City of Richmond

Report to Committee

To:	General Purposes Committee	**Date:**	March 11, 2013
From:	Mike Redpath Senior Manager, Parks	**File:**	11-7200-01/2013-Vol 01
Re:	**Imperial Landing Lot H Infill Feasibility**		

Staff Recommendation

That the staff report "Imperial Landing Lot H Infill Feasibility" dated March 11th, 2013 from the General Manager, Community Services and General Manager Engineering and Public Works be received for information.

Dave Semple
General Manager, Community Services
(604.233.3350)

Robert Gonzalez, General Manager
Engineering and Public Works
(604.276.4150)

Att. 2

REPORT CONCURRENCE			
ROUTED TO:	**CONCURRENCE**	**CONCURRENCE OF GENERAL MANAGER**	
Sustainability	☑		
REVIEWED BY DIRECTORS	**INITIALS:**	**REVIEWED BY CAO**	**INITIALS:**

Staff Report

Origin

At the September 25, 2012 Parks, Recreation & Cultural Services Committee, staff were given the following referral regarding the Imperial Landing Lot H Infill Feasibility Study:

> *1) That staff consider water covered Lot H (located in front of the Imperial Landing dike trail in Steveston Village) as a paid infill site and report back*

This report is also in response to the following 2011 to 2014 Council Term Goals.

4.3. Fill Lot H and provide waterfront facility use (possible museum, market, or other use).

The purpose of this report is to provide an update on information regarding the feasibility of infilling the City-owned water covered "Lot H."

Analysis

Location:

This report focuses specifically on the City owned Lot H, a water covered parcel located in front of the Imperial Landing boardwalk/dike and the Maritime Mixed Use upland development.

The 1.9 acre water covered Lot H **(map Attachment 1)** is the wedge shaped parcel located predominately on the easterly end of this public pathway. The parcel extends out approximately 46 metres (150 feet) south from the existing boardwalk at its Eastern property line and then tapers sharply to meet the Western property line of the dike towards No. 1 Road and Bayview.

Feasibility Study:

The feasibility study conducted by the marine engineering firm, Worley Parsons Canada **(Attachment 2)**, have looked at the conceptual options for:

A. Infilling Lot H both from land based operations (dump trucks disposing fill from potential development sites) and collecting fees from potential developments seeking disposal options for their construction/excavation operations or;

B. Infilling via water based operations (dredging barge/crane operations from potential marine development sites) and collecting fees from potential developments seeking disposal options for their construction/excavation operations.

The report suggests that approximately 40,000 cubic metres of fill material could be utilized to fill-in Lot H. This works out to approximately 5,000 truckloads of fill material to meet future dike elevation standards of up to 4.9m.The feasibility study and analysis provided the advantages and disadvantages of utilizing Lot H as a paid infill site. A paid infill site is an area allocated to receive construction excavation materials such as gravel, soil, sand, concrete, etc. Similar to the recycling

and waste dump sites around the lower mainland, fees are collected from construction operations disposing their excavation materials onto the site.

Since Lot H is a water lot, it would require the construction of a containment 'wall" around its perimeter, also known as a cofferdam. This wall is required to prevent the infill materials from slipping away into the river. A cofferdam can be made from a sheet pile wall which are piles driven around the perimeter to secure a steel or concrete wall in place.

Both options would require the construction of a perimeter cofferdam/retaining wall built around the water covered Lot H parcel at a cost of up to $8.1 million. This cofferdam would contain the infill material and provide the structure to create a new 1.9 acre open green space along the waterfront.

Option A – Infill using Land based Equipment and Operations

Currently, locations for a paid disposal site exist in Tsawwassen, Pitt Meadow, Port Moody and Abbotsford for sand, soil, and gravel. For concrete and asphalt, sites include Ecowaste, Richvan, and the Vancouver Landfill. Disposal fees range from $50-$75 per truckload (not including labour and transportation).

Advantages:

- There is a market demand for local paid infill sites;
- Potential gross revenues of up to $300,000 could be collected thru dumping fees; and
- The City would gain a 1.9 acre waterfront open space.

Disadvantages:

- The existing access to the site is from a commercial/residential area, the Imperial Landing waterfront public boardwalk;
- The trail/boardwalk system linking Steveston Village to Britannia Heritage Shipyards would be closed to the public during infill operations for several weeks or months depending on the construction market;
- Up to 5000 truck loads would travel in and out of this busy waterfront pathway resulting in transportation and traffic challenges within the Steveston area;
- The existing dike system and boardwalk surface would need to be analyzed and tested to withstand heavy construction loads.

- The width of the boardwalk is not consistent and trucks will not have a turning radius for a single construction access. Two entrance and exit points are required including thru the No. 1 Road and the East Bayview access points;

- The No. 1 Road and Bayview access intersection is a primary trail linking the Steveston Village towards Britannia Heritage Shipyards and is a popular pathway for the residents in the community;

- Public concerns regarding noise, safety, and pedestrian traffic considerations during construction operations;

- Top of new ground elevation (to meet future dike standard elevations) at the potential fill site would be over 1 metre higher than the current boardwalk elevation; and

- The potential revenues of up to $300,000 collected from infill operations would only offset a fraction of the cost to construct a cofferdam containment area required to secure the infill.

Option B – Infill using Water based Equipment and Operations

The potential to have infill materials such as concrete, gravel, and sand transported via barges from the waterside could be considered; however, the shallow water depths and the narrow secondary channels in the Steveston waterfront would limit the works to smaller based local operations within the harbour.

It would not be financially feasible for a potential large scale development outside of the Steveston Channel to consider transporting excavation disposal materials onto trucks, then to a smaller barge that can fit into the Steveston Harbour. It would be more feasible for that type of operation to dispose directly to a land base infill site using trucks.

Currently, the Steveston Harbour Authority and Small Crafts Harbour conducts annual pocket dredging in areas that are critical to their operations. Since 2010, due to very limited funding resources available, approximately 10,000 to 20,000 cubic metres of dredged material were removed on an annual basis. This would suggest only 25-50% of the volume required to fill to the top of the infill site would be available thru the local annual dredging operations of the channel. This would result in a multi-year phase approach to achieve the desired volumes required to fill the parcel area from their annual dredging program, and presents an opportunity for other dredge operations such as those coordinated by Port Metro Vancouver to provide fill.

This option would be more technically feasible since access from the water via small barges and cranes could be utilized during operations. Operations from the water side would have less direct impact to the existing boardwalk/diking system.

Advantages:

- There is a market demand for local paid infill sites;
- Potential gross revenues of up to $300,000 could be collected thru dumping fees;
- Site would be accessible for dredging operations that utilizes smaller barge/crane/clamshell units or the use of suction dredging (piping material directly into the containment site);
- The City would gain a 1.9 acre waterfront open space; and
- Little or no impact to upland activities such as the trail boardwalk.

Disadvantages:

- Non localized dredging operations would potentially seek alternative disposal options due to labour and resource intensive operations to transport materials from a larger barge to a smaller barge that can travel into the narrow/shallow waters of the Steveston Harbour Channel. This would result in negligible cost savings for the companies seeking alternative disposal options;
- Successful dredging operations within the Steveston Harbour are subjected to funding availability from Provincial and Federal Government;
- Dredge materials (which is primarily silt and sand) would not be suitable as an infill material for building purposes. It would not have the structural integrity to accommodate a building type structure on the subject property;
- Infill from dredging operations could potentially take longer to complete its targeted fill capacity since it is subjected to current smaller localized operations; and
- The potential revenues of up to $300,000 collected from infill operations would only offset a fraction of the cost to construct a cofferdam containment area required to secure the infill.

