APPENDIX D – Hydraulics and Environmental Comment

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As outlined some of the route options for the proposed walkway pass close to Porirua Stream. There are four design scenarios we have commented on regarding any hydraulic and environmental effects, consenting issues and risks associated with these effects / issues. The four scenarios are:

A. Cutting walkway into existing stream embankment or back filling behind gabion walls.
B. Provide raised boardwalk on piles supported by stream embankment.
C. Provision of a walkway above embankment requiring stabilisation.
D. Provision of bridge abutments.

In order to get a better understanding of the existing situation and hydraulic engineering issues I initially met with Sharyn Westlake (Team Leader Strategy and Technical Support Flood Protection) and James Flanagan (Senior Eng. Flood Protection) of GWRC on 13th August. It was a very constructive talk. Both seemed very supportive of the project and have offered their assistance in the next design stages. For future meetings Sharyn suggested to take minutes to document the consultation for the resource consent

Sharyn explained that under their watercourses agreements with Wellington City Council and Porirua City Council, GWRC maintains the Porirua Stream from the CMA to Seton Nossiter Park (Northeast of Paparangi). Amongst other things the maintenance requirements comprise

a) stream access to carry out maintenance works and
b) maintenance of the flow / flood capacity, e.g. by cutting trees on the embankments, gravel extraction etc.

Sharyn also pointed out some GWRC property ownership issues that might affect the walkway design (e.g. in the Linden Park & Findlay Street area, i.e. end of section A / start of section B). However we did not cover this aspect in greater detail and this would have to be dealt with separately.

As far as the stream access is concerned, GWRC needs to be able to access the stream along the entire length through Tawa with machinery and from the bank edge to minimise any disturbance to the stream bed. However in view of the stream width I believe an access only from one side of the stream should be sufficient for the maintenance works. Moreover there exist a couple of identified access points that would need to be taken into account in future design stages. GWRC are only able to access along the stream bed in emergency conditions under the current freshwater plan and a specific resource consent is required to access the stream bed otherwise, which is not practical for general maintenance activities.

Where the stream banks are vertical or near vertical, for safety reasons this requires machinery to operate with a minimum distance from the bank edge. Where a walkway is proposed along the stream edge, GWRC would like to minimise the risk of damage to the proposed walkway. To allow safe working distance back from the edge of the river bank and to also allow for a walkway, they would expect a minimum width of not less than 7 metres. I pointed out that due to local confinements or property issues this space may not be available in places. A walkway design that allows maintenance machinery to drive on and operate from the walkway may be a feasible solution in those areas. This is common practise in other places and merely may require temporary walkway closure during maintenance works.

The focus of the meeting was on the flow and flood capacity of the Porirua Stream in the Tawa reach. GWRC has some limited hydraulic modelling information from the modelling carried out for the Porirua Stream Improvements in the late 1990's, and more recent modelling for a few sections of the stream (e.g. Findlay Street) and for the Seton Nossitor and Stebbings dam break analyses. The latest hydraulic model for flood hazard of the Porirua Stream was carried out by Connell Wagner for Wellington City Council in 1997. It's a 1D computational hydraulic model using MIKE11, a Danish Hydraulic Institute (DHI) software pack. Our Opus Water Resources Group has also standardised on the 1D and 2D DHI software for hydraulic modelling and has plenty of background experience of using them.

I had the chance to briefly inspect the flood inundation maps for Tawa that illustrated the potential flood zones for 50 and 100 year return period design flows and was able to make a few copies of the final Connell Wagner report (executive summary and hydraulic longitudinal sections). Meanwhile I have also contacted John Boot at WCC for digital versions of the flood inundation maps but have not received any to date.

GWRC has been operating a gauging station on the Porirua Stream approximately 1km from the outlet to the Porirua Harbour since September 1965 (called "Porirua Stream at Town Centre"). The following table, extracted from the GWRC webpage, reflects the flood return periods and respective flows that need to be taken into account in any design works. (Note that Mitchell Stream flows into Porirua Stream north of Tawa but above the gauging station site, so that the flows in Tawa will be smaller.)

Return Period (Year)	Average AnnualPossibility (%)	Flow (m^3/sec)
2 year flood	50	31
5 year flood	20	45
10 year flood	10	55
20 year flood	5	65
50 year flood	2	80
100 year flood	1	92

The flood inundation maps show that the 50 and 100 year return period design flows cannot be retained in the main channel, but spill out of the channel in various places and cause inundation, even in built-up areas. This means that the Porirua Stream is indeed below common design capacity. Any modifications within the main channel and to its lateral floodplain areas that reduce the existing cross-section area, e.g. with the aforementioned scenarios A, B and D, will result in water level changes with most certainly detrimental effects. Sharyn made it clear that GWRC will only accept a footpath design that causes no (or only minor local) water level rises.

Taking this information into account scenario A2, i.e. back filling behind gabions, does not seem a feasible design solution for the walkway along the Porirua Stream. This would reduce the hydraulic cross-section area considerably and result in raising water levels upstream and increase of flow velocities along the modified stream reaches. However scenario A1, i.e. cutting the walkway into the existing stream embankment, would increase the hydraulic cross-section and therefore be a favourable option worth considering.

