis that grain size decreases with distance north (refer to Stantec 2017 and Allis 2018) and will not be suitably representative of the northern beaches for nourishment design.

We recommend conducting a detailed sampling programme along beach transects to determine the properties of each beach where nourishment is proposed.

Imported sediment

Grain size characteristics are a critical design parameter. Consequently, finding an appropriate borrow source for imported material, to best match the properties and size of native beach sediments, is one of the most important factors for nourishment design. Generally, suitable material will have grain sizes predominantly in the fine to very coarse sand size range. Material with similar characteristics to those of the native beach are preferred to maximise compatability with the existing beach system, but also to simplify predictions of future project performance which are often based on past observations of the native beach response.

The presence of very fine sand, silt and clay in small amounts (up to 10%) is acceptable, but acknowledge that this fine fraction is usually lost offshore from the beach system during storms and hence a larger volume of material must be imported to compensate for that volume loss. The fine fraction must also be limited to minimise fine sediment (turbid) discharges to the coastal environment. The maximum percentage of fine sediments in imported materials also needs to be set as a consent condition to avoid excessive fine-sediment discharges to the CMA.

Other qualities of the imported sediment include the physical properties (e.g., grain size, colour, grain density, porosity) and chemical characteristics (e.g., contaminant levels). Here we assume fill complies with the Ministry for the Environment (2002) “Cleanfill” definition and therefore contaminants are not of concern. The colour of the imported sand and how it blends with the native sand may be important factors for the assessment of natural character.

The choice of a nourishment material with slightly different characteristics to native material may be made to satisfy a particular design objective. For the Eastern Bays project it may be advantageous to use slightly coarser sand than the natural beach sand. While this will result in a slightly steeper beach profile it will also improve the resistance to erosion, thereby enhance the stability and longevity. However, this needs to be weighed up against possible loss in beach amenity which is generally reduced with coarser beach material.

Note that the size distribution of imported material will need to be individually tailored to each bay to account for the bay-by-bay variations in particle size grading (i.e. finest at Point Howard Beach, coarsest at York Bay).

Construction process

The relatively small volumes required for the Eastern Bays project, multiple sites and phased construction process (years) suggests that truck-haul will be the most economic fill method via direct placement on the beach followed by reworking into the desired cross-shore shape using earthmoving equipment. Marine based construction placement is not suitable given the high establishment costs and small volumes of fill (e.g. barge-mounted excavator, pumped slurry discharge).

The “overbuilding” method is expected to be the most effective placement method. This involves “overbuilding” the upper part of the beach profile (intertidal and above) to the desired elevation (see Figure 2). However, the constructed beach width will be much greater than the design beach. This overbuilding allows natural wave and current action to redistribute the beach fill down to the deeper parts of the active beach profile. However, this results in a post-construction berm that is initially considerably wider than the target design width, often 2-3 times the design width (e.g. Figure 2). While recognized by project designers, it is often a source of frustration by locals to see the initially wide beach dramatically reduce over a storm or season. For this reason, consultation is important to educate the public and include easy to read information.

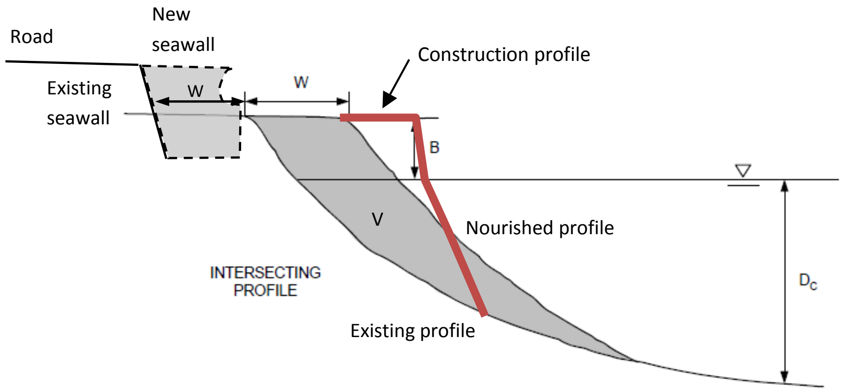

Figure 2 Schematic of beach construction profile using “overbuilding” method [Not to scale]

The “overbuilding” also minimises potential ecological and construction issues with placing beach fill material by machine below the water level, and allows for a slower dispersal of fine sediments by waves than machine-generated plumes. It also enables effective verification that the sectional fill volume (volume per unit length of shoreline) has been place on the beach by the contractor using standard land-based surveying techniques.

Control structures

The use of control structures is sometimes used to stabilise the nourished beach (e.g. lateral groynes, offshore breakwaters) and improve longevity of the beach between re-nourishment. However, structures such as groynes or breakwaters are comparatively more expensive and permanent than beach fill.

At this stage of the Eastern Bays Shared Path proposal, no requirement for groynes or reefs to retain sediment on the beach is anticipated, given the scale and scope of proposed nourishment (typically < 1m additional beach width required), and has not been included in this indicative analysis.

While we do not anticipate the Project requiring control structures at this stage, future detailed design and project optimisation may require an analysis of incorporating control structures to reduce periodic nourishment requirements versus the designing the project without stabilisation structures. If required, control structures will likely be small rock groynes at either end of the nourished beaches, integrated with the rocky outcrops and extending sub-tidally to the depth of closure (approx. -3 m WVD-53). Such control structures may be required in the future to retain sediment on the beach in localised erosion hot spots, or if the enhanced beach does not perform as anticipated. These future decisions could be part of an adaptive plan, following regular monitoring and a review of the effectiveness and acceptability of the beach nourishment in each bay.

Top-up nourishments

Top-up nourishments are anticipated to compensate for slow leakage of sand from each bay over time. In general, top-up nourishments should be anticipated (if monitoring indicates so) on 5-10 year intervals with 10-20% of the initial placement volume required depending on the measured loss rates (CEM, 2008).

These calculations have made no allowance of the volume, cost, frequency or effect of these top-up nourishments. This is because the Eastern Bays beaches are pocket beaches with longshore transport controlled by the headlands at either end and because present beach volume loss rates are small based on aerial photography. Also the new material will subtly alter the natural coastal sediment transport patterns so future loss rates could alter (i.e. future loss rates will be greater than present day but by an unknown amount).

A monitoring programme is essential to establish the performance and future needs of the nourishment project, and to respond to community concerns around the change to the beach planform and beach profile. The monitoring plan must quantify the beach volume loss rate to inform and forecast future top-up nourishment requirements.

Alternatively, the future loss rates could be forecast using assumed loss rates, and used to inflate the initial nourishment volume to compensate for predicted losses in the future. There may be efficiency and cost savings through placing a large volume at the initial placement with a longer interval before top-up nourishments.

Monitoring

Nourished beaches are soft structures which respond dynamically to changing water levels and waves, similar to natural beaches. The dynamic behaviour of a beach together with the need to ensure project functionality over the design life requires that a systematic monitoring plan needs be established for beach fill projects. The main monitoring elements recommended for to establish the performance of the Project are:

- Beach profile surveys beyond the depth of closure (monthly for 6 months, then 3 monthly for 1 year, and annually thereafter),
- Beach sediment sampling (pre-fill, post-fill, annually for 2-5 years or longer),
- Shoreline photography, either aerial or land-based (as frequent as sediment sampling).
- Contingency for post-storm profile surveying and photography.

The monitoring surveys are used to establish the performance of the nourishment project, how the borrow material mixes with the native material, and guide timelines on future “top up” renourishment programmes.

Conditions for consent

Important points to consider in advancing the project and consent conditions include:

- Specification of the size distribution in borrow materials (i.e. a median grain size and an envelope of acceptable grain sizes)
- Specify the maximum/reasonable percentage of fine sediments in borrow materials to limit turbid discharges to the coastal environment.
- Consider the metric of the beach amenity that is required to be maintained. For example, retaining the existing width (or a width we define) of beach at high tide with an allowance for +/- metres averaged over 24 months and/or coarseness of the beach sediment
- Consider the timeframe of the beach maintenance e.g. maintaining beach condition for N years, or the life of the consent, or in perpetuity, or until supplanted by a long-term HCC adaptation plan,
- Consider the timing and frequency of any necessary beach top-up nourishments e.g. completed by November in any year, and carried out no more than once in every two-year period (may also require a particular season to be avoided for ecological reasons).

Further information requirements

A more detailed study should include gathering more information about key parameters for beach nourishment design. Some suggested steps to develop the design include:

1 – Determine properties of native beach material and identify target parameters for borrow material within each bay (e.g. grading, colour, particle shape, density, porosity). This requires measuring the sediment size distribution for each beach by taking multiple samples along each beach between the crest and depth of closure (-3 m WVD-53), including samples from the surface and below ground level.

2 – Obtain sediment size distribution for potential borrow sources, assess options for multiple sources and specify if any blending or sieving requirements to match target parameters.

3 – Re-evaluate volumetric analysis to establish imported material requirements and costs.

4 – Detailed assessment of present-day beach volume changes

5 – Establish the short and long-term economic costs once further information is received.

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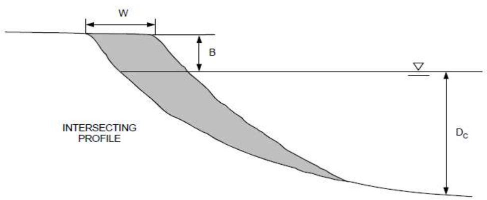
Stantec (2018) Eastern Bays Shared Path: Design Features Report. Prepared for Hutt City Council. DRAFT, March 2018: 24.

Berm height = high tide = 0.68 m WVD-53 [B]	0.68	Memo TABLE 3: Beach areas from EOS calulations (29-11-2018): RevJ F				Closure Depth	Beach details					Beach widths (average)		
Beach name	Tide stage elevation	Tide stage	Existing beach area (A)	New beach area	Seawall encroachment onto beach area	Depth of closure for calculation [Dc]	Beach length	Beach slope	Beach slope	Beach slope	Distance offshore to depth of closure assuming linear profile	Average existing beach width [A/L]	Average new beach width	Change to average beach width without nourishment [W]
Units	(m WVD-53)	-	(m^2)	(m^2)	(m^2)	(m WVD-53)	(m)	(degrees)	(1V:?H)	-	(m)	(m)		
Point Howard Beach	-0.29	low	2135	1770	-365	2.90	120	8	7.1	0.141	20.6	17.8	14.8	3.04
	0.195	mid	1219	854	-365							10.2	7.1	3.04
	0.68	high	399	229	-170							3.3	1.9	1.42
Sorrento Bay Beach	-0.29	low	435	394	-41	2.90	40	12	4.7	0.213	13.6	10.9	9.9	1.03
	0.195	mid	186	145	-41							4.7	3.6	1.03
	0.68	high	15	0	-15							0.4	0.0	0.38
Lowry Bay	-0.29	low	6513	5666	-847	2.90	450	7	8.1	0.123	20.6	14.5	12.6	1.88
	0.195	mid	3561	2786	-775							7.9	6.2	1.72
	0.68	high	1855	1123	-732							4.1	2.5	1.63
York Bay	-0.29	low	2531	2255	-276	2.70	150	8	7.1	0.141	19.2	16.9	15.0	1.84
	0.195	mid	1022	787	-235							6.8	5.2	1.57
	0.68	high	366	223	-143							2.4	1.5	0.95
Mahina Bay	-0.29	low	2755	2488	-267	2.70	225	10	5.7	0.176	19.2	12.2	11.1	1.19
	0.195	mid	1637	1277	-360							7.3	5.7	1.60
	0.68	high	720	351	-369							3.2	1.6	1.64
Sunshine Bay	-0.29	low	1604	1473	-131	2.70	250	10	5.7	0.176	19.2	6.4	5.9	0.52
	0.195	mid	1022	884	-138							4.1	3.5	0.55
	0.68	high	648	537	-111							2.6	2.1	0.44

Sum of beach areas (all beaches)

Tide	Existing (m^2)	New (m^2)	Change (m^2)
low	15973	14046	-1927
mid	8647	6733	-1914
high	4003	2463	-1540



Assumptions (all beaches)

Sand is even distribution along the beach 2.6 t/m^3

Well matched borrow material and native material grain size distribution (very important)

Assumes linear cross-shore profile

Assumes linear alongshore beach (no inclusion of beach curvature)

Assumed sand bulk density

Existing beach profiles are reasonably healthy

Nourishment is purely to offset loss of area not to address sediment deficits in the profile

Control structures not required

Intersecting beach design profile

Total nourishment requirements					Memo Table 5: Proxy nourishment volumes	Import volume requirements	Check on outcome after nourishment				
Volume required to offset loss of beach width to tide level [V=W(Dc+B)]	Total volume required over bay length	Max volume required over all tide levels	Overfill factor (loss factor at placement)	Total volume required including overfill [V_total]	Volume of 1m deep excavation over bay length based on loss at high tide [V_proxy]	Volume required to import [V_import = V_total - V_proxy]		Vol placed (excl bulking)	average beach width at tide stage after nourishment V/(L*(Dc+B))-W	Change to beach area after nourishment	New beach area at tide stage after nourishment
(m^3/m length)	(m^3)	(m^3)	-	(m^3)	(m^3)	(m^3)		(m^3)	(m)	(m^2)	(m^2)
10.9	1307	1307	1.3	1699	170	1529	3.04	1307	1.13	136	2271
10.9	1307	Low					3.04		0.48	57	1276
5.1	609						1.42		1.63	195	594
3.7	147	147	1.3	191	21	170	1.03	147	0.38	15	450
3.7	147	Low					1.03		0.16	6	192
1.3	53.7						0.38		0.65	26	41
6.7	3032	3032	1.3	3942	732	3210	1.88	3032	0.70	315	6828
6.2	2775	Low					1.72		0.45	205	3766
5.8	2621						1.63		0.26	115	1970
6.2	933	933	1.3	1213	143	1070	1.84	933	0.74	111	2642
5.3	794	Low					1.57		0.58	87	1109
3.2	483						0.95		0.89	133	499
4.0	902	1247	1.3	1621	369	1252	1.19	1247	1.11	251	3006
5.4	1217	High					1.60		0.31	71	1708
5.5	1247						1.64		0.00	0	720
1.8	443	466	1.3	606	111	495	0.52	466	0.25	63	1667
1.9	466	Mid					0.55		0.09	23	1045
1.5	375						0.44		0.11	27	675

	All beaches			
	Total vol excl bulking (m^3)	Total vol incl bulking	Total proxy volume (m^3)	Total import volume (m^3)
Rev J	7132	9272	1545.5	7726.5
Rev F	4011	5215	939	4276
Change from Rev F	3121	4057	607	3450
Change from Rev F (%)	77.8	77.8	64.7	80.7