Order of Magnitude Cost Estimates

Worley Parsons report provided an order of magnitude costs for the construction of the project including a potential cost recovery estimate of $300,000 from gross revenues of a paid infill site.

The conceptual estimate of $8.1 million do not include any administrative and legal costs, the cost of building a service road over the existing dike/boardwalk nor any costs associated with the geo-technical investigation and studies required for the engineering design of the perimeter cofferdam/ sheet pile retaining wall for the containment of the infill. Considerations should also

be made with any potential remediation for the existing dike/boardwalk system if it were to be damaged during construction operations.

The consultant's report provided this conceptual estimate with a 50% contingency since there are multiple components required for a more detail cost estimate. A detailed cost estimate to investigate all the variable components would cost between $75,000 - $100,000 for further engineering and environmental consultation, geotechnical and soil analysis, depth soundings, surveys and preliminary working drawings for the cofferdam.

Construction of a Cofferdam to infill Lot H **(Conceptual estimate $8,130,000)**

Infill Lot H for additional waterfront green space and the construction of a cofferdam perimeter which would contain the fill quantities required.

Regulatory and Approval Processes

The feasibility of infilling the City's Lot H water covered lot has revealed that there would be a high level of regulatory review, construction and operational challenges. Approvals would be required from a wide range and number of agencies such as Port Metro Vancouver, the Ministry of the Environment and Fisheries and Oceans Canada.

Environmental Impact

The Worley Parsons feasibility study did not include a thorough environmental impact assessment of the existing habitat and consideration of infill options associated with the riparian habitats comprised within Lot H. Should any of the proposed options be considered in the future, a full environmental study would be required for consideration of options and approvals from Fisheries and Oceans Canada and other triggering agencies on the Fraser River. Though costing for each infill scenario included general environmental compensation costing, future environmental assessments will require a full analysis of habitat impacts and resulting compensatory costs.

The City's Lot H is approximately 65% green and 35% red-coded habitat according to the Fraser River Estuary Management Program habitat coding map. Typically, development may occur with fewer restrictions in green coded habitat which corresponds to Low Productivity (limited habitat and function value). Red coded habitat indicates High Productivity (highly productive and diverse habitat that supports critical fish and wildlife functions). Development of red coded zones is restrictive and only projects that are undertaken specifically for public health and safety would be considered.

Until options for infill scenarios are presented to Fisheries and Oceans Canada and other triggering FREMP agencies, it is uncertain whether an infill of red-coded habitat will be

supported. Further studies will be required in order to determine feasibility and compensatory options for infill scenario.

Financial Impact

There are no financial implications with this report.

Additional Considerations

If the land based infill operations were to be considered, there would be significant impacts to the boardwalk/dike/trail system that is currently being remediated.

Currently, the City's 600 foot long modular floats are located in front of Lot H which is accessed by the existing pier head/look-out. This popular site is used daily by residents of the community, recreational fishermen, tourists, and it is also home to multiple City special events such Ships to Shore and Dragon Boat Races. By infilling Lot H, significant modifications would be required to maintain the existing modular floats at this location since the existing pier head/look-out will have to be integrated as part of the cofferdam/containment area. This would result in additional costs of up to $250,000 that have not been considered within the Worley Parsons report.

Conclusion

The potential for a paid infill site within the City owned water covered Lot H is not a recommended option based on the cost and the potential impacts to the neighbourhood and site. The potential gross revenue of $300,000 for dumping fees collected would not amount to a significant contribution within the overall scope of the project. In order to consider this option, the City would first have to construct a cofferdam/containment perimeter of Lot H at a cost of up to $8.1 million.

Mike Redpath
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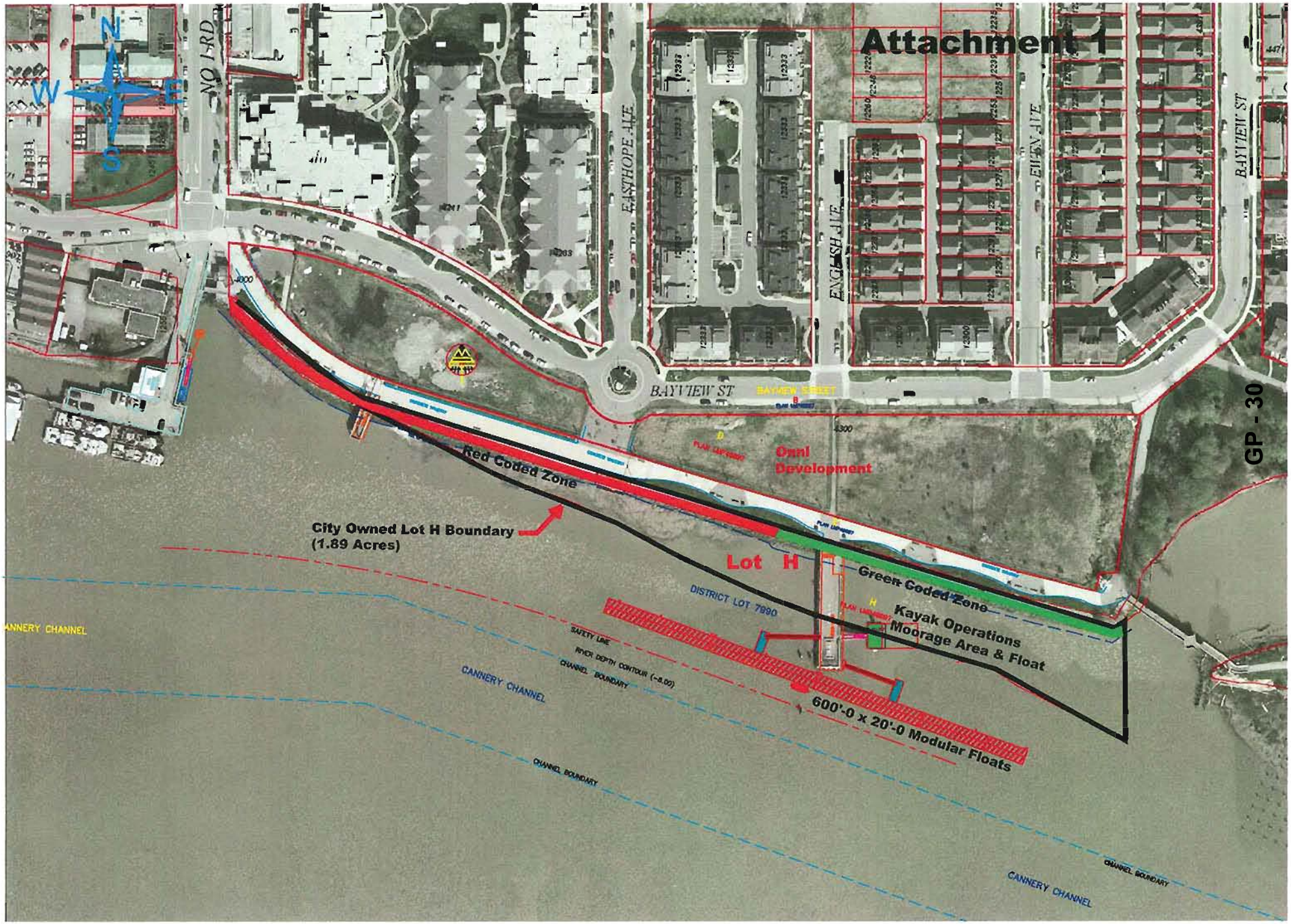
John Irving
Director, Engineering & Public Works
(604-276-4140)

Attachment 1



WorleyParsons
resources & energy

EcoNomics

CITY OF RICHMOND

Feasibility of a Paid Infill Lot H at Imperial Landing

307071-00356 – 00-MA-REP-0001

15 November 2012

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1. INTRODUCTION

WorleyParsons Canada Services Ltd. (WorleyParsons) is pleased to provide this evaluation and associated recommendations for undertaking land reclamation at Lot H, located at the Imperial Landing site in Steveston Village, B.C. Imperial landing is a river front public park adjacent to Bayview Street from No. 1 Road at the West end to Railway Avenue at the East end. Figure A below shows the general layout of the site.

