greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Shed 39, 2 Fryatt Quay
Pipitea, Wellington 6011
PO Box 11646
Manners Street
Wellington 6142
T 04 384 5708
F 04 385 6960
www.gw.govt.nz

**IN CONFIDENCE**
**By email**

31 January 2020

File Ref: HZRD-2-416

Shannon Watson
GHD
Level 2, Grant Thornton House
215 Lambton Quay
Wellington 6011

Tena koe Shannon,

I write in response to your email dated 21 January 2020 requesting a formal response to matters arising from submissions to the Eastern Bays Shared Pathway consent application.

In particular you asked me to respond to matters requiring expert advice relating to submission points covering aspects of the project related to; mitigation structure design, beach renourishment, loss of beach, climate change and resilience, alternative approaches and monitoring. The points I have responded to specifically are contained within submissions from the following parties:

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| 1. | Submitter No. 12 | Kathleen and Jeff Hobbs |
| 2. | Submitter No. 18 | Lorraine Girvan |
| 3. | Submitter No. 31 | Carole Hobbs |
| 4. | Submitter No. 53 | Jo Cullhane |
| 5. | Submitter No. 63 | John Arnold Butt |
| 6. | Submitter No. 66 | Michael Sheridan |
| 7. | Submitter No. 73 | Janet Hay |
| 8. | Submitter No. 80 | East Harbour Environmental Association Incorporated |
| 9. | Submitter No. 117 | Megan Turner |
| 10. | Submitter No. 158 | Sally Bain |
| 11. | Submitter No. 159 | Te Aranui O Pōneke, The Great Harbour Way Trust |
| 12. | Submitter No. 161 | Department of Conservation |
| 13. | Submitter No. 163 | Ruth Gilbert |
| 14. | Submitter No. 164 | Graeme Lyon |
| 15. | Submitter No. 179 | Geoffery Rashbrooke |
| 16. | Submitter No. 128 | Janice Heine |

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|---|---|---|
| 17. | Submitter No. 168 | Richmond Esmond Atkinson |
| 18. | Submitter No. 173 | Carol Lough |
| 19. | Submitter No. 177 | Judith Lawrence |
| 20. | Submitter No. 190 | Bruhlmann Gertrud (Trudi) |

My responses are set out by theme and include a summary of the main points raised in the submissions that I comment directly on.

# 1. Seawall design (incl. beach access)

## 1.1 Submission points summary

1.1.1 A number of submissions express concern that the proposed design will not reduce the incidences of overtopping, flooding and deposition of sand, gravel, driftwood and debris on the road and consequently will not prevent road closures. Some people felt because the walls were being pushed seaward it could result in more airborne spray.

1.1.2 Some submissions made note of the materials used in the design and thought there was too much use of concrete, that the structures were too large, or that they shouldn't use revetments for fear of boulders ending up on the road.

1.1.3 There were concerns that the recurve design may cause scouring of the beach and that seawalls cause wave deflection that makes swimming and boating less enjoyable.

1.1.4 Some people expressed concerns about the cost of the project.

1.1.5 There is a general concern that seawalls and revetments limit access to the beach.

## 1.2 Response

### 1.2.1 Sub-standard design

Marine Drive and a number of houses that have been built immediately landward and in some cases seaward of the road, are very low lying and close to the coastal marine environment (CMA) and naturally prone to coastal hazards. There are a limited range of options available to mitigating these hazards and these have been assessed and weighed against a range of criteria to develop a design that meets as many of these criteria as practicable, whilst being pragmatic and cost effective.

When it comes to preventing overtopping and coastal flooding from waves and storm surge it boils down to two main options: Large scale hard engineered options that are wide and high enough to prevent wave overtopping or; extensive beach renourishment to push the mean water level seaward and create a wide buffer between the land and sea that can absorb wave energy and hold back high water levels.

The decisions involved in this project are a balance between a range of criteria (both needs and values) including; financial cost, environmental impacts, impacts on access to the beach, visual amenity, public access, hazard mitigation and road maintenance, resilience to climate change and sea level rise.