	Beach length fo	beach slope (degrees)	
Point Howard I	120	8	20.6
Sorrento Bay B	40	12	13.6
Lowry Bay	450	7	20.6
York Bay	150	8	19.2
Mahina Bay	225	10	19.2
Sunshine Bay	250	10	19.2

Memo TABLE 6

Bay	Tide stage*	Average beach width lost (m/m length)	Volume V required to offset loss of beach width at tide level (m^3/m length)	Total volume required over total bay length (m^3)	Minimum requirement to nourish at tidal stage (m^3)	Total volume required including 1.3 overfill factor (m^3)
Point Howa	low	3.04	10.89	1307	1307	1699
	mid	3.04	10.89	1307		
	high	1.42	5.07	609		
Sorrento B	low	1.03	3.67	147	147	191
	mid	1.03	3.67	147		
	high	0.38	1.34	54		
Lowry Bay	low	1.88	6.74	3032	3032	3942
	mid	1.72	6.17	2775		
	high	1.63	5.82	2621		
York Bay	low	1.84	6.22	933	933	1213
	mid	1.57	5.30	794		
	high	0.95	3.22	483		
Mahina Ba	low	1.19	4.01	902	1247	1621
	mid	1.60	5.41	1217		
	high	1.64	5.54	1247		
Sunshine B	low	0.52	1.77	443	466	606
	mid	0.55	1.87	466		
	high	0.44	1.50	375		

Memo TABLE 7

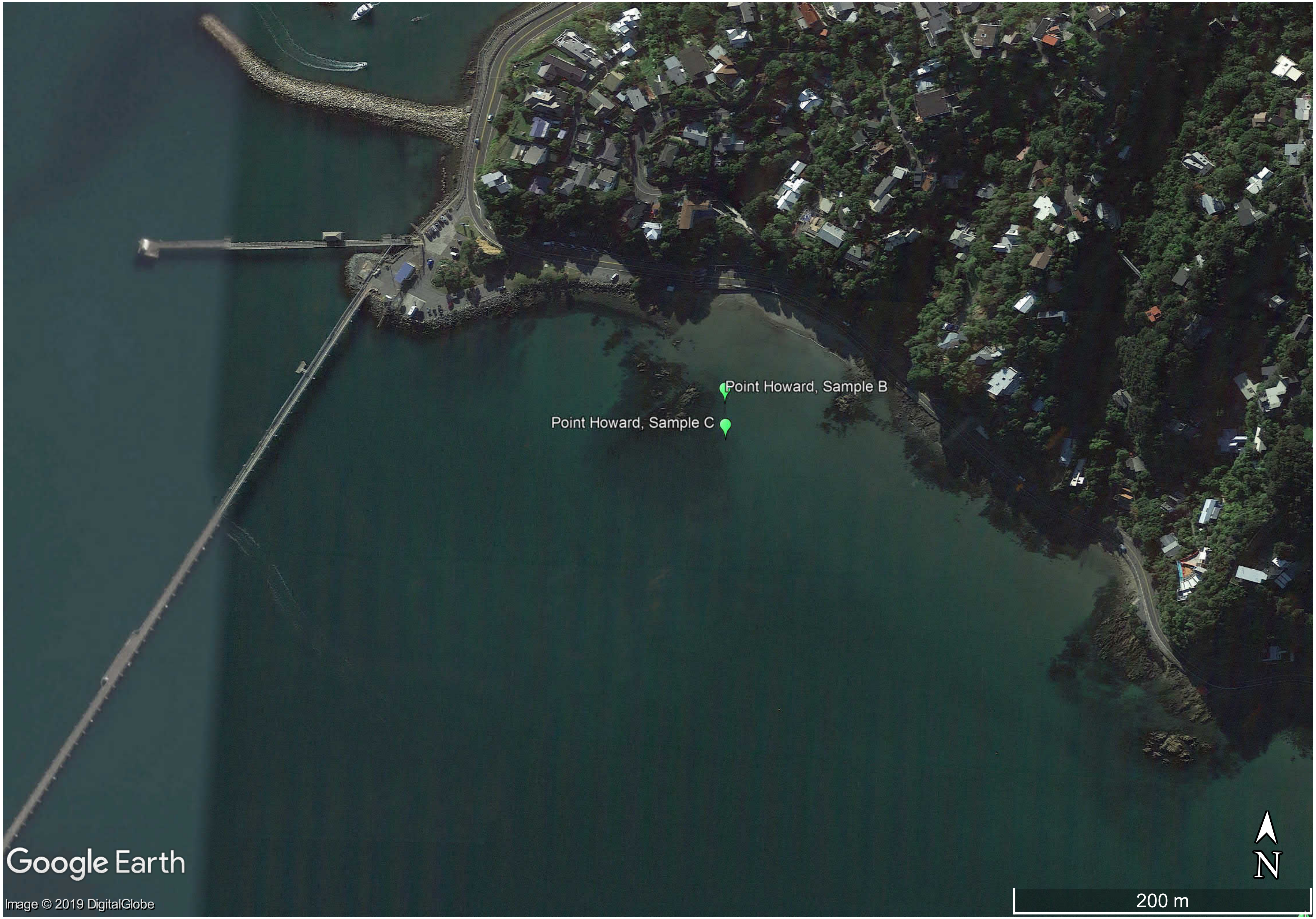
Bay	Nourished beach length (m)	Beach width lost at high tide (m)	Total volume required including overfill (m^3)	Volume nourished by proxy (m^3)	Volume required to import (m^3)	Offshore distance of new sand placement (m from seawall)	Average depth change (m)
Point Howa	120	1.42	1699	170	1529	57	
Sorrento B	40	0.38	191	21	170	47	
Lowry Bay	450	1.63	3942	732	3210	65	
York Bay	150	0.95	1213	143	1070	49	
Mahina Ba	225	1.64	1621	369	1252	45	
Sunshine B	250	0.44	606	111	495	45	

Memo TABLE 1 (Summary)

Point Howa	120	1.42	1699	170	1529
Sorrento B	40	0.38	191	21	170
Lowry Bay	450	1.63	3942	732	3210
York Bay	150	0.95	1213	143	1070
Mahina Ba	225	1.64	1621	369	1252
Sunshine B	250	0.44	606	111	495

Appendix B: Particle size distribution for priority beaches and subtidal area

- **Lowry Bay – high tide line (Lowry Bay-1 – T+T, 3/12/2018)**
- **Lowry Bay – mid low line (Lowry Bay 01 low – GHD 2015)**
- **York Bay – high tide line (York Bay -1) – T+T, 3/12/2018)**
- **Point Howard, Sample B**
- **Point Howard, Sample C**
- **Lowry Bay, Sample F**
- **Lowry Bay, Sample H**
- **Lowry Bay, Sample J**
- **York Bay, Sample L**
- **York Bay, Sample M**



Point Howard, Sample B
Point Howard, Sample C
Google Earth
Image © 2019 DigitalGlobe
N
200 m


Lowry Bay, Sample F
Lowry Bay, Sample H
Lowry Bay - mid low line
Lowry Bay - high tide line
Lowry Bay, Sample J
Google Earth
N
200 m


York Bay, Sample L
York Bay - high tide line
York Bay, Sample M
Google Earth
N
200 m

GEOTECHNICS

Our Ref: 1009111.0.0.0/REP1
Customer Ref: 1008227
14 December 2018

Tonkin + Taylor
PO Box 2083
Wellington

Attention: Michael Paine

Dear Michael

Eastern Bays Lab

Laboratory Test Report

Samples from the above mentioned site have been tested as received according to your instructions. Test results are included in this report.

As requested all samples have been returned to the customer in glass jars.

Descriptions are enclosed for your information, but are not covered under the IANZ endorsement of this report.

Please reproduce this report in full when transmitting to others or including in internal reports.

If we can be of any further assistance, feel free to get in touch. Contact details are provided at the bottom of this page.

GEOTECHNICS LTD

Report prepared by:

S. Simpson

....

Siobhan Simpson
Field Technician

Authorised for Geotechnics by:

Paul Burton
I have reviewed this document
2018.12.17 08:28:16 +13'00'

....

Paul Burton
Project Director

Report checked by:

....

Alan Benton
Wellington Manager
Approved Signatory

IANZ ACCREDITED LABORATORY

Tests indicated as not accredited are outside the scope of the laboratory's accreditation

14-Dec-18
document2

GEOTECHNICS
2 Hunter Street,
Wellington 6011
New Zealand
p. +64 4 381 8584

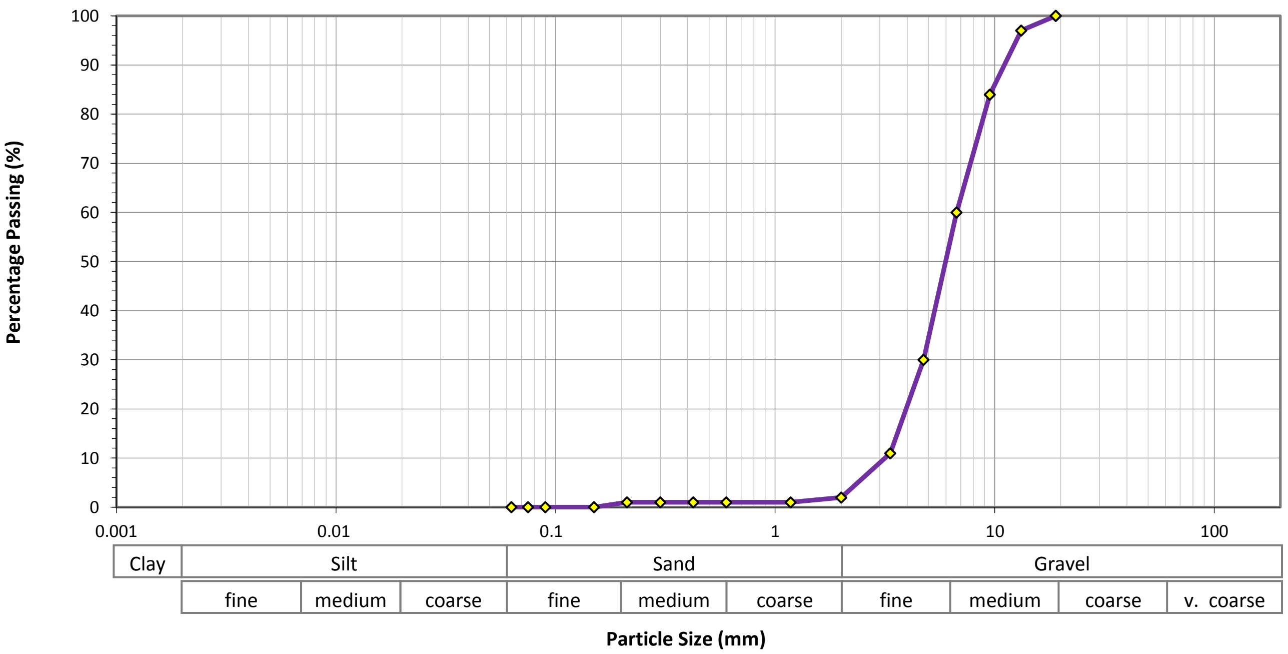
Geotechnics Project ID	1009111
Customer Project ID	1008227
Customer Project Name	EBaysharprev

DETERMINATION OF THE PARTICLE SIZE DISTRIBUTION - NZS 4402:1986 - Test 2.8.1 (Wet Sieve)

TEST DETAILS

LOCATION	**ID**	Eastbourne South		
	Description	Eastern Bays		
	Data	N/A		
SAMPLE	**Geotechnics ID**	GEOT201812063	**Date Received**	6/12/2018
	Reference	Eastbourne South - Low Beach	**Depth**	0.00m
	Description	Fine to medium GRAVEL, with trace sand; dark grey. Moist to wet; well graded. Trace broken shells.		
SPECIMEN	**Reference**	1	**Depth**	N/A
	Description	N/A		

TEST RESULTS



Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)
150	-	26.5	-	4.75	30	0.300	1
100	-	19.0	100	3.35	11	0.212	1
75.0	-	16.0	-	2.00	2	0.150	0
63.0	-	13.2	97	1.18	1	0.090	0
53.0	-	9.50	84	0.600	1	0.075	0
37.5	-	6.70	60	0.425	1	0.063	0

TEST REMARKS

• The material used for testing was natural, whole soil. • The percentage passing the <0.063mm was obtained by difference. • Insufficeint sample mass for IANZ accreditation.

This test result is not IANZ accredited.