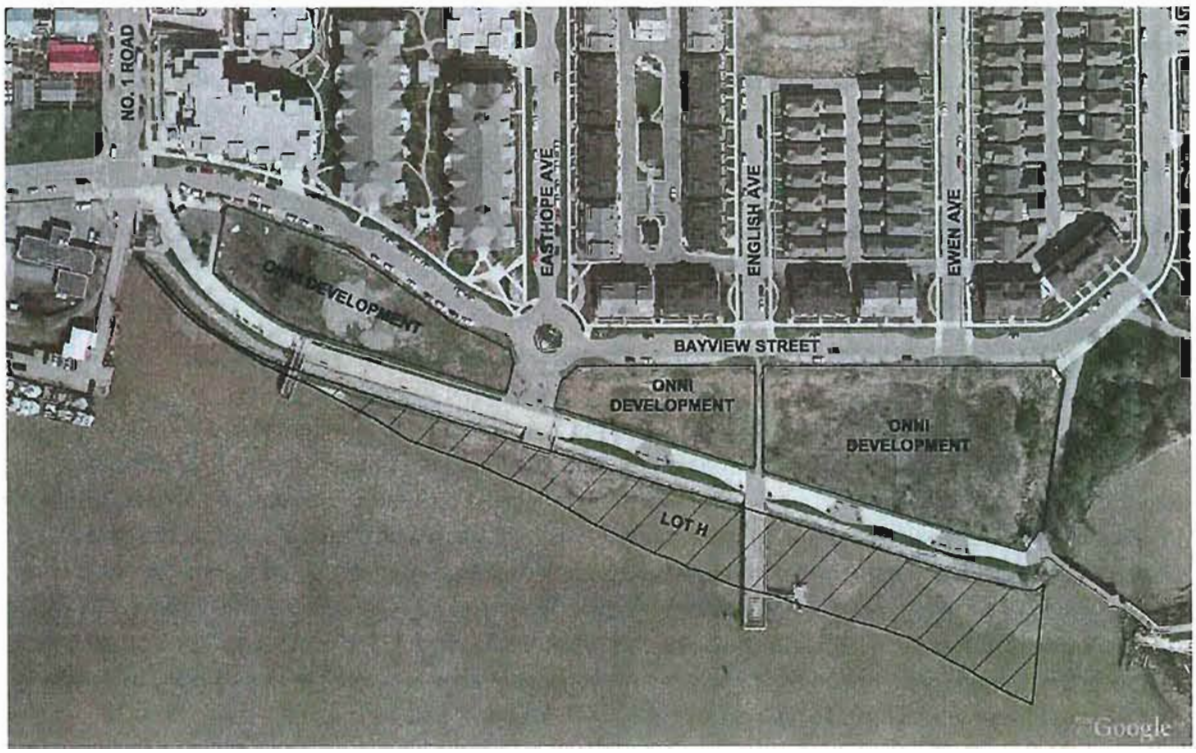

Figure A General Site Layout

2. REFERENCES

The following documents were reviewed in reference to this study:

1. Revised Imperial Landing Infill Cost Study – Review of Design Options and Order-of-Magnitude Cost for Installation, dated October 26, 2011(attached).
2. CoR Report to Committee dated March 13, 2012, File: 06-2345-00 / Vol.01.

3. CoR Parks, Recreation & Cultural Services Committee, dated Tuesday, September 25, 2012.
4. Survey Plan of District Lot 7990, dated October 23, 2002 (attached).

3. BACKGROUND

This evaluation is a continuation of the Revised Imperial Landing Infill Cost Study completed by WorleyParsons on October 26, 2011 and compares Option 4 presented previously to setting up a paid infill lot (Lot H), discussed here. By having developers dispose of their non-structural fill, City of Richmond (CoR) seeks to determine if charging for non-structural fill can be used as a source of revenue to offset the overall cost of the project. As seen in the attached legal survey in Appendix A, Lot H covers about one third the area of the Imperial Landing site that was discussed in the October 2011 report.

4. RESULTS

CoR has requested that WorleyParsons evaluate two options for reclaiming land to expand the park area: placing fill versus constructing a pile and deck structure.

4.1 Option A - Infilling of Lot H using disposal fee fill

WorleyParsons understands that the City of Richmond is considering this project to reclaim Lot H using non-structural fill acquired by using Lot H as a paid infill site to extend the green space. The finished elevation of this park would be at +4.9 m to match the proposed dike elevation requirements as discussed in reference 1. The revenue generated from creating this infill site would be used to offset the cost of creating this additional park space. The city would have to build a cofferdam at the perimeter of Lot H to contain the fill. This would require approval from Fraser River Estuary Management Program (FREMP). As previously discussed in Reference 1 above, this would likely require 1:1 compensation for the fill prism footprint. Since there is no option for this onsite, an equivalent area of shoreline at another CoR property along Fraser River would have to be created as per FREMP guidelines.

4.1.1 Option A-1 - Infill using Land based Equipment

Advantages

Property developers in the lower mainland dispose of non-structural fill on a daily basis. Currently, the only available options for a paid disposal exist in Tsawwassen, Pitt Meadow and Port Moody or as far away as Abbotsford. Round trip by a truck transporting this material can take up to as much as 2 to 3 hours depending on traffic. The labour and transportation costs are in addition to the tipping cost that range anywhere from $50-$75 per truckload. This creates a market demand for local paid infill sites, provided that adequate access for heavy dump trucks can be made available.

There are a few upcoming residential developments that will be under construction in the nearby area, such as the Quintet in downtown Richmond and other building in the Metro Vancouver area that can use the site for disposing non-structural fill, provided that the material is not contaminated. The City would have to provide a perimeter cofferdam structure to contain the fill prior to opening this paid fill site.

Disadvantages

From the limited sounding survey information available, the estimated volume required to infill lot H to an elevation of +4.9 m is approximately 40,000 m^3. On average, a dump truck can haul as much as 8 m^3 of soil. This requires approximately 5,000 trucks to complete the infill.

At lot H, the existing access to the waterfront is via a residential area located adjacent to a city-owned dike and public concrete walkway system. The dike and existing infrastructure would have to be analyzed for withstanding heavy construction loads. The width of the concrete paved walkway is not consistent and would prove difficult logistically for heavy trucks that require a larger turning radius. Noise consideration due to a large number of trucks would also need to be taken into account as the site is near residential building.