The chosen design is a moderate mix of hard engineering (seawalls and revetments) and soft engineering (beach renourishment) to satisfy these criteria and minimise the footprint of the structures and effects on the environment. In order to prevent waves and spray overtopping, the revetments and seawalls would have to be both higher and wider which would reduce public access and amenity, involve considerably more reclamation of the coastal marine environment and be substantially more expensive. The beaches in the Bays are modest, with small sediment inputs and large scale renourishment programmes to build out the shoreline would be out of character with the natural amenity and cause smothering of the nearshore environment that impact on nearshore ecology.

### 1.2.2 Choice of materials

As discussed above, the decisions involved in this project are a balance between a range of criteria. The materials for the hard engineering aspects of this project are limited to rock and concrete because the proximity of infrastructure to the CMA requires robust durable materials that can withstand the impacts from coastal storms. Soft engineering options are limited by the small scale nature of the beaches that would be out of character to implement extensive coastal nourishment programmes.

### 1.2.3 Recurve seawall design

The recurve seawall is designed to reduce wave overtopping and return water to the beach. The design will cause no more or less scouring than would occur with a purely vertical wall. All seawalls cause some degree of scouring at the toe of the structure. This is because they interrupt the natural flow of swash across the foreshore and cause swash/wave reflection and reduce sediment deposition on the foreshore. This also causes the beach to be wetter for longer throughout the tide cycle that makes the beach more susceptible to erosion and scouring. This is the trade-off for using seawalls and between protecting infrastructure at the coast or effecting some sort of retreat and allowing the beach to operate naturally.

### 1.2.4 Project costs

Designing and building infrastructure and mitigation methods at the coast to withstand the impacts from storms, large waves and salt corrosion is expensive. The historical legacy of development around this coast means that the council and infrastructure providers are locked into protecting existing development. This comes at a cost and it must be weighed against the cost of doing nothing or simple maintenance of the status quo, that may end up being more expensive in the long run.

### 1.2.5 Restriction of public access

The design criteria for this project require materials and structures that can withstand the impacts from coastal storms and impacts from large waves. There is a trade-off between protecting infrastructure and providing safe walking and cycling access along Marine Drive and access to the shoreline. The more steps and access points through a seawall or revetment there are, the lesser its effectiveness because these become conduits for water and debris to flow through during storms. Because of this, access points also require more frequent maintenance because they are more susceptible to damage from coastal storms.

# 2. Beach renourishment

## 2.1 Submission points summary

2.1.1 There was a desire for additional beach nourishment to occur in places including Mahina and Okiwi Iti Bay.

2.1.2 Some submitters felt that the nourishment will not be effective and that over time the beaches will diminish in volume in part because there will be no follow up maintenance or that the renourishment material will be eroded.

2.1.3 Some submitters believe the gravels in the nourishment material will be preferentially sorted to the surface and upper parts of the foreshore where they will reduce the enjoyment of recreational beach users.

2.1.4 There is concern that the nourishment in Lowry Bay will impact on and potentially smother the seagrass community.

2.1.5 Some submitters were unhappy about the change in colour and texture of the imported material and that this will impact on amenity values.

## 2.2 Response

You asked me to make a qualified comment on the likely success of beach nourishment as proposed (ie, will the material used for renourishment remain in place to the extent necessary to consider it successful) and any recommendations that could be adopted by the applicant to further enhance the likelihood of successful renourishment noting that, at this stage HCC have not offered to undertake ongoing renourishment of the beaches.

### 2.2.1 Additional beach nourishment

Beach nourishment can be an effective method for offsetting loss of beach from encroachment and providing amenity that also acts as a natural defence against erosion and flooding. The scale and spatial extent of a nourishment is governed by the feasibility of nourishing to ensure material isn't unduly lost from the system (ie, coastal processes), the ability to source suitable sediments and related costs and effects on backshore, inter-tidal and nearshore ecology.