Approved By	ABB	**Date**	14/12/2018

GEOTECHNICS

2 Hunter Street,
Wellington 6011
New Zealand

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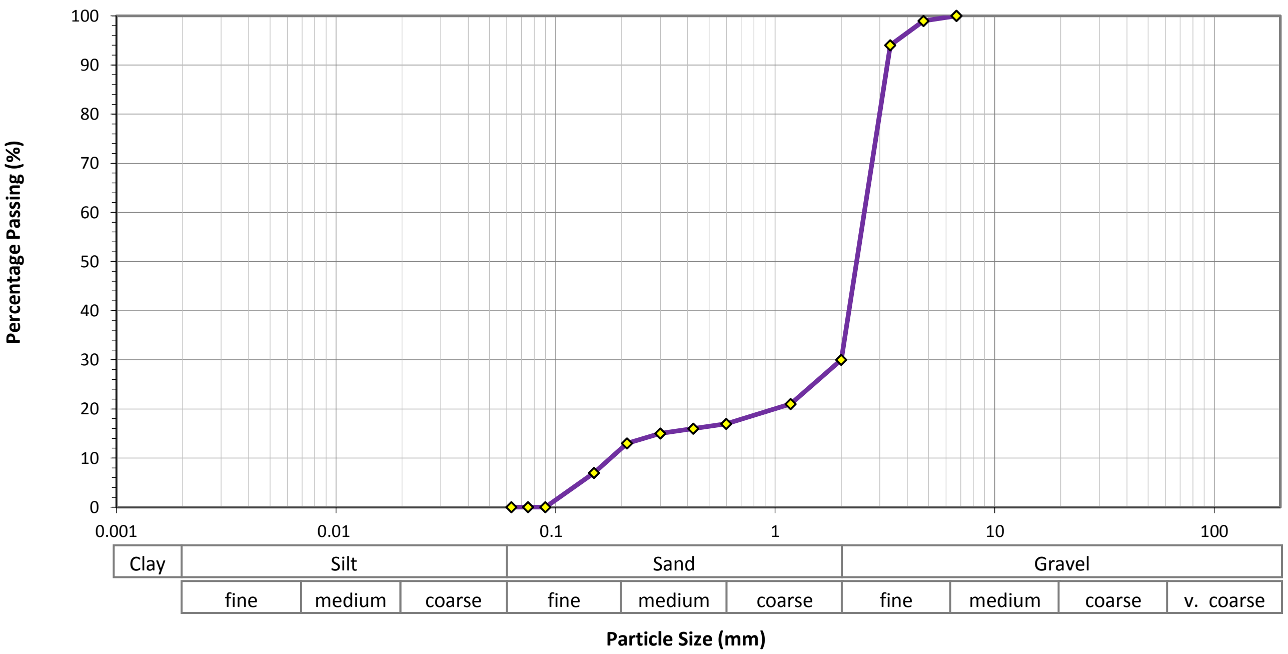
Geotechnics Project ID	1009111
Customer Project ID	1008227
Customer Project Name	EBaysharprev

DETERMINATION OF THE PARTICLE SIZE DISTRIBUTION - NZS 4402:1986 - Test 2.8.1 (Wet Sieve)

TEST DETAILS

LOCATION	**ID**	Eastbourne South		
	Description	Eastern Bays		
	Data	N/A		
SAMPLE	**Geotechnics ID**	GEOT201812064	**Date Received**	6/12/2018
	Reference	Eastbourne South - Mid Beach	**Depth**	0.00m
	Description	Sandy fine to medium GRAVEL; dark grey. Moist; poorly graded. Trace broken shells.		
SPECIMEN	**Reference**	1	**Depth**	N/A
	Description	N/A		

TEST RESULTS



Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)
150	-	26.5	-	4.75	99	0.300	15
100	-	19.0	-	3.35	94	0.212	13
75.0	-	16.0	-	2.00	30	0.150	7
63.0	-	13.2	-	1.18	21	0.090	0
53.0	-	9.50	-	0.600	17	0.075	0
37.5	-	6.70	100	0.425	16	0.063	0

TEST REMARKS

• The material used for testing was natural, whole soil. • The percentage passing the <0.063mm was obtained by difference.

This test result is IANZ accredited.

Approved By	ABB	**Date**	14/12/2018

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2 Hunter Street,
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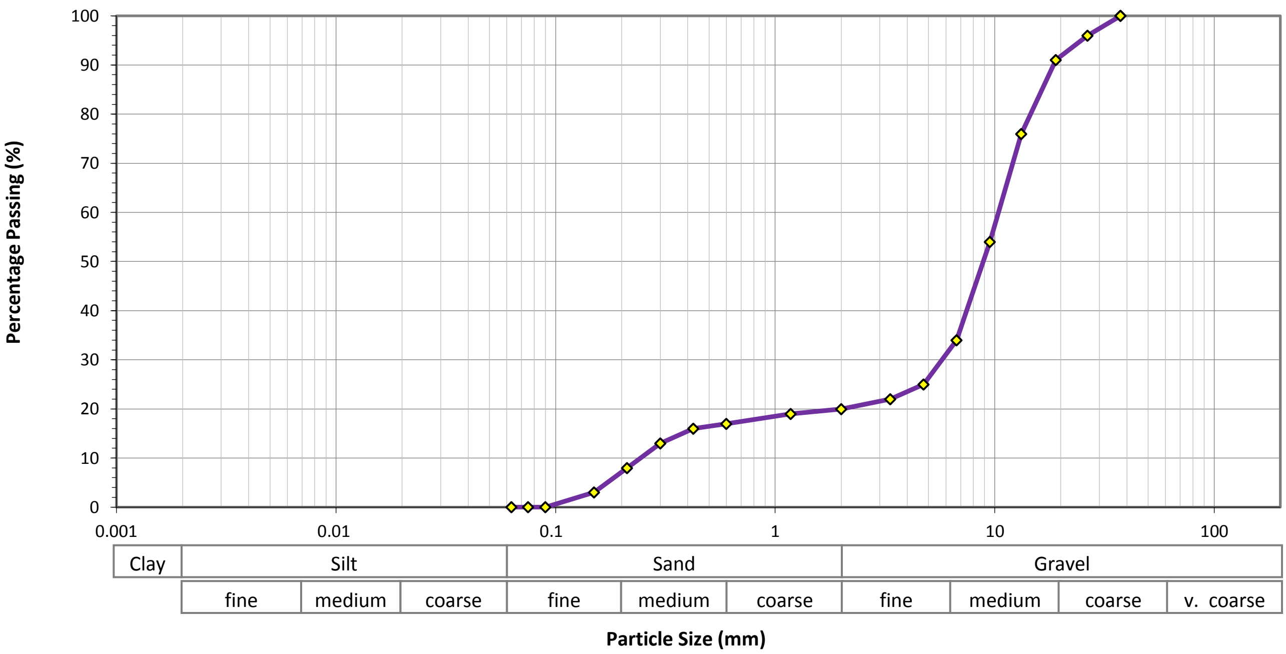
Geotechnics Project ID	1009111
Customer Project ID	1008227
Customer Project Name	EBaysharprev

DETERMINATION OF THE PARTICLE SIZE DISTRIBUTION - NZS 4402:1986 - Test 2.8.1 (Wet Sieve)

TEST DETAILS

LOCATION	**ID**	Lowry Bay		
	Description	Eastern Bays		
	Data	N/A		
SAMPLE	**Geotechnics ID**	GEOT201812062	**Date Received**	6/12/2018
	Reference	Lowry Bay-1	**Depth**	0.00m
	Description	Sandy fine to coarse GRAVEL; grey. Moist; well graded. Minor broken shells.		
SPECIMEN	**Reference**	1	**Depth**	N/A
	Description	N/A		

TEST RESULTS



Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)
150	-	26.5	96	4.75	25	0.300	13
100	-	19.0	91	3.35	22	0.212	8
75.0	-	16.0	-	2.00	20	0.150	3
63.0	-	13.2	76	1.18	19	0.090	0
53.0	-	9.50	54	0.600	17	0.075	0
37.5	100	6.70	34	0.425	16	0.063	0

TEST REMARKS

• The material used for testing was natural, fraction passing a 19mm sieve. • The percentage passing the <0.063mm was obtained by difference. • Insufficient sample mass for IANZ accreditation.

This test result is not IANZ accredited.

Approved By	ABB	**Date**	14/12/2018

GEOTECHNICS

2 Hunter Street,
Wellington 6011
New Zealand

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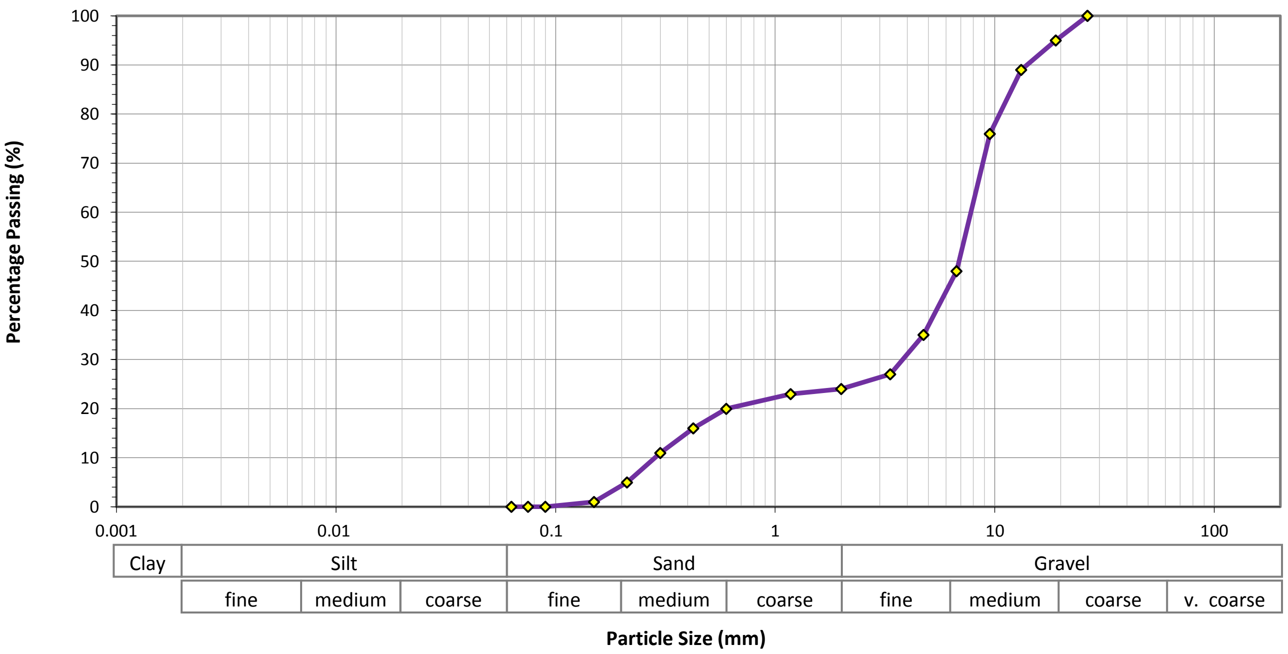
Geotechnics Project ID	1009111
Customer Project ID	1008227
Customer Project Name	EBaysharprev

DETERMINATION OF THE PARTICLE SIZE DISTRIBUTION - NZS 4402:1986 - Test 2.8.1 (Wet Sieve)

TEST DETAILS

LOCATION	**ID**	York Bay		
	Description	Eastern Bays		
	Data	N/A		
SAMPLE	**Geotechnics ID**	GEOT201812061	**Date Received**	6/12/2018
	Reference	York Bay-1	**Depth**	0.00m
	Description	Sandy fine to coarse GRAVEL; grey. Moist; well graded. Trace broken shells.		
SPECIMEN	**Reference**	1	**Depth**	N/A
	Description	N/A		

TEST RESULTS



Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)
150	-	26.5	100	4.75	35	0.300	11
100	-	19.0	95	3.35	27	0.212	5
75.0	-	16.0	-	2.00	24	0.150	1
63.0	-	13.2	89	1.18	23	0.090	0
53.0	-	9.50	76	0.600	20	0.075	0
37.5	-	6.70	48	0.425	16	0.063	0

TEST REMARKS

• The material used for testing was natural, fraction passing a 19mm sieve. • The percentage passing the <0.063mm was obtained by difference. • Insufficient sample mass for IANZ accreditation.

This test result is not IANZ accredited.

Approved By	ABB	**Date**	14/12/2018

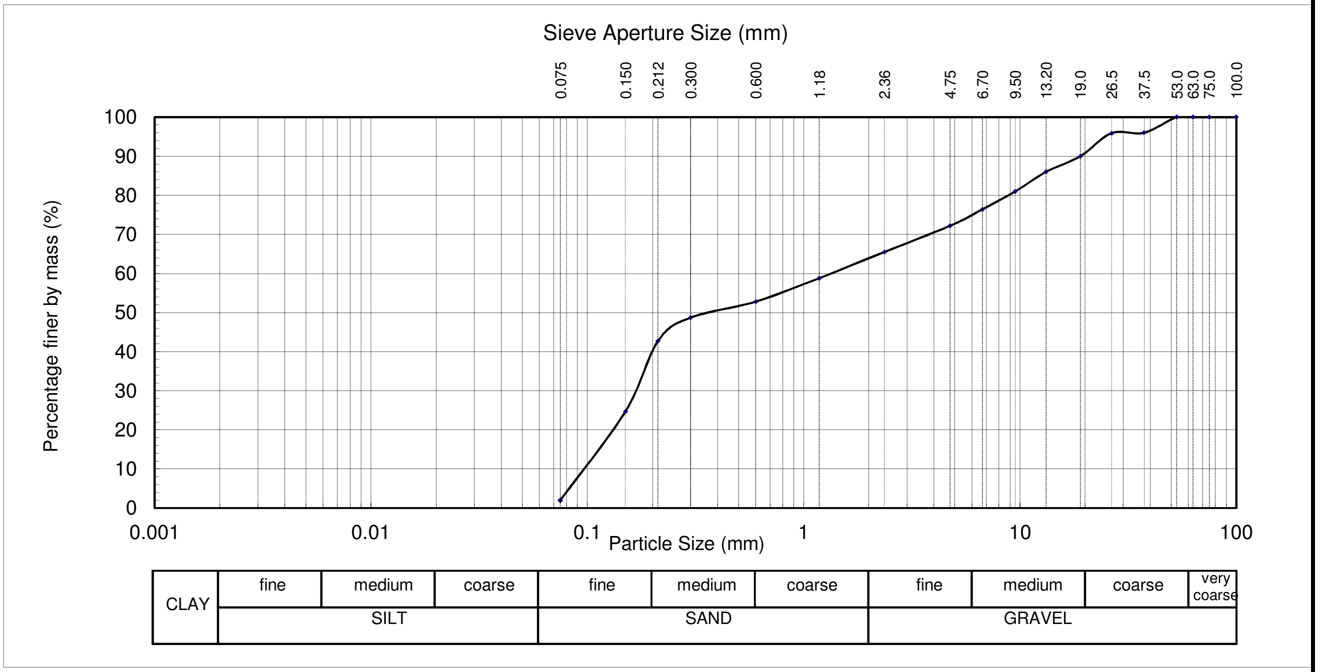
PARTICLE SIZE ANALYSIS
TEST REPORT

Project:	**Eastern Bays Sediment**
Location:	**Point Howard to York Bay**
Client:	**Tonkin + Taylor**
Contractor:	**Tonkin + Taylor**
Sampled by:	**Kirsty Brennan (EOS Ecology)**
Date sampled:	**11 Feb 19 at 14:28**
Sampling method:	**Diver**
Sample source:	**Point Howard Sub tidal**
Sample description:	**SAND-GRAVEL**
Sample condition:	**As received**
Solid density (fines)	**N/A** t/m^3
Water content as rec'd	**30.2** % Whole Sample

Report No:	**522900/1323**
Sample No:	**OR436B**
Client Ref:	**N/A**

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
100	**100**	19.0	**90**	1.18	**59**				
75.0	**100**	13.2	**86**	0.600	**53**				
63.0	**100**	9.50	**81**	0.300	**49**				
53.0	**100**	6.70	**76**	0.212	**43**				
37.5	**96**	4.75	**72**	0.150	**25**				
26.5	**96**	2.36	**66**	0.075	**2**				

Percent passing finest sieve obtained by difference



Test Methods (where used)	**Notes**
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve)	History: Oven dried .
Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer)	Uncalibrated sieve sizes 0.212mm
	Sample size submitted for testing is less than NZS 4402 specifies for this size fraction