4.1.2 Option A-2 - Infill using Water based equipment

Advantages

Fraser River Pile Driving (FRPD) dredges the Fraser River every year to maintain clear navigation channels. The structural fill from this dredging is commercially sold. The non-structural material is hauled off in a bottom opening dumper barge to a deep ocean site for dumping. This material could be dumped at Lot H using a crane bucket placement from the marine side given that a perimeter cofferdam is already built.

Disadvantages

FRPD mainly uses bottom opening dumper barges to offload their disposal material in deeper ocean. They have an ongoing license and approval to dump their material at their designated deep ocean site. The bulk of their costs for this disposal come from the time and resources required to take the barge out to sea. To infill at a shallow shore end would require bucket placement of material from a larger barge, that must remain in deeper water. This option is labour and resource intensive and would likely not yield a revenue stream for the city.

4.2 Order of Magnitude Cost Estimate

Tabulated below are order of magnitude costs for charging disposal fee from land side tipping of infill.

Table A Estimate Order of Magnitude Costs for Option A-1 – Sheet Pile Wall with Reclaimed Fill using Disposal Fee Fill from Landslide

Description	Cost
Demolition of existing decks	$60,000
Mobilization / demobilization	300,000
Marine habitat compensation	500,000
Sheet pile / cofferdam installation	4,100,000
Reclaimed fill (top of cofferdam at + 4.9 meters)	(300,000)
Timber deck	760,000
Subtotal	**$5,420,000**
Contingency and Engineering (50%)	2,710,000
Total	**$8,130,000**

In reviewing the above costs, please note the following:

1. The estimate is based on in-house experience with similar projects and prices provided by the suppliers.
2. The sheet pile cost estimate is based on a maximum 10 m sheet pile length. A complete geotechnical study is required to verify embedment depth and hence the adequacy of the pile length.
3 Soil and water environmental remediation are not included.
4. Park programming costs including but not limited to, grass, plants, sidewalks, lighting, handrails, and buildings are not included.
5. The contingency is not a reflection of the accuracy of the estimate, but covers items of work which will have yet to be performed, and elements of cost which will be incurred, but which are not explicitly detailed or described due to the level of engineering which has been completed to date. Contingency is not intended to cover the scope changes.
6. The estimate is considered to be a reasonable order-of-magnitude and is not intended to be used to set a project budget.
7. The estimate does not account for salvage value of existing piers, floats, or gangways located on site.

8. Marine habitat compensation estimate is based on compensated land located within this proposed site.

9. No cost estimation has been included for the museum building structure.

10. HST is not included in the estimated costs.

4.3 Option B – Option 4 (Reference 1 – Pile and Deck Structure)

This option is discussed in detail in WorleyParsons report cited as Reference 1 above. While this option does not require infill, it does require soil improvement prior to installation of a pile and deck structure. This pile and deck structure is proposed to be offset from shore by approximately 10 m and would support a museum building. The elevation at the top of the finished pile and deck structure would be at +4.9 m to match the proposed dike elevation. This option is detailed in drawing number 307071-00356-00-MA-DAL-1503, Rev.A appended to Reference 1.

An order of magnitude cost estimate for this option is presented as Table D on page 6 of Reference 1. The total estimated cost is approximated at $8,000,000.

5. CONCLUSION

WorleyParsons suggests that Lot H may be used as a paid infill lot. However, the cost associated with maintaining / improving the existing infrastructure due to damage and demand of heavy construction equipment makes this option impractical. Logistically, having thousands of dump trucks transport soil through narrow access ways in close proximity to residential area would be difficult. The noise level so close to residential occupancy will be less than desirable. And it would require many developments in the metro Vancouver area to generate the volume of soil required to infill this lot. The timing of material availability would be outside of CoR's control and would greatly affect the schedule of this project.

The marine infill option would not generate revenue for the city. The material revenue would be offset by labour and equipment required to place the material so close to shallow riverfront. Placement would have to be carried out by mechanical means using buckets. FRPD's preferred method for disposal is through bottom opening barges which cannot be used at shallow water depths.

It has been our experience that it would be challenging to get FREMP's approval for a vertical sheet pile wall structure in the Fraser River. The paid lot option would incur additional land mitigation costs that outweigh the revenue generated by the city.

For the reasons stated above, the pile and deck structure discussed as Option 4 in detail in Reference 1 above would be the more practical of the two options. From previous experience, it would be much simpler to get an approval from FREMP for a pile and deck type of construction. Pile and deck structure that is off set from shore allows plenty of natural light to enter the water. Additionally the pile and deck would be carried out from the River reducing onshore disturbance.

Appendix 1 References

WorleyParsons
resources & energy

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26 October 2011

Proj. No.: 307071-00356
File Loc.: Burnaby

City of Richmond
Parks and Recreation Department
5599 Lynas Lane
Richmond, BC
V7C 5B2 Canada

Attention: Marcus Liu

Dear Mr. Liu:

RE: REVISED IMPERIAL LANDING INFILL COST STUDY REVIEW OF DESIGN OPTION AND ORDER-OF-MAGNITUDE COST FOR INSTALLATION

The City of Richmond (CoR) is investigating the feasibility of infilling the shoreline at the Imperial Landing Park in Steveston, BC, to expand the usable park area and possibly add a public space building. WorleyParsons Canada Services Ltd. (WorleyParsons) was requested to provide engineering services to develop conceptual options and order-of-magnitude cost estimates.

1. SCOPE OF SERVICES

WorleyParsons' scope of services is summarized below:

- Development of concepts for five conceptual options for the waterfront development at the Imperial Landing Park.
- Develop order-of-magnitude cost estimates (±50%) for each of the five options.
- Development of conceptual drawings illustrating the five conceptual options.
- Preparation of a letter describing the concepts and presenting the cost estimates.
- Preparation of comments on environmental and permitting issues related to the five options considered.

2. DESIGN CONSIDERATIONS

2.1 Design Criteria

The design criteria considered for the concept options is:

- Service Life: 50 years
- Uniform Distributed Live Load: 4.8 kPa
- Vehicular Load: Park maintenance pickup truck
- 2011 City of Richmond Flood Level Including Freeboard: 4.9 m
- Area of Museum Building to be Located on Site (Options 3 and 4): 1,400 sq. m

2.2 Tides and Bathymetry

Published tidal levels for the Fraser River to hydrographic tide and chart datum are listed below:

- Higher High Water Level (HHWL): +2.1 m
- Lower Low Water Level (LLWL): -2.3 m

2.3 Potential Geotechnical Considerations

No geotechnical field investigations have been conducted to date at the site to verify existing ground conditions or verify slip circle stability of the sheet pile retaining wall. Slip circle stability determines the recommended depth of fixity required for installation of a sheet pile wall. At this level of conceptual engineering, the height of the sheet pile wall has been estimated at 10 m.

The CoR drawing titled "Imperial Landing Waterfront Park Infill Proposal of Lot H and District Lot 7990" highlights approximately 5,000 cu. m of contaminated soil located within the park boundaries.

WorleyParsons have undertaken projects in the vicinity of the park site. Based on our experience at nearby sites, it is expected that the in-situ soil will liquefy under the design seismic event specified in the BC Building Code. To address this, it is recommended that either a cellular dam structure or soil densification in combination with a pile and deck structure be installed to minimize lateral movements during an earthquake.