It may be feasible to increase the amount and locations where nourishment occurs in this project, as per some submitter's requests, but it will require further examination to ensure that there is material available and that it won't impact on coastal ecology such as the seagrass meadow in Lowry Bay.

### 2.2.2 Beach nourishment ineffective

The fact that beaches presently exist along the Bays, is proof that they are able to withstand the effects of waves and currents and storms without being completely eroded. This is unlikely to change if they are renourished or topped up with additional material.

Under sea level rise there will be a gradual loss of the beaches along the Bays of this project, starting with the loss of beaches at high tide and moving to complete loss at all stages of the tide. This is inevitable where the backshore is fixed with hard engineered structures that prevent the natural migration of the foreshore inland in response to a change in the environment from climate change and sea level rise.

The other process that leads to a slow loss in beach volume is attrition of beach gravels under wave breaking and swash flow where the input of fresh sediments from longshore transport is very low.

Both these effects can be offset with beach renourishment, but in the medium term will require maintenance to top-up the volume of the beaches. In this way, the recreational amenity of the beaches can still be enjoyed. In the longer term as the sea level rises, other options will be required to prevent the complete loss of the beaches along the Bays.

### 2.2.3 Gravels

The sorting of gravels and sands in a beach is controlled by a range of factors, including the composition percentages of sands and gravels in the sediment, the wave exposure and tide range. After storms, it is not uncommon to see patches of sand and/or gravel preferentially sorted into stringers or placers along the shoreline. Usually, in the ensuring days and weeks these are sorted back into a more homogeneous mix.

If the composition of the beach sediments are dominated by gravels, they will be more prevalent in the foreshore and for longer, particularly after storms. If the composition of the sediments has more sand then they will tend to bury the gravels.

Mixed sand and gravel beaches in a micro-tidal environment such as Wellington Harbour, that has a tide range of only 0.85 m, will remain a homogeneously mixed. This is evidenced by the existing situation along the beaches of the eastern Harbour shoreline. Some beaches that have a mixed range of sediments do get preferentially sorted with gravels sorted into the upper foreshore and sands into the lower foreshore, creating a low tide terrace. But these beaches generally have a large tide range and a moderately energetic wave environment that acts to sort the sediments regularly throughout the tide cycle.

### 2.2.4 Nourishment causing smothering

There is the potential for some beach renourishment sands to be transported down into the nearshore and cover some of the seagrass meadows in Lowry Bay. The risk of this can be managed by close monitoring the renourishment to ensure that it doesn’t cause smothering. In the mixed sand and gravel beaches, the sediments tend to remain in the foreshore, and be transported back and forward along the shore in response to wave activity, rather than be transported on and offshore into the nearshore as happens on swell dominated, open coast sandy beaches.

### 2.2.5 Nourishment colour and texture

The sediments that make up the beaches along the Bays are mostly greywacke sands and gravels derived from local rivers and streams, the erosion of rocky outcrops and headlands, colluvium from slips in the escarpment and roading base-coarse and aggregate. The sediments are transported in to the beaches via longshore sediment transport along the Harbour, dominantly from the south, and to much lesser degree from the north. As the sediments are transported along the shore, they experience attrition into smaller particles and weathering to form the grey-yellow colour typically associated with greywacke sediments. Fresh nourishment material will have a slightly different colour (more grey) and may be slightly coarser in order to enhance its emplacement on the beach, but over time this material with weather to be more yellow in colour and grade into finer sizes.

# 3. Loss of beach

## 3.1 Submission points summary

3.1.1 Some submitters were concerned that the structures, including the double and triple curved walls, would cause scouring of the beach and at the toe of the seawalls, thereby undermining the structures and potentially leading to a complete loss of the beach in some places.

3.1.2 Other submitters were concerned that the project itself would diminish the size of the beaches through reclamation of the foreshore for construction of the seawalls and pathway including at Point Howard Beach.