Date Tested: 19-25/02/19
Date Reported: 26/02/19

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Designation *Technical Officer (MJ Mclachlan)*
Date: 26/02/19

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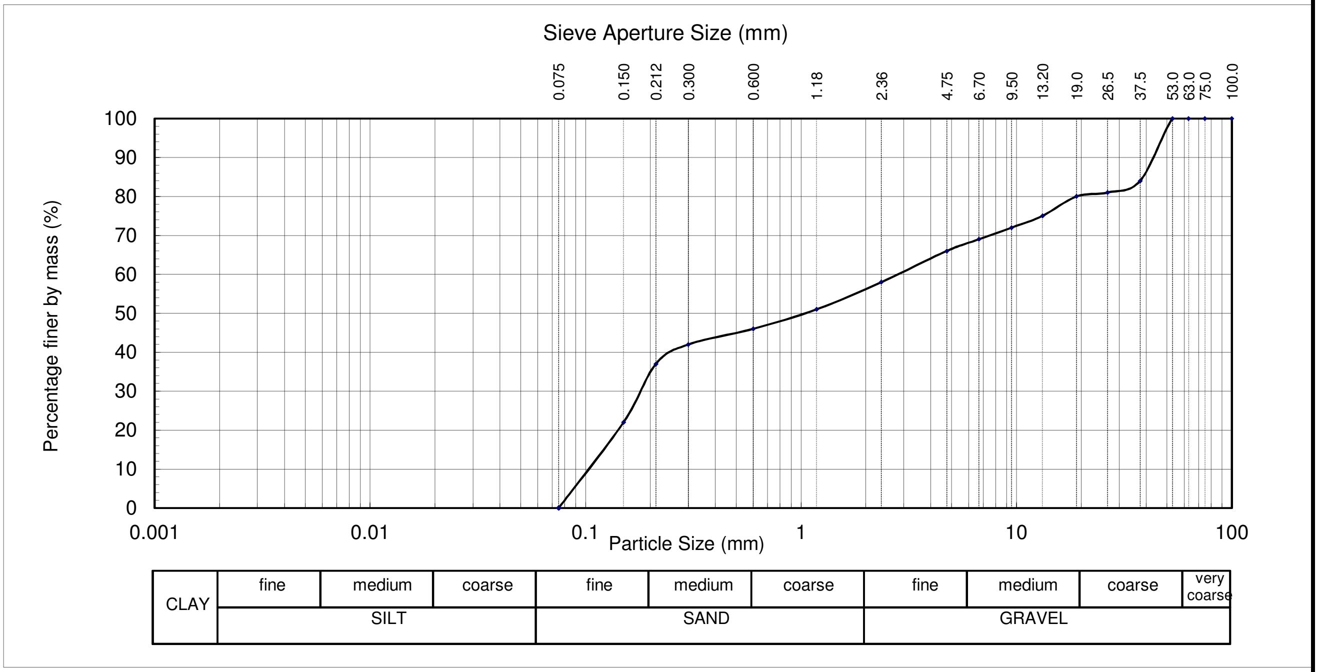
PARTICLE SIZE ANALYSIS
TEST REPORT

Project:	**Eastern Bays Sediment**
Location:	**Point Howard to York Bay**
Client:	**Tonkin + Taylor**
Contractor:	**Tonkin + Taylor**
Sampled by:	**Kirsty Brennan (EOS Ecology)**
Date sampled:	**11 Feb 19 at 14:17**
Sampling method:	**Diver**
Sample source:	**Point Howard Sub tidal**
Sample description:	**SAND-GRAVEL**
Sample condition:	**As received**
Solid density (fines)	**N/A** t/m^3
Water content as rec'd	**27.2** % Whole Sample

Report No:	**522900/1323**
Sample No:	**OR436C**
Client Ref:	**N/A**

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
100	**100**	19.0	**80**	1.18	**51**				
75.0	**100**	13.2	**75**	0.600	**46**				
63.0	**100**	9.50	**72**	0.300	**42**				
53.0	**100**	6.70	**69**	0.212	**37**				
37.5	**84**	4.75	**66**	0.150	**22**				
26.5	**81**	2.36	**58**	0.075	**0**				
Percent passing finest sieve obtained by difference									



Test Methods (where used)	**Notes**
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve)	History: Oven dried .
Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer)	Uncalibrated sieve sizes 0.212mm
	Sample size submitted for testing is less than NZS 4402 specifies for this size fraction

Date Tested: 19-25/02/19
Date Reported: 26/02/19

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PARTICLE SIZE ANALYSIS
TEST REPORT

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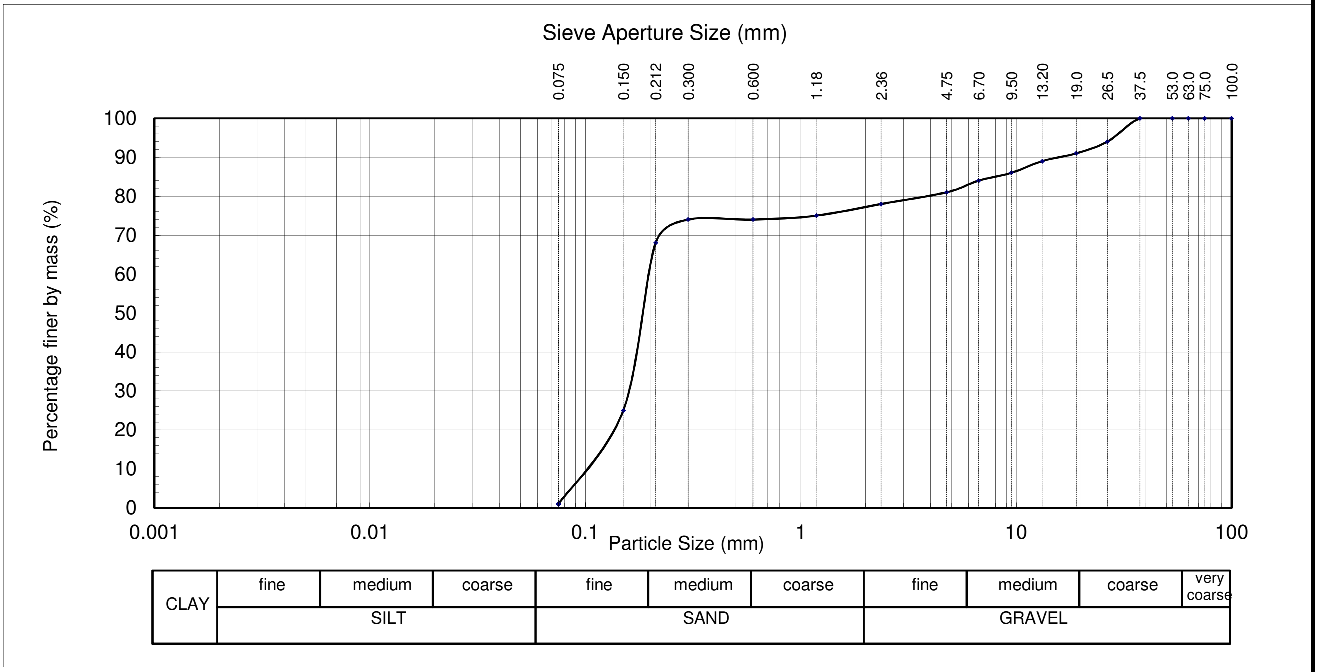
Project:	**Eastern Bays Sediment**
Location:	**Point Howard to York Bay**
Client:	**Tonkin + Taylor**
Contractor:	**Tonkin + Taylor**
Sampled by:	**Kirsty Brennan (EOS Ecology)**
Date sampled:	**11 Feb 19 at 15:25**
Sampling method:	**Diver**
Sample source:	**Lowry Bay Sub tidal**
Sample description:	**Gravelly SAND**
Sample condition:	**As received**
Solid density (fines)	**N/A** t/m^3
Water content as rec'd	**23.0** % Whole Sample

Report No:	**522900/1323**
Sample No:	**OR436F**
Client Ref:	**N/A**

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
100	**100**	19.0	**91**	1.18	**75**				
75.0	**100**	13.2	**89**	0.600	**74**				
63.0	**100**	9.50	**86**	0.300	**74**				
53.0	**100**	6.70	**84**	0.212	**68**				
37.5	**100**	4.75	**81**	0.150	**25**				
26.5	**94**	2.36	**78**	0.075	**1**				

Percent passing finest sieve obtained by difference



Test Methods (where used)	**Notes**
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve)	History: Oven dried .
Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer)	Uncalibrated sieve sizes 0.212mm
	Sample size submitted for testing is less than NZS 4402 specifies for this size fraction

Date Tested: 19-25/02/19
Date Reported: 26/02/19

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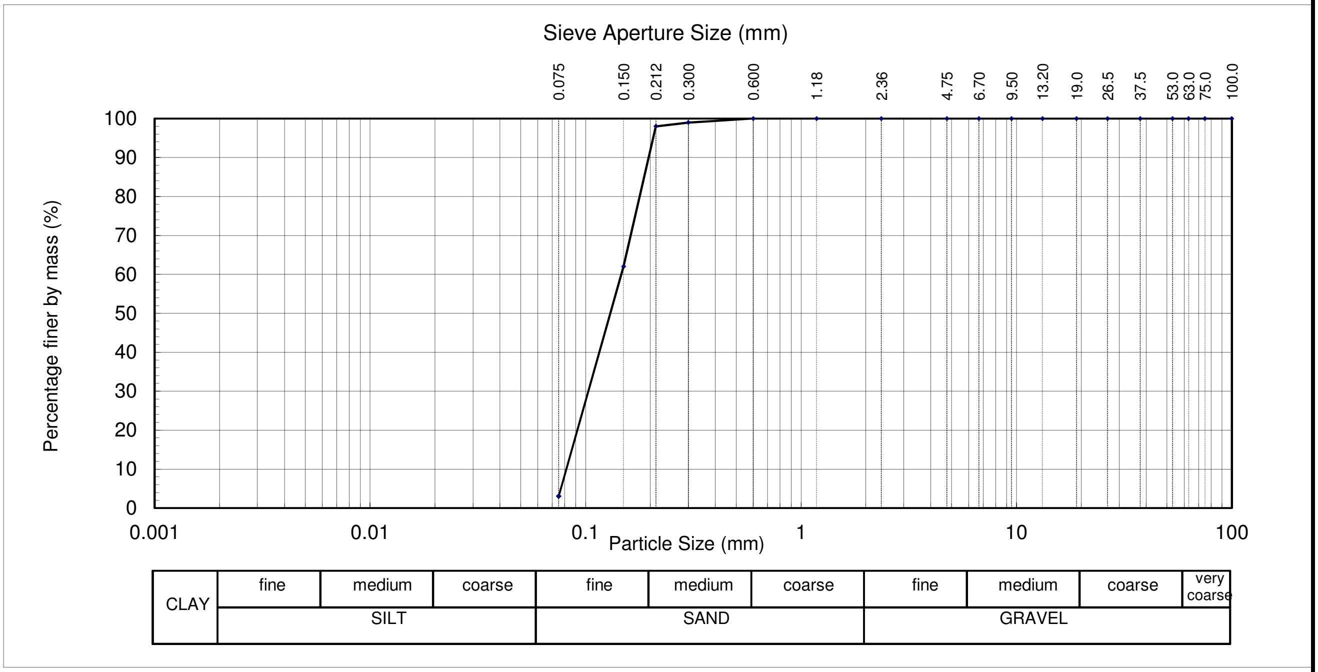
PARTICLE SIZE ANALYSIS
TEST REPORT

Project:	**Eastern Bays Sediment**
Location:	**Point Howard to York Bay**
Client:	**Tonkin + Taylor**
Contractor:	**Tonkin + Taylor**
Sampled by:	**Kirsty Brennan (EOS Ecology)**
Date sampled:	**11 Feb 19 at 15:54**
Sampling method:	**Diver**
Sample source:	**Lowry Bay Sub tidal**
Sample description:	**SAND**
Sample condition:	**As received**
Solid density (fines)	**N/A** t/m^3
Water content as rec'd	**48.2** % Whole Sample

Report No:	**522900/1323**
Sample No:	**OR436H**
Client Ref:	**N/A**

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
100	**100**	19.0	**100**	1.18	**100**				
75.0	**100**	13.2	**100**	0.600	**100**				
63.0	**100**	9.50	**100**	0.300	**99**				
53.0	**100**	6.70	**100**	0.212	**98**				
37.5	**100**	4.75	**100**	0.150	**62**				
26.5	**100**	2.36	**100**	0.075	**3**				

Percent passing finest sieve obtained by difference



Test Methods (where used)	**Notes**
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve)	History: Oven dried .
Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer)	Uncalibrated sieve sizes 0.212mm

Date Tested: 19-25/02/19
Date Reported: 26/02/19

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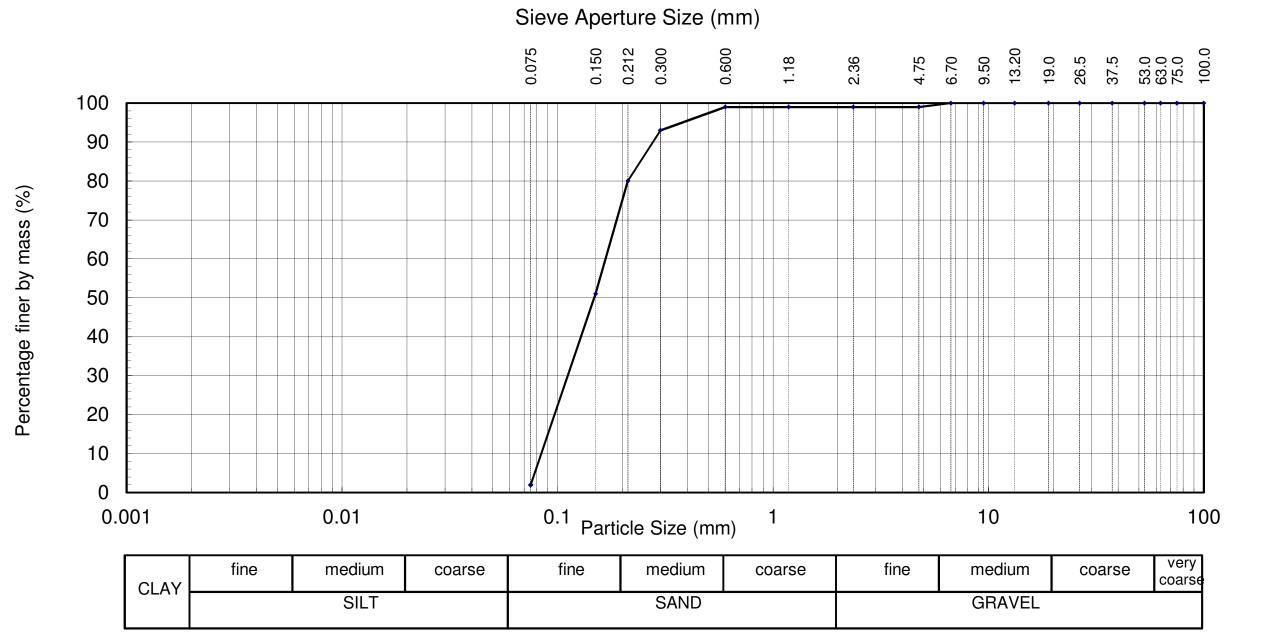
PARTICLE SIZE ANALYSIS
TEST REPORT