A cellular dam structure offers two advantages. Firstly, it allows for compensation of marine habitat lost due to the proposed infill; and secondly, it can be designed to act as a seismic berm to reduce the risk of liquefaction and slope failure along the shoreline. This will reduce the amount of lateral displacement experienced by retained soils and any structures supported on this retained soil. At this level of concept engineering, a cellular dam consisting of two parallel sheet pile walls spaced approximately 10 m apart and interconnected perpendicularly by sheet pile wall sections at about 10 m spacing to create a series of "cells" is recommended. The engineered infill for this structure should be granular backfill which is less susceptible to liquefaction.

Densification for the pile and deck structure detailed in Option 4 will be required. It can be achieved by the use of stone columns, vibro-compaction, or by employing timber compaction piles. The area requiring densification would at a minimum have to include the entire footprint of the building structure.

2.4 Environmental and Permitting Considerations

Vertical sheet steel pile structures offer little habitat value for aquatic organisms as they do not provide crevice habitat for fish and invertebrates.

The Harmful Alteration, Destruction, or Disruption (HADD) of a Fraser River Estuary Management Program (FREMP) red zone area is not usually considered for compensation. Mitigation measures are typically required to conserve such areas. A design to mitigate environmental impact could consist of offsetting a pile supported pier structure away from the shore so that riparian vegetation is not shaded.

There is a potential environmental liability associated with the contaminated area realized during dredging. Consideration should be given to remediation by "capping" this area, if the natural rate of sediment deposition does not accomplish this.

Due to euryhaline conditions, colonization of constructed habitat features, such as planting benches, will meet with limited success usually confined within the uppermost intertidal area.

3. CONCEPTUAL ARRANGEMENTS

The general arrangement plan for this site is attached in Appendix 1 as Drawing No. 00356-00-MA-DGA-1500.

3.1 Option 1 - Sheet Pile Wall with Engineered Fill

Option 1, shown on Drawing No. 00356-00-MA-DGA-1501 in Appendix 1, requires the installation of a steel sheet pile wall located directly offshore from the current shoreline, approximately 430 m long. The structure shall be backfilled with engineered fill and will be capable of supporting commercial structures such as the proposed museum building. The total area in-filled shall be 15,750 sq. m.

3.2 Option 2 - Sheet Pile Wall with Reclaimed Fill

Option 2, shown on Drawing No. 00356-00-MA-DGA-1501 in Appendix 1, requires the installation of a steel sheet pile wall as described above in Option 1, except that the backfill uses non-engineered reclaimed fill. In this option, the in-filled area shall be used for a park space only, with no building development. Since the infill is of a reclaimed nature, it is expected that the sheet pile wall toe depth would likely be deeper than that of Option 1.

3.3 Option 3 - Sheet Pile Wall and Pile and Deck Structure with Reclaimed Fill

Option 3, shown on Drawing No. 00356-00-MA-DGA-1502 in Appendix 1, requires the installation of a steel sheet pile wall as described above in Option 2, as well as a pile supported structure within the in-filled area capable of supporting a two-storey museum structure. The piles in this option are to be steel tubes that have cast-in-place concrete pile caps and precast concrete stringers.

3.4 Option 4 - Pile and Deck Structure

Option 4, shown on Drawing No. 00356-00-MA-DGA-1503 in Appendix 1, consists of a pile supported structure capable of supporting a two-storey museum structure. The piles in this option are to be steel tubes that have cast-in-place concrete pile caps and precast concrete stringers. The pile and deck structure will be offset from shore approximately 10 m to allow natural light to pass through. Densification of this area using stone columns, vibro-compaction, or timber compaction piles will be required.

3.5 Option 5 - Sheet Pile Wall with Reclaimed Fill and Concrete Flood Wall

Option 5, shown on Drawing No. 00356-00-MA-DGA-1504 in Appendix 1, requires the installation of a steel sheet pile wall as described above in Option 1, except that the backfill uses reclaimed fill. In this option, the in-filled area shall be used for a park space only, with no building development. The finished elevation of the in-filled site will be at 3.7 m. A concrete breakwater will be built to the elevation of 4.9 m to prevent flood waters from entering this in-filled area. This breakwater may be disguised as an architectural feature of the park.

4. ENVIRONMENTAL EVALUATION OF OPTIONS

Options 1, 2, and 3 will require compensation (likely 1:1) for the fill prism footprint. As there is no option for this on-site, due to the scale of the proposed project, CoR would need to create (excavate and liberate) an equivalent area of shoreline at another CoR property on the Fraser River, in accordance with FREMP guidelines for no net loss.

Option 4 is the most readily approvable, as a pier supported structure will not require compensation for infill and could be offset from the shore. Designs for this option should incorporate mitigation to reduce shading impacts to riparian vegetation and aquatic habitat.

5. COST ESTIMATE

Conceptual order-of-magnitude capital cost estimates have been prepared based on the scope of work described above and are summarized in Tables A to E.

Table A Estimated Order-of-Magnitude Costs for Option 1 - Sheet Pile Wall with Engineered Fill

Description	Cost
Demolition of existing decks.	$60,000
Mobilization / demobilization.	300,000
Marine habitat compensation.	500,000
Sheet pile / cofferdam installation.	6,585,500
Engineered fill.	4,550,000
Timber deck.	800,000
Subtotal	**$12,795,500**
Contingency and Engineering (50%)	6,397,750
Total	**$20,000,000**

Table B Estimated Order-of-Magnitude Costs for Option 2 - Sheet Pile Wall with Reclaimed Fill

Description	Cost
Demolition of existing decks.	$60,000
Mobilization / demobilization.	300,000
Marine habitat compensation.	500,000
Sheet pile / cofferdam installation.	6,585,000
Reclaimed fill.	1,400,000
Timber deck.	800,000
Subtotal	**$9,645,000**
Contingency and Engineering (50%)	4,822,500
Total	**$15,000,000**

Table C Estimated Order-of-Magnitude Costs for Option 3 - Sheet Pile Wall and Pile and Deck Structure with Reclaimed Fill

Description	Cost
Demolition of existing decks.	$60,000
Mobilization / demobilization.	500,000
Marine habitat compensation.	500,000
Sheet pile / cofferdam installation.	6,585,000
Pile and deck structure.	2,800,000
Reclaimed fill.	1,400,000
Timber deck.	800,000
Subtotal	**$12,645,000**
Contingency and Engineering (50%)	6,322,500
Total	**$19,000,000**

Table D Estimated Order-of-Magnitude Costs for Option 4 - Pile and Deck Structure

Description	Cost
Mobilization / demobilization.	$500,000
Marine habitat compensation.	200,000
Pile and deck structure.	2,800,000
Soil densification.	1,500,000
Subtotal	**$5,000,000**
Contingency and Engineering (50%)	2,500,000
Total	**$8,000,000**

Table E Estimated Order-of-Magnitude Costs for Option 5 - Reclaimed Fill and Concrete Breakwater

Description	Cost
Demolition of existing decks.	$60,000
Mobilization / demobilization.	300,000
Marine habitat compensation.	500,000
Sheet pile / cofferdam installation.	6,585,000

Description	Cost
Reclaimed fill.	1,400,000
Concrete breakwater wall.	160,000
Timber deck.	800,000
Subtotal	$9,805,000
Contingency and Engineering (50%)	4,902,500
Total	$15,000,000

In reviewing the above costs, please note the following:

- The estimate is based on in-house experience with similar projects and prices provided by the suppliers.
- The sheet pile cost estimate is based on a maximum 10 m sheet pile length. A complete geotechnical study is required to verify embedment depth and hence the adequacy of the pile length.
- Soil and water environmental remediation are not included.
- Park programming costs including but not limited to, grass, plants, sidewalks, lighting, handrails, and buildings are not included.
- The contingency is not a reflection of the accuracy of the estimate, but covers items of work which will have yet to be performed, and elements of cost which will be incurred, but which are not explicitly detailed or described due to the level of engineering which has been completed to date. Contingency is not intended to cover the scope changes.
- The estimate is considered to be a reasonable order-of-magnitude and is not intended to be used to set a project budget.
- The estimate does not account for salvage value of existing piers, floats, or gangways located on site.
- Marine habitat compensation estimate is based on compensated land located within this proposed site.
- No cost estimation has been included for the museum building structure.
- HST is not included in the estimated costs.