An assessment of effects / issues of scenario B will require in-depth hydraulic calculations and modelling of the potentially affected stream reaches. We have been informed, however, that the latest MIKE11 hydraulic model is owned by Connell Wagner and not by WCC. At this point it is uncertain whether we could access the model, e.g. with the help of WCC, to carry out modelling works. From a cost-efficiency point of view it would be beneficial, in any case, to obtain and use the existing model.
An issue that would need to be addressed in conjunction with scenario B is potential clogging by debris. Single spaced piles tend to catch floating debris, especially during flood flows. Such debris accumulations can result in flow capacity reductions and local water level rises. In extreme cases the weight of debris accumulations together with the resulting loads from flow velocity forces can pose a risk to the structural integrity of piles or piers and therefore need to be taken into account in the structural design. Debris accumulations also need to be removed from time to time, i.e. require intensified maintenance.

Initially scenario C seems the most feasible design option, especially if the walkway stabilisation / foundation could to be placed beyond the main channel and its embankments. However this scenario would require further hydraulic investigations to determine sufficient walkway soffit levels above the design flood levels including freeboard recommendations.

The design and placing of bridge abutments (Scenario D) or piers should always be investigated from a hydraulic engineering point of view to assess their hydraulic effects, for example on water levels up- and downstream of the bridge, scour and lateral erosion potential and the need for erosion / scour protection. In view of the existing flow capacity issues I suggest to merely envisage single span bridges (i.e. without piers) with abutments beyond the main channel and its embankments. This scenario would also require further hydraulic investigations to determine adequate soffit levels for the design flood levels including freeboard recommendations.

I have compiled some typical costs to assist you with your costs estimates:

- Rip Rap / Rock armour protection: 70 - 80 $/t (stones incl. placing)
  Assume a specific weight of 1.7 t/m^3 and layer thickness of 0.6 - 0.8 m plus 0.1 - 0.2 m filter layer or geosynthetic (e.g. filter fleece at 25 $/m^2).
- Gabions: 400 - 475 $/m^3 or between 600 - 900 $/basket depending on basket size.
  Common basket sizes vary between 1.5 - 2 m in length and 0.5 -1 m in width/height.
  For examples see:
  www.maccaferri.co.nz/afawcs0121364/ID=67/SID=465517339/productdetails.html

Unfortunately I cannot provide you with standard costs for boardwalks on piles. The costs are site- and design-specific and will depend on the construction, i.e. its foundation, supporting substructure, cantilever (width), balustrade, wood material etc.

Works or modifications in waterways nearly always go along with environmental impacts. The effects that need to be distinguished are:

- temporary effects, e.g. during construction works and
- long-term effects, e.g. during its lifetime operation and possible decommissioning of an asset.

Construction works can have major impacts to the environment, but they usually can be mitigated to a certain degree. Possible effects are:

- Noise, air pollution (e.g. dust, emissions, odours) etc.
- Alterations to the stream hydrology.
- Direct disruption of aquatic habitat due to machinery working in the stream / river bed.
- Turbidity due to earthworks which in extreme cases can result in colmation (clogging) of the hyporheic interstitial causing oxygen deficiencies in the stream bed.
- Pollution from faulty machinery or negligent handling of hazardous substances on the construction site.

Long-term effects can result from the alterations to the natural environment or habitat.

It is advisable to assess all possible effects to the environment during the detail design phases, e.g. by means of an Environmental Impact Assessment (EIA). The basic idea of an EIA is to identify, predict, evaluate and mitigate the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made.

The identified issues can then be planned for and/or precautions taken. These can be for example

- special conditions in the tender documents,
- specific site measures (e.g. safety devices or designated areas for refuelling machinery, changing hydraulic oil or applying lubricants),
- experts (e.g. ecologist) supervising certain works of the contractors and interacting with the contract manager, who can for example identify existing features of stream habitat worth preserving and suggest or carry out specific remedial works if necessary (e.g. fish recovery).

From our experience with projects in the Wellington area, works or modifications in waterways will require some kind of environmental impact assessment as part of the consent application. For example the EIA for the Hutt River Stopbanks Improvements was carried out by a planner from GWRC (being the client of the works).

The time requirement and costs for these kinds of works are difficult to assess at this early stage as they depend on the design of the walkway, the affected stream length, the type of possible environmental impacts, the construction time and other determining factors. In other countries costs for EIA and expert advice have been found to be between 1 and 3% of the total project costs (max. 5% in complex infrastructure projects). Accordingly I suggest to include an item for a study-like EIA and some expert advice during the construction phase.

Another environmental aspect that will require some further consideration is the WCC “Wellington Wet and Wild Bush and Streams Regeneration Plan” that I’m aware of. I am currently trying to get hold of the details and to find out if the Porirua Stream is part of this programme.

As far as the consenting issues and its associated risks are concerned our Wellington Environmental Management Team can assist you with the information you need for the next steps. I will contact Lisa Gooch and ask for the relevant information to be compiled for you.