Project:	**Eastern Bays Sediment**
Location:	**Point Howard to York Bay**
Client:	**Tonkin + Taylor**
Contractor:	**Tonkin + Taylor**
Sampled by:	**Kirsty Brennan (EOS Ecology)**
Date sampled:	**12 Feb 19 at 7.55**
Sampling method:	**Diver**
Sample source:	**Lowry Bay Sub tidal**
Sample description:	**SAND**
Sample condition:	**As received**
Solid density (fines)	**N/A** t/m^3
Water content as rec'd	**32.1** % Whole Sample

Report No:	**522900/1323**
Sample No:	**OR436J**
Client Ref:	**N/A**

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
100	**100**	19.0	**100**	1.180	**99**				
75.0	**100**	13.2	**100**	0.600	**99**				
63.0	**100**	9.50	**100**	0.300	**93**				
53.0	**100**	6.70	**100**	0.212	**80**				
37.5	**100**	4.75	**99**	0.150	**51**				
26.5	**100**	2.36	**99**	0.075	**2**				

Percent passing finest sieve obtained by difference



Test Methods (where used)	**Notes**
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve)	History: Oven dried .
Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer)	Uncalibrated sieve sizes 0.212mm

Date Tested: 19-25/02/19
Date Reported: 26/02/19

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PARTICLE SIZE ANALYSIS
TEST REPORT

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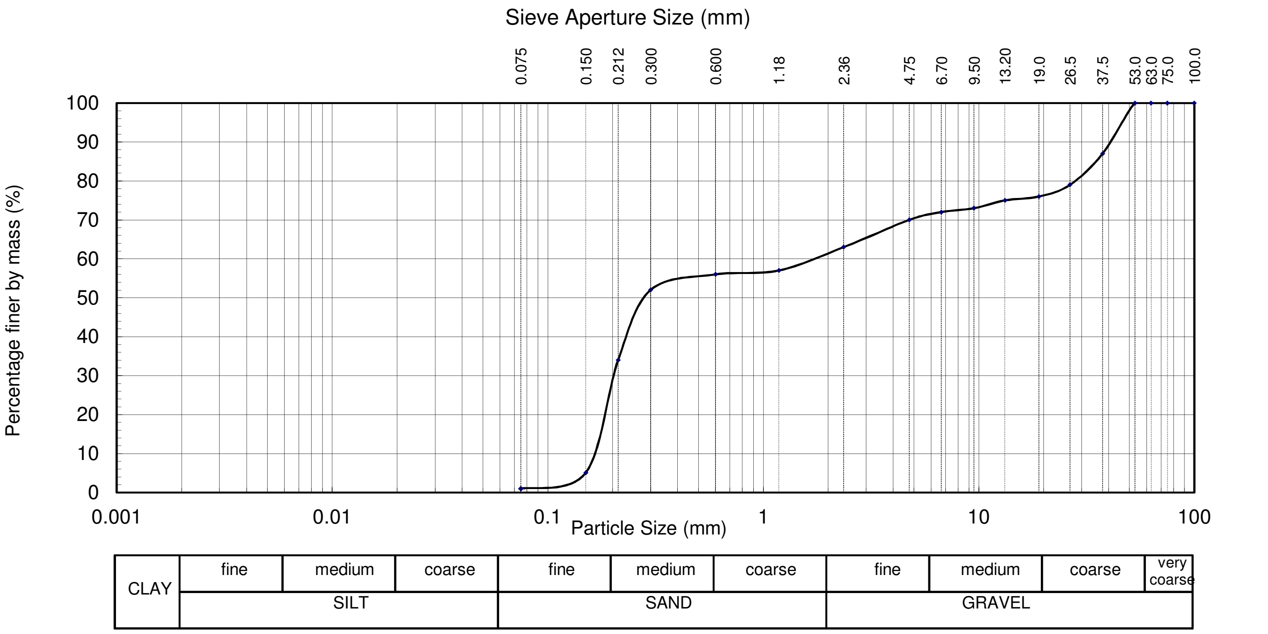
Project:	**Eastern Bays Sediment**
Location:	**Point Howard to York Bay**
Client:	**Tonkin + Taylor**
Contractor:	**Tonkin + Taylor**
Sampled by:	**Kirsty Brennan (EOS Ecology)**
Date sampled:	**11 Feb 19 at 12:40**
Sampling method:	**Diver**
Sample source:	**York Bay Sub tidal**
Sample description:	**SAND-GRAVEL**
Sample condition:	**As received**
Solid density (fines)	**N/A** t/m^3
Water content as rec'd	**23.5** % Whole Sample

Report No:	**522900/1323**
Sample No:	**OR436L**
Client Ref:	**N/A**

Sieve Analysis						**Hydrometer Analysis**			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
100	**100**	19.0	**76**	1.18	**57**				
75.0	**100**	13.2	**75**	0.600	**56**				
63.0	**100**	9.50	**73**	0.300	**52**				
53.0	**100**	6.70	**72**	0.212	**34**				
37.5	**87**	4.75	**70**	0.150	**5**				
26.5	**79**	2.36	**63**	0.075	**1**				

Percent passing finest sieve obtained by difference



Test Methods (where used)	**Notes**
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve)	History: Oven dried .
Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer)	Uncalibrated sieve sizes 0.212mm
	Sample size submitted for testing is less than NZS 4402 specifies for this size fraction

Date Tested: 19-25/02/19
Date Reported: 26/02/19

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PF-LAB-100 (20/03/2018)

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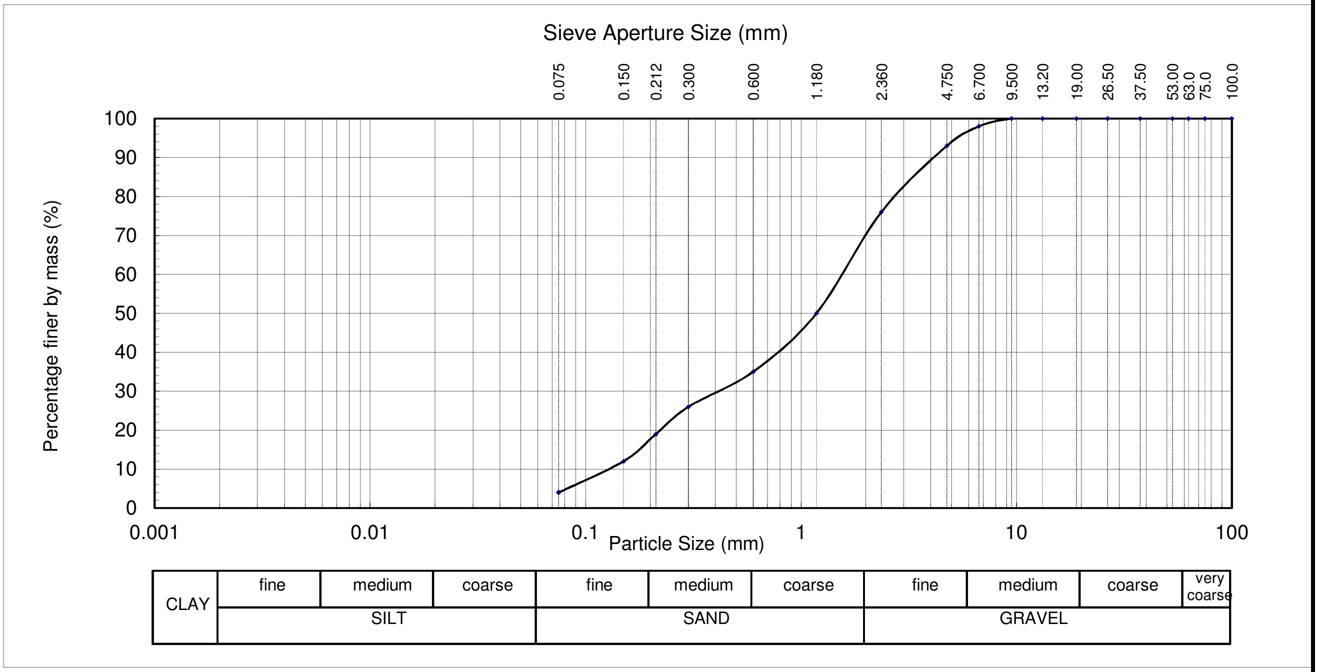
PARTICLE SIZE ANALYSIS
TEST REPORT

Project:	**Eastern Bays Sediment**
Location:	**Point Howard to York Bay**
Client:	**Tonkin + Taylor**
Contractor:	**Tonkin + Taylor**
Sampled by:	**Kirsty Brennan (EOS Ecology)**
Date sampled:	**11 Feb 19 at 12:28**
Sampling method:	**Diver**
Sample source:	**York Bay Sub tidal**
Sample description:	**SAND-GRAVEL.**
Sample condition:	**As received**
Solid density (fines)	**N/A** t/m^3
Water content as rec'd	**25.1** % Whole Sample

Report No:	**522900/1323**
Sample No:	**OR436M**
Client Ref:	**N/A**

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
100	**100**	19.0	**100**	1.180	**50**				
75.0	**100**	13.2	**100**	0.600	**35**				
63.0	**100**	9.50	**100**	0.300	**26**				
53.0	**100**	6.70	**98**	0.212	**19**				
37.5	**100**	4.75	**93**	0.150	**12**				
26.5	**100**	2.36	**76**	0.075	**4**				
Percent passing finest sieve obtained by difference									



Test Methods (where used)	**Notes**
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve)	History: Oven dried .
Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer)	Uncalibrated sieve sizes 0.212mm

Date Tested: 19-25/02/19
Date Reported: 26/02/19

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Point Howard Sample B

Point Howard Sample C

Lowry Bay Sample F

Lowry Bay Sample H

Lowry Bay Sample J

York Bay Sample L

York Bay Sample M

Appendix C: Particle size distribution of possible borrow areas

- **South of Eastbourne – upper intertidal (Eastbourne South – Mid beach – T+T, 3/12/2018)**
- **South of Eastbourne – lower intertidal (Eastbourne South – Low beach – T+T, 3/12/2018)**
- **Strand Park River Gradings – 2 No. bulk sample (Opus, 26/06/2008)**
- **Centre Port Channel Dredging – 4 No. samples (Opus, 4/11/2014)**
- **Ferney Hill (Tasman) and Camerons Quarry (Otago) data for Oriental Bay (T+T, 19/02/2008)**

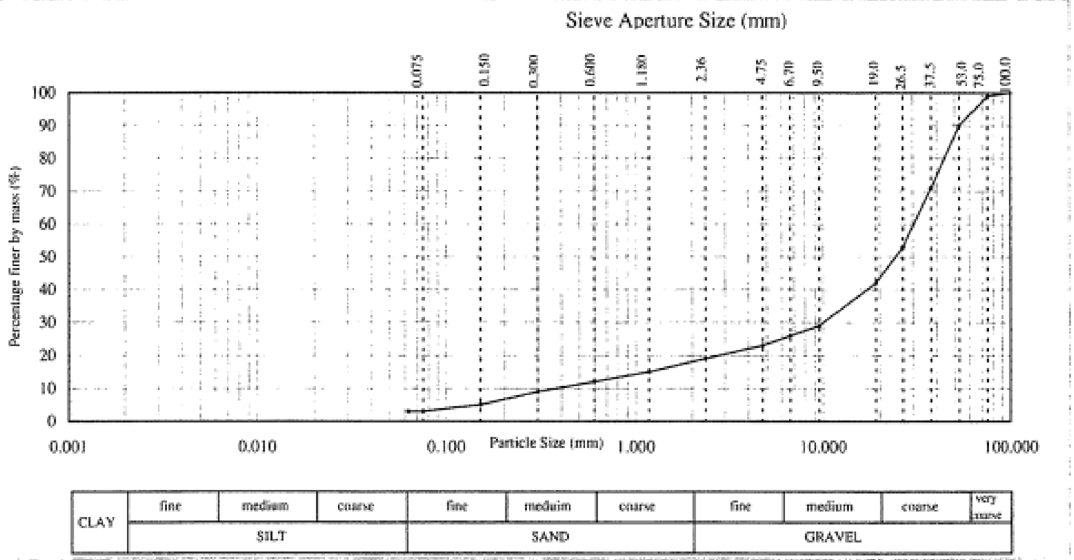
PARTICLE SIZE ANALYSIS
TEST REPORT

PRELIMINARY

Project:	**Strand Park River Gradings**
Location:	**Lower Hutt**
Client:	**Opus Wellington**
Contractor:	**N/A**
Sampled by:	**Client**
Date sampled:	**26.6.08**
Sampling method:	**Test Pit, bulk sample**
Sample source:	**Ewen Beach 0.5m**
Sample description:	**GRAVEL: f-c, with sand**
Sample Condition:	**As received**
Solid Density	**n/a** t/m^3 **Assumed**
Water content as rec'd	**5.2** % **Whole**

Report No:	**522900/878**
Sample No:	**2-08/099**
Client Ref:	**350378.03 1CL**

Sieve Analysis						**Hydrometer Analysis**			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
100.0	**100**	19.0	**42**	1.18	**15**				
75.0	**99**	9.50	**29**	0.600	**12**				
53.0	**90**	6.70	**26**	0.300	**9**				
37.5	**71**	4.75	**23**	0.150	**5**				
26.5	**53**	2.36	**19**	0.075	**3**				