6. CONCLUSION

In light of the environmental considerations discussed above and the order-of-magnitude cost estimates presented, Option 4 is the most feasible option of the five presented in this letter. It allows for the creation of additional public space without adversely affecting the environment or disturbing any contaminated soil. It is important to note that each of these five options require detailed engineering prior to construction.

Regards,

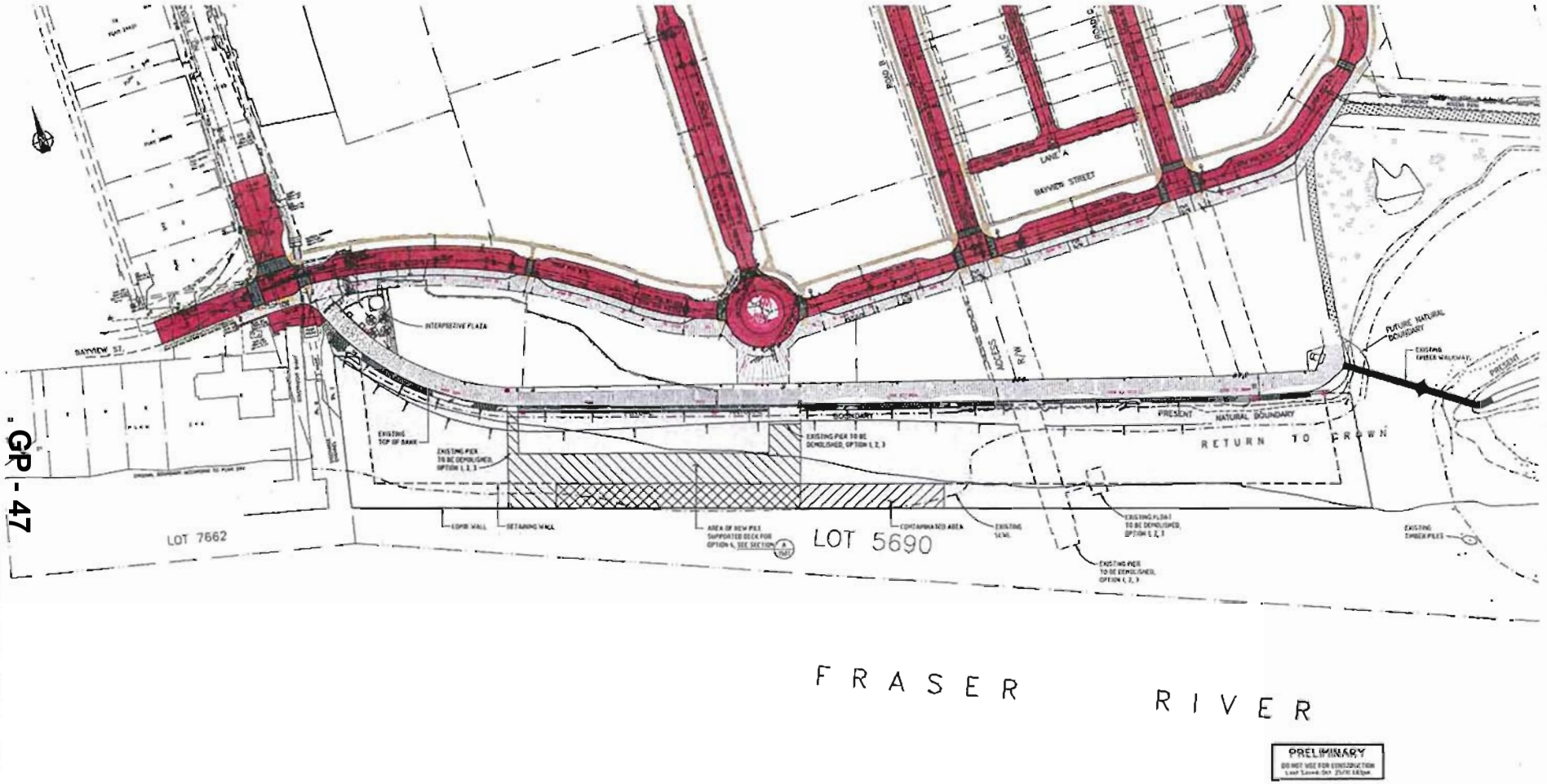
Nadia Krys, P.Eng., P.E.
Marine Structural Engineer

BC Business Unit
Infrastructure & Environment
WorleyParsons Canada Services Ltd.

NBK/tmw
enc.

cc: Anthony Peterson, WorleyParsons Canada Services Ltd.
Mark Ramsden, WorleyParsons Canada Services Ltd.
Daniel Leonard, WorleyParsons Canada Services Ltd.
Steve Colwell, WorleyParsons Canada Services Ltd.

Appendix 1 Drawings



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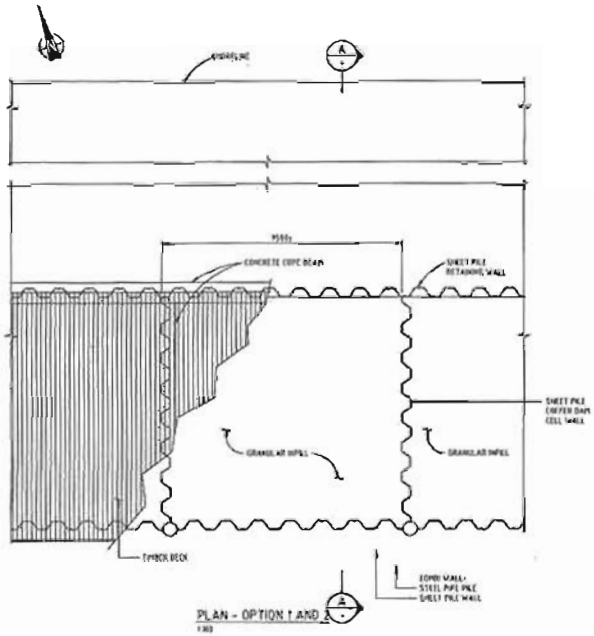
PRELIMINARY
DO NOT USE FOR CONSTRUCTION