## 3.2 Response

### 3.2.1 Recurved seawalls

The recurve seawall is designed to reduce wave overtopping and return water to the beach. The design will cause no more or less scouring than would occur with a purely vertical wall. All seawalls cause some degree of scouring at the toe of the structure. This is because they interrupt the natural flow of swash across the foreshore and cause swash/wave reflection and reduce sediment deposition on the foreshore. This also causes the beach to be wetter for longer throughout the tide cycle that makes the beach more susceptible to erosion and scouring. This is the trade-off for using seawalls and between protecting infrastructure at the coast or effecting some sort of retreat and allowing the beach to operate naturally. However, the design takes this scouring into account and the structures are built to have foundations that are footed below the depth of scouring that occurs in the beach, and to be tied back landward thereby preventing structural failure. Standard asset monitoring will also pick up natural wear and tear from aging and damages from storms that inevitably occur and ensure that maintenance can be performed before a structure fails completely.

### 3.2.2 Reclamation

The project does involve a degree of encroachment into the CMA. This is spread out along the shore so that on average it is no more than around 1.0 seaward than the existing footprint of the seawalls. Where there are significant recreational and amenity beaches along the coast it is proposed that sediment renourishment be undertaken to offset this loss.

# 4. Climate change (incl. resilience)

## 4.1 Submission points summary

4.1.1 There were some submitters that expressed concern that the shared path will only improve resilience for a finite period and that beach enhancement will only have temporary benefits. Some people expressed the belief that the design is excessive. It was argued that over time due to climate change and sea level rise, it will be become more regularly flooded, the beaches will be lost and ultimately, in the medium to long term it may not be usable and HCC will have to raise the level of the road.

4.1.2 To this end some people argued that the seawalls were based upon incorrect asset life management and that they should be built later in the project to allow for sea level rise.

4.1.3 A number of submitters felt that the infrastructure should be adaptable to future impacts from climate change and sea level rise related hazards.

## 4.2 Response

### 4.2.1 Finite resilience

At this stage we know the rate of sea level rise and the likely impacts over the next 30 years (ie the design life of the structures) and can reasonably design the seawalls to withstand these effects and be adaptable to modification at a later date if changes in the climate become more extreme than they are currently tracking.

### 4.2.2 Incorrect asset management

Effects are occurring now – flooding and sea level rise are already having an impact. We know the current rate of local relative sea level rise we can foreseeably design the structures to account for this whilst retaining a design that is adaptable to future modifications.

### 4.2.3 Adaptable design

The seawalls are designed to be modular, and can have additional curves and height added to them if required at a future date.

# 5. Alternate methods/further suggestions (incl. rip-rap islands)

## 5.1 Submission points summary

5.1.1 A number of submitters suggested that breakwaters, surf breaks, rock rip-rap rock islands or other artificial structures could be constructed to absorb wave energy before it reaches the shore, particularly in the high energy places, obviating the need to build seawalls and reducing impacts from storms and waves on the pathway. Others argued that these structures would also stop gravel movement from blocking drains and pipes and will slow the loss of sand from the beaches, reducing the need for beach nourishment.

5.1.2 One person would like the seawall to continue fully into Sunshine Bay rather than the proposed rock revetment structure.

5.1.3 A number of submitters commented on the desire to see more use of boardwalks, particularly in areas where it becomes too narrow for cyclists and pedestrians to use the pathway safely.

## 5.2 Response

### 5.2.1 Rip-rap islands

A number of options exist to reduce the effects of wave energy reaching a shoreline. One of which is an offshore, detached breakwater or reef style structure as suggested by a number of submitters. Two ideas raised by submitters that have been used in coastal management solutions elsewhere are some shore parallel reefs or islands that could be set up in series, or just be a single larger structure and a submerged reef that could be constructed to direct incoming swell into a surfable wave.