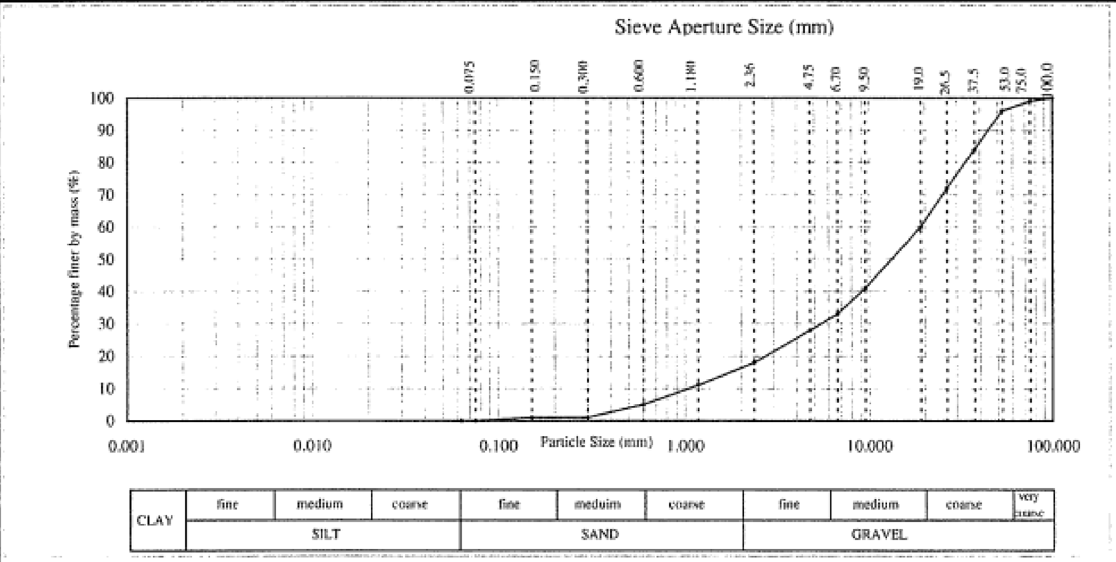
PARTICLE SIZE ANALYSIS
TEST REPORT

Project:	**Strand Park River Gradings**
Location:	**Lower Hutt**
Client:	**Opus Wellington**
Contractor:	**N/A**
Sampled by:	**Client**
Date sampled:	**26.6.08**
Sampling method:	**Test Pit, bulk sample**
Sample source:	**Block Road 0.1-0.2m**
Sample description:	**GRAVEL: f-c, with sand**
Sample Condition:	**As received**
Solid Density	**n/a** t/m^3 **Assumed**
Water content as rec'd	**3.1** % **Whole**

PRELIMINARY

Report No:	**522900/878**
Sample No:	**2-08/098**
Client Ref:	**350378.03 1CL**

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
100.0	**100**	19.0	**60**	1.18	**11**				
75.0	**99**	9.50	**41**	0.600	**5**				
53.0	**96**	6.70	**33**	0.300	**1**				
37.5	**84**	4.75	**28**	0.150	**1**				
26.5	**72**	2.36	**18**	0.075	**0**				



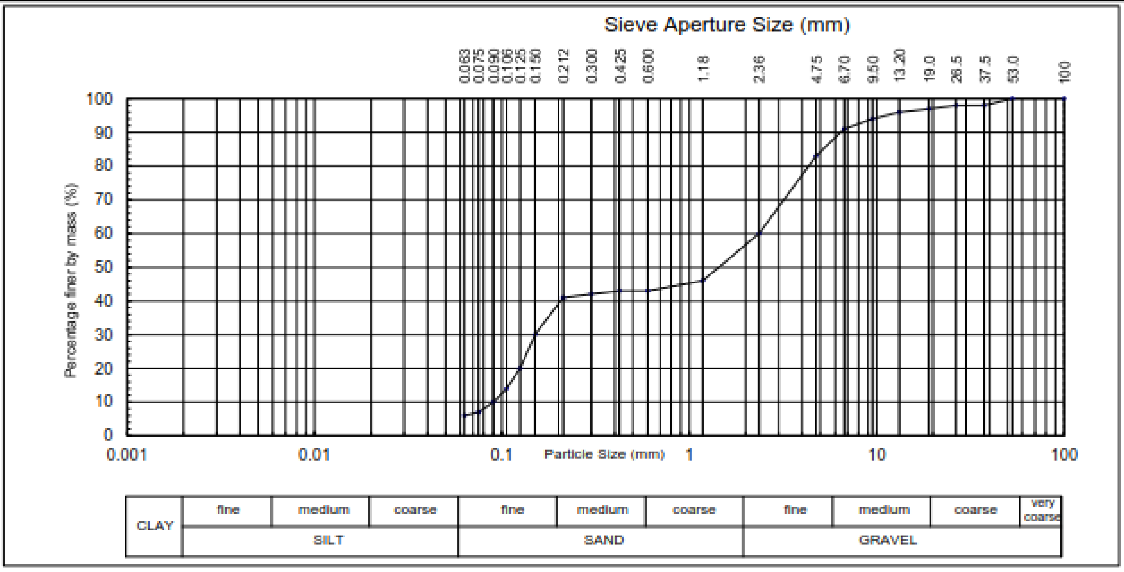
PARTICLE SIZE ANALYSIS
TEST REPORT

OPUS

Project:	**EN-02-1207**
Location:	**Wellington Harbour**
Client:	**Tonkin and Taylor Ltd**
Contractor:	**N/a**
Sampled by:	**SPP**
Date sampled:	**1/10/14**
Sampling method:	**Vibracore, Grab , Piston**
Sample source:	**Wellington Harbour - FB93-16**
Sample description:	**Harbour Sediment**
Sample condition:	**As Received**
Solid density (-0.063mm)	**n/a** t/m^3 **not tested**
Water content as rec'd	**19.7** % **whole**

Report No:	**522900/1104**
Sample No:	**2-14/131**
Project No:	**85452.006**

Sieve Analysis						Hydrometer Analysis (not tested)			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
100.0	**100**	6.70	**91**	0.212	**41**				
53.0	**100**	4.75	**83**	0.150	**30**				
37.5	**98**	2.36	**60**	0.125	**20**				
26.5	**98**	1.18	**46**	0.106	**14**				
19.00	**97**	0.600	**43**	0.090	**10**				
13.20	**96**	0.425	**43**	0.075	**7**				
9.50	**94**	0.300	**42**	0.063	**6**				
Percent passing the finest sieve is obtained by difference									



Test Methods:

Notes:

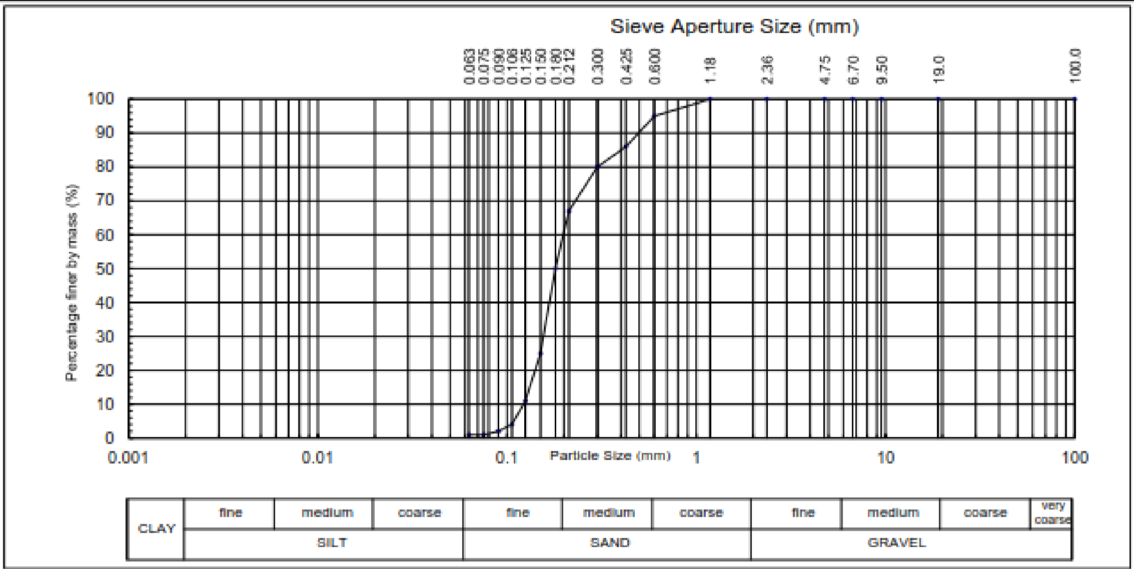
PARTICLE SIZE ANALYSIS
TEST REPORT

Project:	**EN-02-1207**
Location:	**Wellington Harbour**
Client:	**Tonkin and Taylor Ltd**
Contractor:	**N/a**
Sampled by:	**SPP**
Date sampled:	**4/11/14**
Sampling method:	**Vibracore, Grab , Piston**
Sample source:	**Wellington Harbour - HEV07-1**
Sample description:	**Harbour Sediment**
Sample condition:	**As Received**
Solid density (-0.063mm)	**n/a** t/m^3 **not tested**
Water content as rec'd	**22.3** % **whole**

Report No:	**522900/1104**
Sample No:	**2-14/147**
Project No:	**85452.006**

Sieve Analysis						Hydrometer Analysis (not tested)			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
100.0	**100**	1.18	**100**	0.150	**25**				
19.0	**100**	0.600	**95**	0.125	**11**				
9.50	**100**	0.425	**86**	0.106	**4**				
6.70	**100**	0.300	**80**	0.090	**2**				
4.75	**100**	0.212	**67**	0.075	**1**				
2.36	**100**	0.180	**50**	0.063	**1**				

Percent passing the finest sieve is obtained by difference



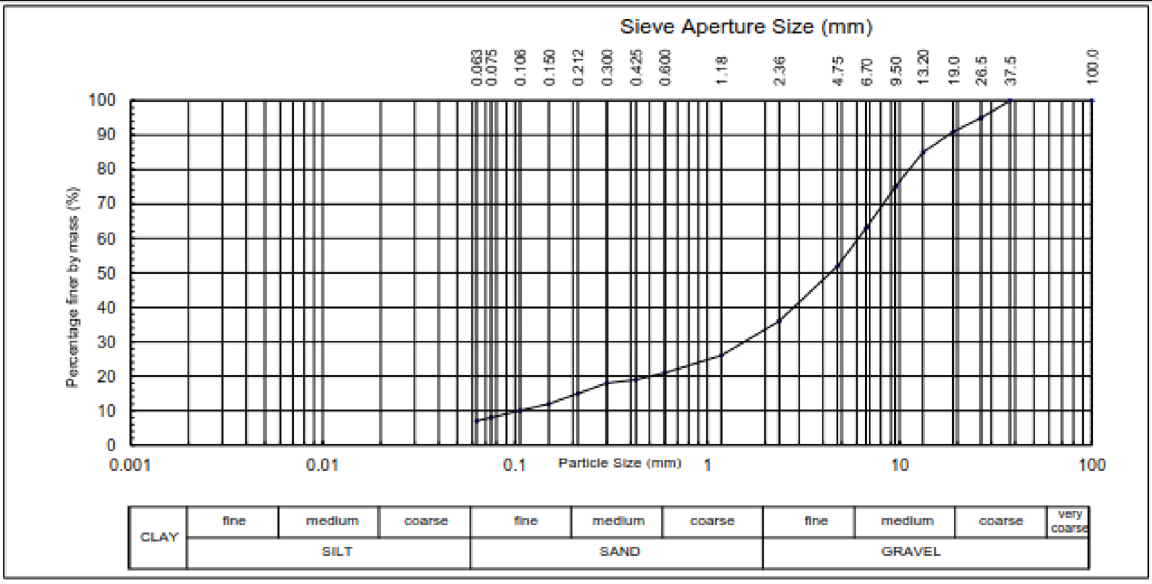
PARTICLE SIZE ANALYSIS
TEST REPORT

OPUS

Project:	**EN-02-1207**
Location:	**Wellington Harbour**
Client:	**Tonkin and Taylor Ltd**
Contractor:	**N/a**
Sampled by:	**SPP**
Date sampled:	**5/11/14**
Sampling method:	**Vibracore, Grab , Piston**
Sample source:	**Wellington Harbour - TCV03-2**
Sample description:	**Harbour Sediment**
Sample condition:	**As Received**
Solid density (-0.063mm)	**n/a** t/m^3 **not tested**
Water content as rec'd	**10.3** % **whole**

Report No:	**522900/1104**
Sample No:	**2-14/140**
Project No:	**85452.006**

Sieve Analysis						Hydrometer Analysis (not tested)			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
100.0	**100**	6.70	**63**	0.300	**18**				
37.5	**100**	4.75	**52**	0.212	**15**				
26.5	**95**	2.36	**36**	0.150	**12**				
19.0	**91**	1.18	**26**	0.106	**10**				
13.20	**85**	0.600	**21**	0.075	**8**				
9.50	**75**	0.425	**19**	0.063	**7**				
Percent passing the finest sieve is obtained by difference									

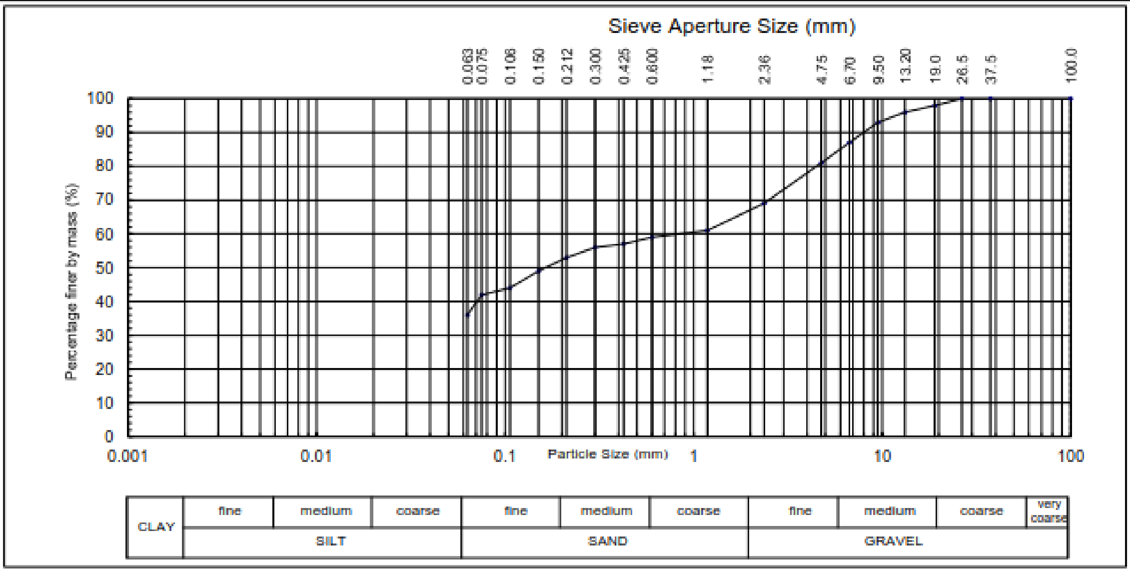


PARTICLE SIZE ANALYSIS
TEST REPORT

Project:	**EN-02-1207**
Location:	**Wellington Harbour**
Client:	**Tonkin and Taylor Ltd**
Contractor:	**N/a**
Sampled by:	**SPP**
Date sampled:	**5/11/14**
Sampling method:	**Vibracore, Grab , Piston**
Sample source:	**Wellington Harbour - TCV03-1A**
Sample description:	**Harbour Sediment**
Sample condition:	**As Received**
Solid density (-0.063mm)	**n/a** t/m^3 **not tested**
Water content as rec'd	**19.9** % **whole**