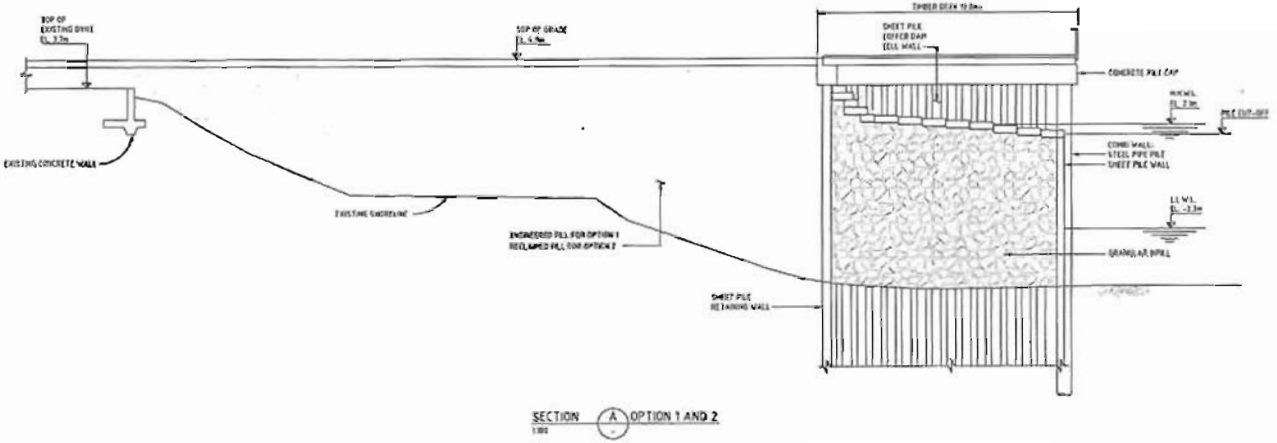
PLAN

REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	TA/OWNER	REF DRAWING No.	REFERENCE DRAWING TITLE
B	25-OCT-11	RE-ISSUED FOR CLIENT REVIEW	JB	-	MBK	-	-	-		
A	14-OCT-11	ISSUED FOR CLIENT REVIEW	BM	-	MBK	-	-	-		

DESIGN STAGE: AS SHOWN
ENGINEERING AND PERMIT STAMPS (as required)
OneWay
WORLEYPARSONS PROJECT No: 00356
DESCRIPTION
Richmond
WorleyParsons
IMPERIAL LANDING INFILL STUDY
GENERAL ARRANGMENT
DRG No: 00356-00-MA-DGA-1500
REV: B



PLAN - OPTION 1 AND 2



SECTION A OPTION 1 AND 2

PRELIMINARY
DO NOT USE FOR CONSTRUCTION

REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
B	25-OCT-11	RE-ISSUED FOR CLIENT REVIEW	JR	-	NBK	-	-	-		
A	14-OCT-11	ISSUED FOR CLIENT REVIEW	JR	-	NBK	-	-	-		

D SHEET | SCALE AS SHOWN

Oneway

ENGINEERING AND PERMIT STAMPS (as Required)

DEVELOPER

Richmond

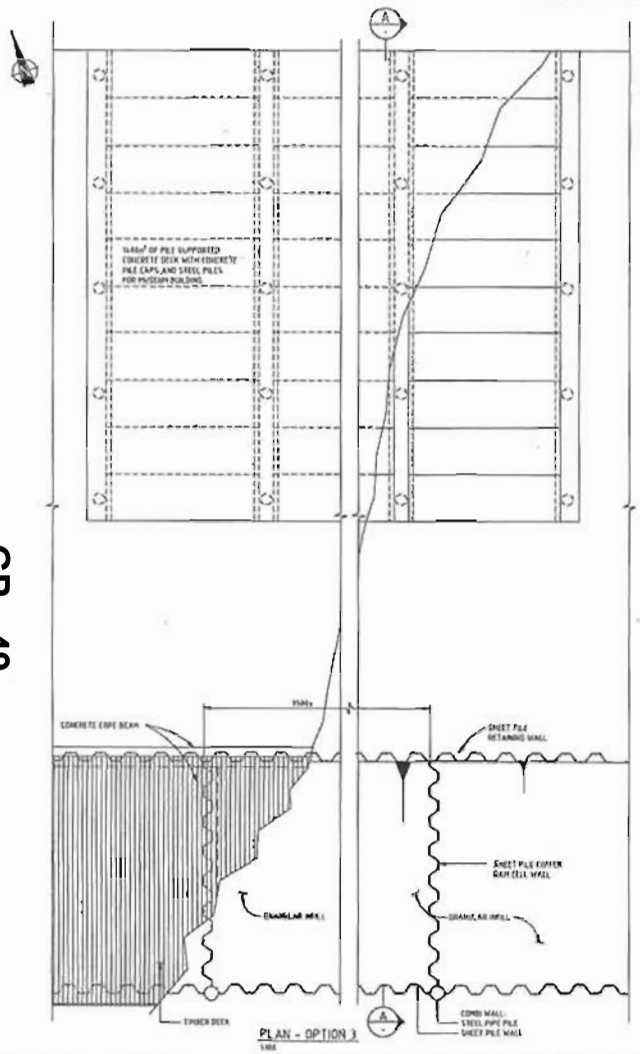
WorleyParsons

IMPERIAL LANDING INFILL STUDY
PART PLAN AND SECTIONS
OPTION 1 AND 2

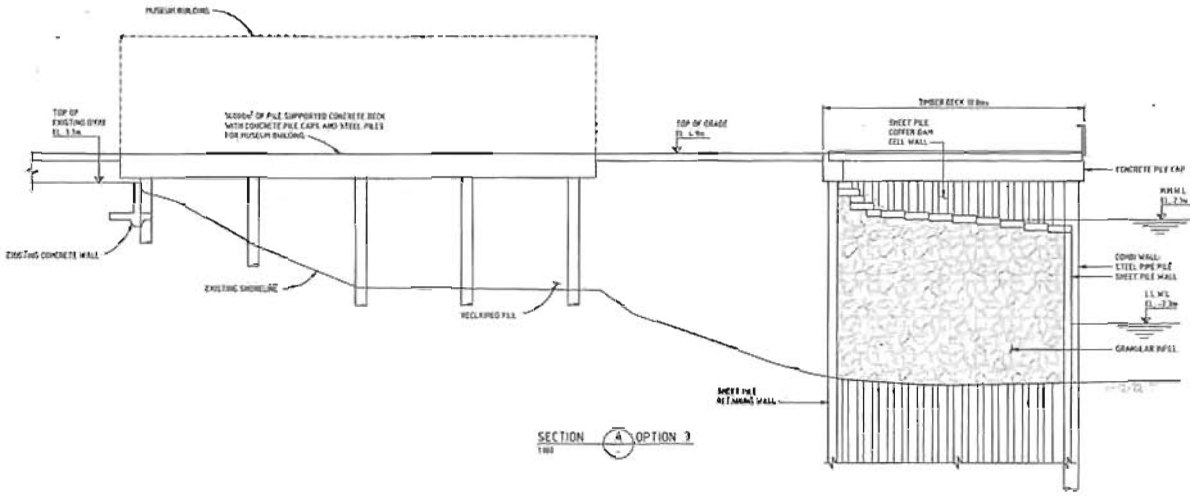
WORLEYPARSONS PROJECT No: 00356

DRG No: 00356-00-MA-DAL-1501

REV: B



PLAN - OPTION 3



SECTION A OPTION 3

PRELIMINARY
DO NOT USE FOR CONSTRUCTION

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A	25-OCT-11	ISSUED FOR CLIENT REVIEW	JB	-	MM	-	-	-		

SHEET SCALE AS SHOWN

ENGINEERING AND PERMIT STAMPS (as Required)