For coastal management purposes, detached breakwaters are designed to have two main effects. One is to reduce wave energy reaching the shore and the second and related purpose is to encourage sand build up on the beach. The theory is, they create a lower energy wave shadow in the leeward side of the structure that reduces wave energy reaching the shore whilst at the same time encouraging sand deposition and accretion of the beach. As the beach grows in width, this helps buffer infrastructure from wave impacts and coastal flooding. A further, recreational use can be added to the structure by constructing in such a way as to create a surf wave.

There are two main reasons why such breakwaters would not be suitable for the stretch of coast along the eastern bays. The first is that there is very little sediment accumulation along this shoreline with very small sediment inputs from both longshore currents and from offshore. The Bays can all be considered pocket beaches that are semi-closed cells. Sediment moves around within them depending on the wave conditions, but only small quantities of fresh sediment are making into the cells. The structure would effectively only be operating to reduce wave energy, a function that can be performed by shore based structures. Secondly, it wouldn't stop all wave energy, it would only reduce it. In a storm, the coastal hazards are two-fold; large waves that cause erosion and structural damage and extreme water levels from storm surge that cause flooding and deposition of debris. In other words, a breakwater would still require seawall upgrades to reduce the impacts from flooding. It is also unlikely they would prevent sand and gravel from blocking stormwater outlets.

It is unlikely an artificial surf reef would be successful for its intended purpose along the eastern bays shoreline, because surf reefs require an open coast swell environment to be functional. The eastern bays coast is exposed to wind waves, from the northwest and south. Deeper ocean swell waves are strongly attenuated as they enter Wellington Harbour and have limited presence in the inner reaches of the Harbour. Artificial surf reefs are hugely expensive to develop, implement and maintain and likely to be beyond the budget of this project.

### 5.2.2 Sunshine Bay seawall extension

Like a lot of the decision making that is involved in this and similar projects, the decision to retain a revetment in the middle of Sunshine Bay is a pragmatic one taking into account a range of different considerations. The elevation of the carriageway in Sunshine Bay is only 2.0 m amsl, and is easily overtopped by wave runup because of its exposure to large northwest wind waves that break close to shore. The existing revetment was built to counter this and provide some protection for infrastructure and houses on the other side of the road that is also low-lying. The proposed design is working in with the existing structure and upgrading it, rather than removing it and extending the seawall.

From a coastal processes perspective there's no reason why the seawall couldn't be extended further along Sunshine Bay. It would potentially take up less of the CMA and free up foreshore for recreational beach users. However, it is possible it would require some rip-rap toe protection to help absorb wave runup and reduce overtopping and toe scour. A more detailed opinion on this option would require a coastal engineering assessment. It may be worth checking with HCC and Stantec to get further comment on this this.

#### 5.2.3 Boardwalks

In terms of providing wider access with boardwalks in areas that are constrained and narrow. Boardwalk construction has to be carefully designed in a coastal environment. Cantilevered boardwalks are one way to achieve this, but they have to be heavily engineered to withstand upward forcing wave impacts during a storm. This usually results in a visually obtrusive structure, that overhangs the coastal marine environment (CMA) and requires expensive ongoing monitoring and maintenance. The New Zealand Coastal Policy Statement (NZCPS) still considers this occupation of the CMA.

# 6. Monitoring

## 6.1 Submission points summary

6.1.1 Some people were concerned that the monitoring period was not long enough and suggested a longer period was required and that a review should be undertaken after two years to determine whether continuous monitoring is needed. It was argued this would aid the development of additional adaptive designs pathways.

## 6.2 Response

### 6.2.1 Monitoring

The proposal is that monitoring is flexible and that it will be for two years with the option to extend that for another 3 years if it is warranted. This should be enough time to allow the new seawalls and beach nourishments to obtain a new equilibrium with the wave and current climate in each bay. As to the longer term monitoring of the effectiveness of the whole project from the impacts of sea level rise and climate change; this would be undertaken through standard asset management processes within Hutt City Council.

Nāku noa, nā

**Dr Iain Dawe**
Senior Policy Advisor (Hazards)
Environmental Policy

DD: (04) 830-4031
iain.dawe@gw.govt.nz

Copy: Jo Frances