Report No:	**522900/1104**
Sample No:	**2-14/138**
Project No:	**85452.006**

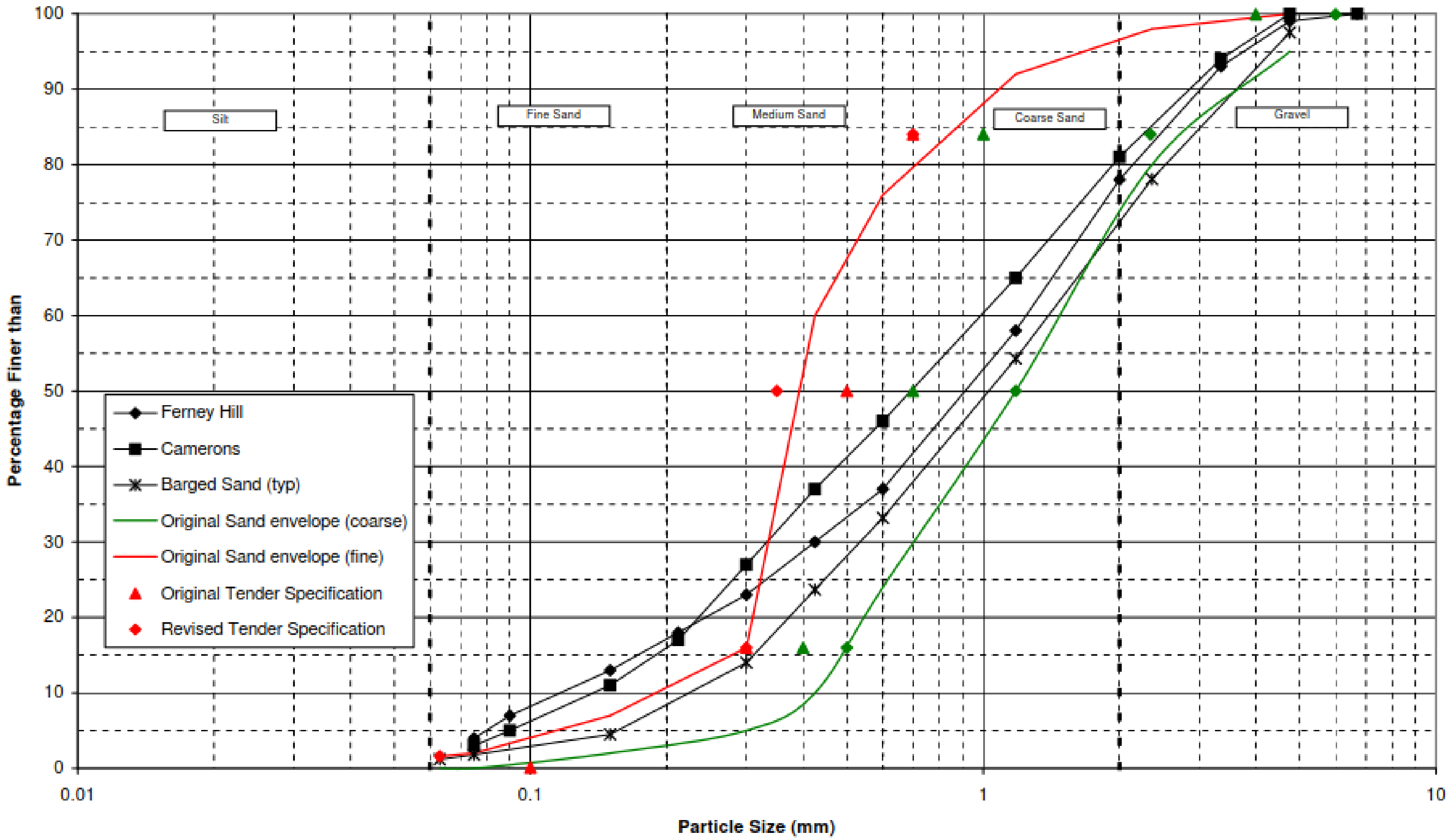
Sieve Analysis						Hydrometer Analysis (not tested)			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
100.0	**100**	6.70	**87**	0.300	**56**				
37.5	**100**	4.75	**81**	0.212	**53**				
26.5	**100**	2.36	**69**	0.150	**49**				
19.0	**98**	1.18	**61**	0.106	**44**				
13.20	**96**	0.600	**59**	0.075	**42**				
9.50	**93**	0.425	**57**	0.063	**36**				
Percent passing the finest sieve is obtained by difference									



TONKIN & TAYLOR
Particle Size Distribution - Sand Sources v
Original Specification

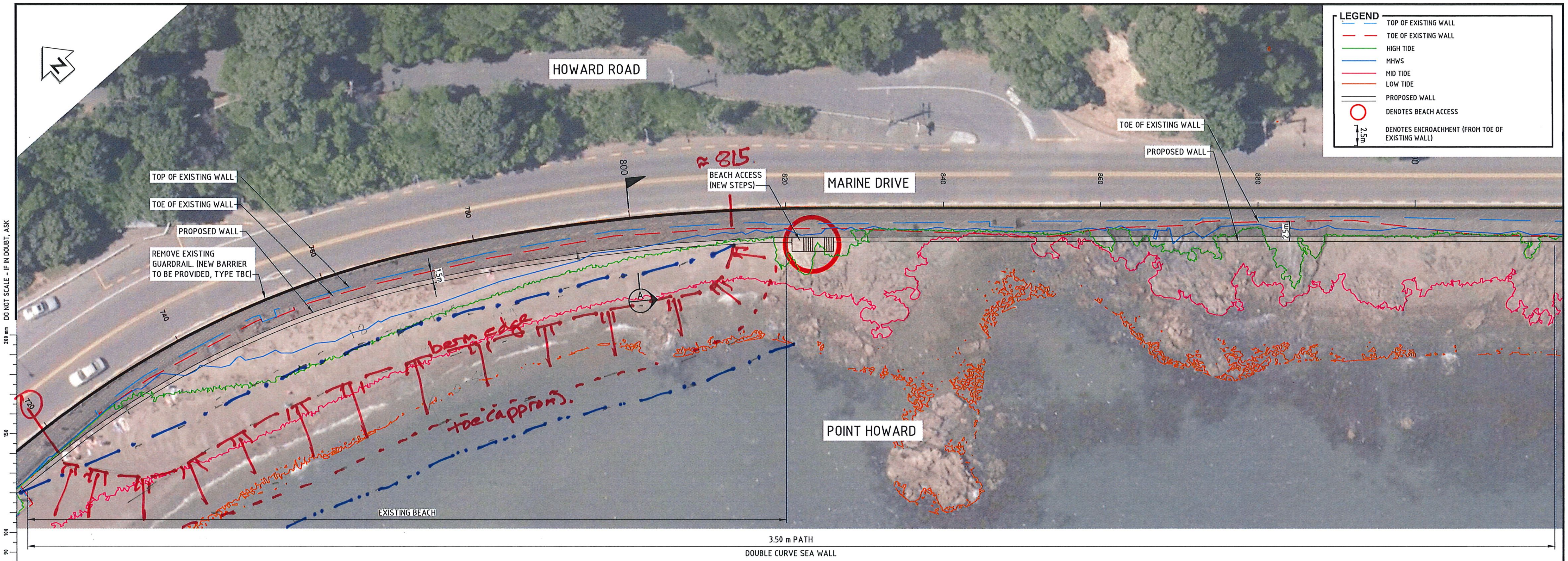
Job No: 82927.303
Project: Oriental Bay New Sand

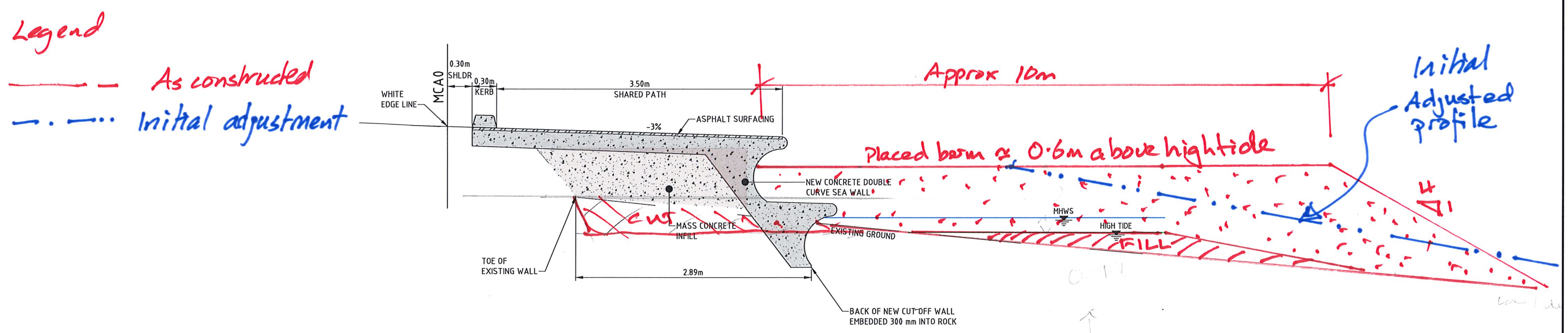
Date: 19-Feb
Analysis by: TRJJ
Checked by:



Note: Symbols in red denote fine end of envelopes; green symbols denote coarse end

Appendix D: Beach nourishment extents





SECTION A
SCALE ~~1:25~~ NTS

CONSTRUCTION PLACEMENT OF BEACH NOURISHMENT (typical)

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
J	FOR CONSENT - ROCK REVETMENT REMOVED AND PATH WIDTH CHANGED	KVS	JP		08/18
H	FOR CONSENT - MINOR AMENDMENT	KVS	JP		05/18
G	FOR CONSENT	KVS	JP		04/18
F	MINOR AMENDMENT	KVS	JP		09.03.2018
E	MINOR AMENDMENT	KVS	JP		02.03.2018
D	PRELIMINARY DESIGN	GC	JP		19.09.17
C	FOR REVIEW - MANY SHEETS ADDED, MANY SHEETS RE-NUMBERED	PJ COOK	JP		08/17

SURVEYED
DESIGNED
DRAWN
CAD REVIEW
DESIGN CHECK
DESIGN REVIEW
APPROVED
PROF REGISTRATION:

NOT APPROVED

Stantec

Client: HUTT CITY TE AWA KAIRANGI

HUTT CITY COUNCIL
EASTERN BAYS SHARED PATH - DBC

PLAN - MCA0
POINT HOWARD SORRENTO BAY STATION 720 - 900

Status Stamp: WORKING PLOT
Date Stamp:
Scales: 1 : 250 (A1)
Drawing No.: 80509137-01-001-C221
Rev.: J

Last modified: Aug 26 2018 By Kevin Singh

ORIGINAL SIZE A1

DO NOT SCALE - IF IN DOUBT, ASK

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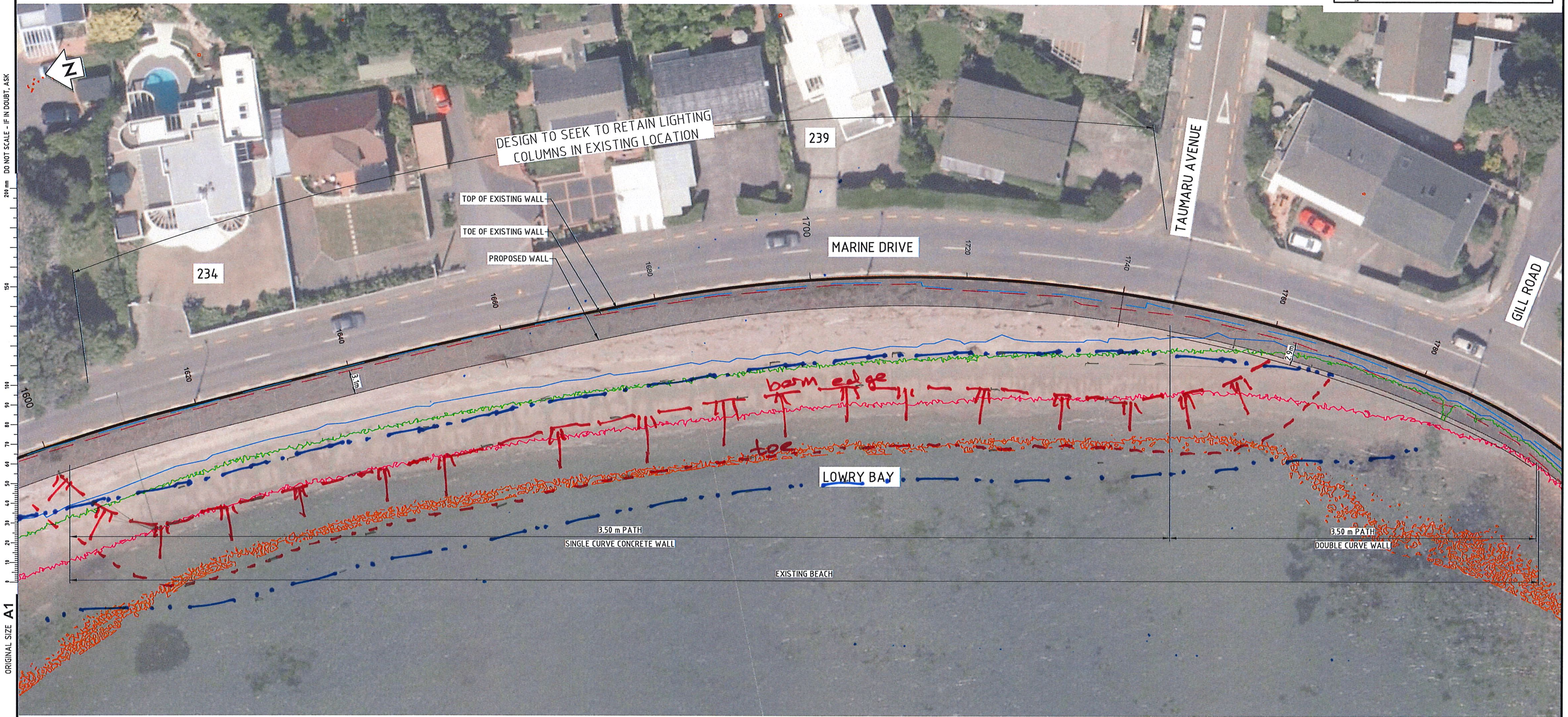
LEGEND
- TOP OF EXISTING WALL
- TOE OF EXISTING WALL
- HIGH TIDE
- MHWS
- MID TIDE
- LOW TIDE
- PROPOSED WALL
- DENOTES BEACH ACCESS
- 2.5m DENOTES ENCROACHMENT (FROM TOE OF EXISTING WALL)