CUSTOMER

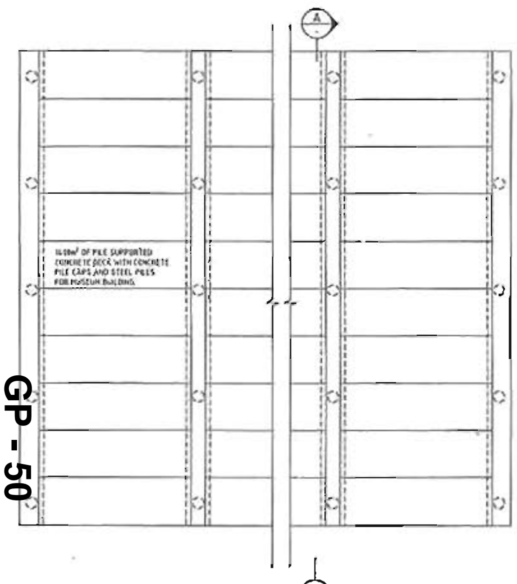
WorleyParsons

IMPERIAL LANDING INFILL STUDY
PART PLAN AND SECTIONS
OPTION 3

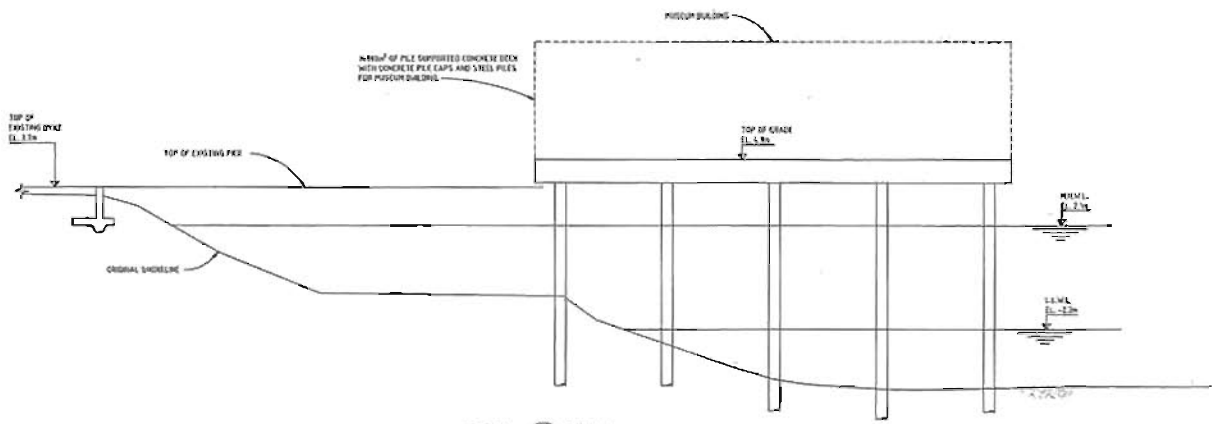
WORLEYPARSONS PROJECT No
00356

DRG No
00356-00-MA-DAL-1502

REV
A



PLAN - OPTION 4



SECTION A OPTION 4

PRELIMINARY
DO NOT USE FOR CONSTRUCTION

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SCALE: AS SHOWN

OneWay

WORLEYPARSONS PROJECT No: 00356

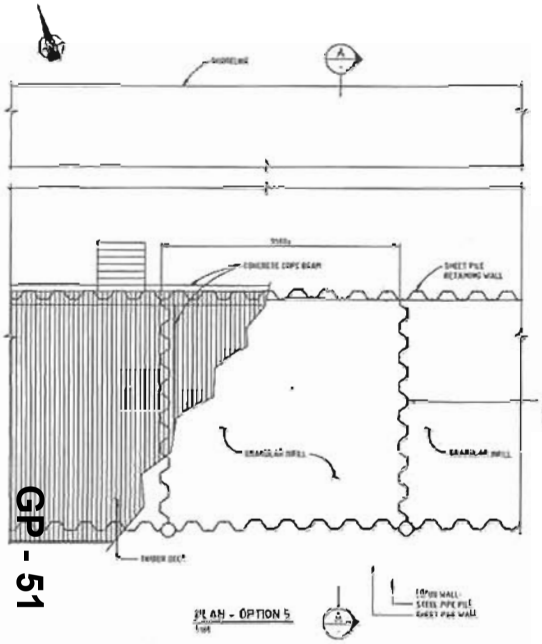
ENGINEERING AND PERMIT STAMPS (As Required)

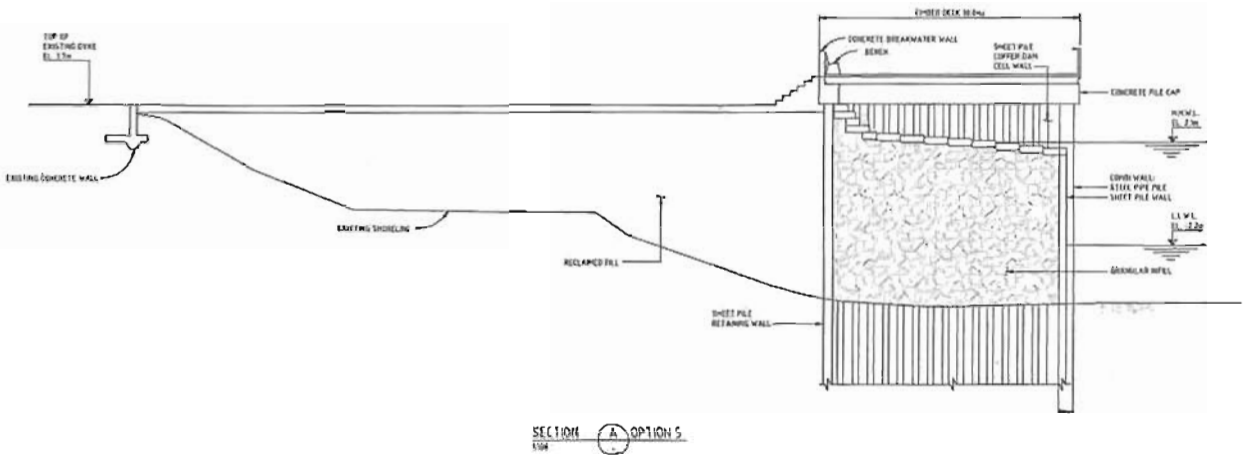
CUSTOMER: Richmond

WorleyParsons

IMPERIAL LANDING INFILL STUDY
PART PLAN AND SECTIONS
OPTION 4

DWG No: 00356-00-MA-DAL-1503 REV: A





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PRELIMINARY
DO NOT USE FOR CONSTRUCTION

REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF Drawing No	REFERENCE DRAWING TITLE
A	25-OCT-11	ISSUED FOR CLIENT REVIEW	JB	-	MBK	-	-	-		

SHEET SCALE A3 SHEET
OneWay
WORLEYPARSONS PROJECT No
00356

ENGINEERING AND PERMIT STAMPS (as Required)

CUSTOMER
Richmond

WorleyParsons

IMPERIAL LANDING INFILL STUDY
PART PLAN AND SECTIONS
OPTION 5

DRG No 00356-00-MA-DAL-1504 REV A

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PROJECT 307071-00356 - FEASIBILITY OF A PAID INFILL LOT H AT IMPERIAL LANDING

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Issued for Client Review	N. Krys	D. Seavey	T.D. Leonard	15-Nov-15		