Legend

As constructed

initial adjustment

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
J	FOR CONSENT - ROCK REVETMENT REMOVED AND PATH WIDTH CHANGED	KVS	JP		08/18
H	FOR CONSENT - MINOR AMENDMENT	KVS	JP		05/18
G	FOR CONSENT	KVS	JP		04/18
F	MINOR AMENDMENT	KVS	JP		09.03.2018
E	MINOR AMENDMENT	KVS	JP		02.03.2018
D	PRELIMINARY DESIGN	GC	JP		19.09.17
C	FOR REVIEW - MANY SHEETS ADDED, MANY SHEETS RE-NUMBERED	PJ COOK	JP		08/17

SURVEYED	
DESIGNED	
DRAWN	
CAD REVIEW	
DESIGN CHECK	
DESIGN REVIEW	NOT APPROVED
APPROVED	
PROF REGISTRATION:	

Stantec

Client: HUTT CITY TE AWA KAIRANGI

HUTT CITY COUNCIL
EASTERN BAYS SHARED PATH - DBC

PLAN - MCA0
LOWRY BAY STATION 1600 - 1780

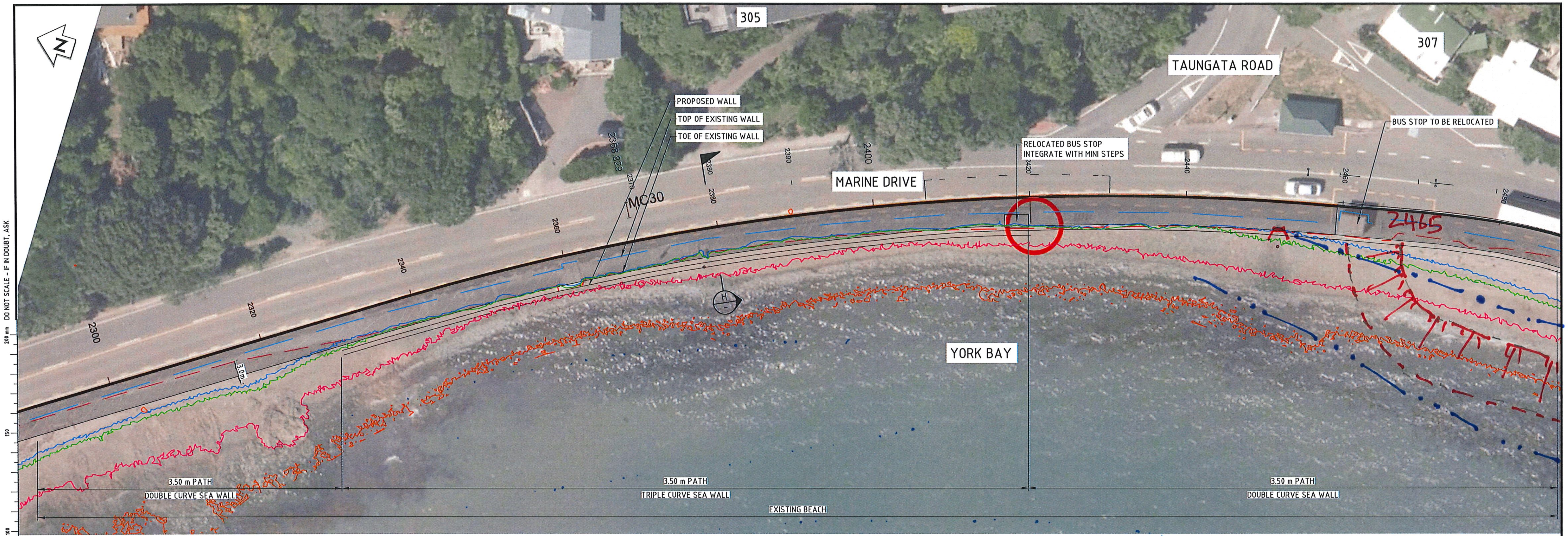
Status Stamp: WORKING PLOT

Date Stamp

Scales 1 : 250

Drawing No. 80509137-01-001-C226

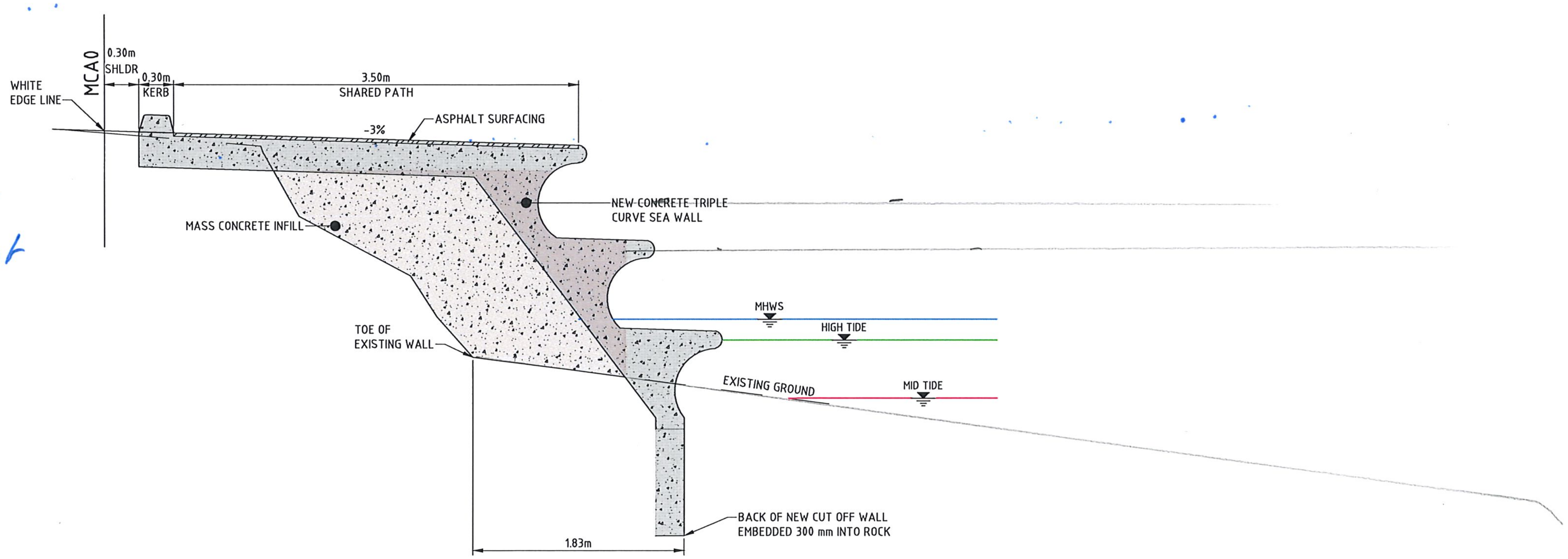
Rev. J



Legend

As constructed

Initial adjustment



SECTION H
SCALE 1 : 25

LEGEND

- TOP OF EXISTING WALL
- TOE OF EXISTING WALL
- HIGH TIDE
- MHWS
- MID TIDE
- LOW TIDE
- PROPOSED WALL
- DENOTES BEACH ACCESS
- 2.5m DENOTES ENCROACHMENT (FROM TOE OF EXISTING WALL)

DO NOT SCALE - IF IN DOUBT, ASK

ORIGINAL SIZE A1

Last modified: Aug 24 2018 By Kevin Singh

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
J	FOR CONSENT - ROCK REVETMENT REMOVED AND PATH WIDTH CHANGED	KVS	JP		08/18
H	FOR CONSENT - MINOR AMENDMENT	KVS	JP		05/18
G	FOR CONSENT	KVS	JP		04/18
F	MINOR AMENDMENT	KVS	JP		09.03.2018
E	MINOR AMENDMENT	KVS	JP		02.03.2018
D	PRELIMINARY DESIGN	GC	JP		19.09.17
C	FOR REVIEW - MANY SHEETS ADDED, MANY SHEETS RE-NUMBERED	PJ COOK	JP		08/17

SURVEYED	
DESIGNED	
DRAWN	
CAD REVIEW	
DESIGN CHECK	
DESIGN REVIEW	NOT APPROVED
APPROVED	
PROF REGISTRATION:	

Stantec

Client: HUTT CITY TE AWA KAIRANGI

HUTT CITY COUNCIL
EASTERN BAYS SHARED PATH - DBC

PLAN - MCA0
YORK BAY STATION 2300 - 2480

Status Stamp: WORKING PLOT
Date Stamp:
Scales: 1 : 250
Drawing No.: 80509137-01-001-C230
Rev.: J

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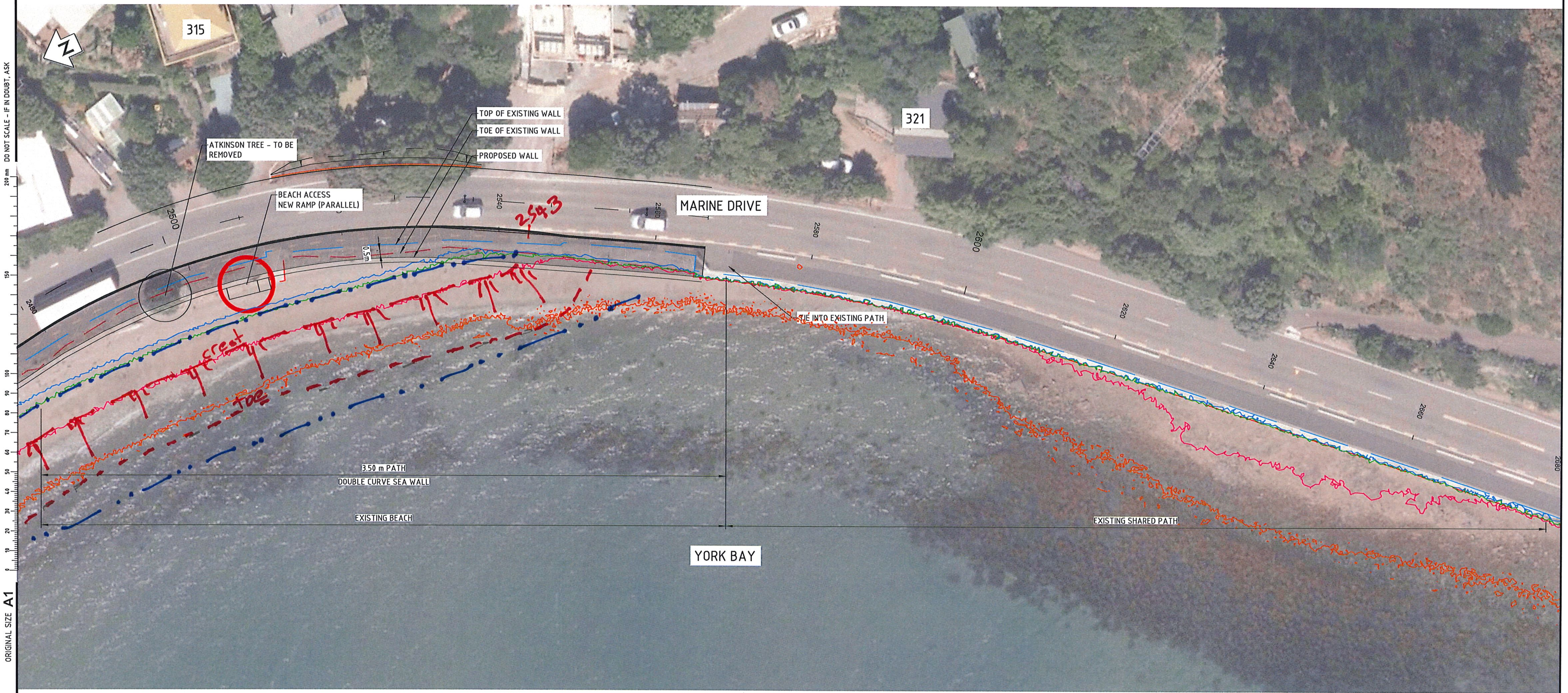
LEGEND

- TOP OF EXISTING WALL
- TOE OF EXISTING WALL
- HIGH TIDE
- MHWS
- MID TIDE
- LOW TIDE
- PROPOSED WALL
- DENOTES BEACH ACCESS
- 2.5m DENOTES ENCROACHMENT (FROM TOE OF EXISTING WALL)



Legend

As constructed

Initial adjustment

ORIGINAL SIZE A1

DO NOT SCALE - IF IN DOUBT, ASK

Last modified: Aug 24 2018 By Kevin Singh

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
J	FOR CONSENT - ROCK REVETMENT REMOVED AND PATH WIDTH CHANGED	KVS	JP		08/18
H	FOR CONSENT - MINOR AMENDMENT	KVS	JP		05/18
G	FOR CONSENT	KVS	JP		04/18
F	MINOR AMENDMENT	KVS	JP		09.03.2018
E	MINOR AMENDMENT	KVS	JP		02.03.2018
D	PRELIMINARY DESIGN	GC	JP		19.09.17
C	FOR REVIEW - MANY SHEETS ADDED, MANY SHEETS RE-NUMBERED	PJ COOK	JP		08/17

SURVEYED
DESIGNED
DRAWN
CAD REVIEW
DESIGN CHECK
DESIGN REVIEW
APPROVED
PROF REGISTRATION:

NOT APPROVED

Stantec

Client:

HUTT CITY TE AWA KAIRANGI

HUTT CITY COUNCIL
EASTERN BAYS SHARED PATH - DBC

PLAN - MCA0
YORK BAY STATION 2480 - 2680

Status Stamp: WORKING PLOT

Date Stamp

Scales 1 : 250

Drawing No. 80509137-01-001-C231

Rev. J

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