Prepared for

City of Campbell River

OSTLER PARK FORESHORE RESTORATION PROJECT

CONCEPTUAL DESIGN REPORT

RFP 16-12 | September 6, 2016 | Submitted by: Mark DeGagné, P.Eng.

JPH Consultants Inc. landscape architecture environmental management soft shore protection

McElhanney

GreatPacific Engineering & Environment

McElhanney Consulting Services Ltd.

1307 Shoppers Row
Campbell River BC, V9W 2C9

Contact: Mark DeGagné, P.Eng,

Phone 250-287-7799
Email: mdegagne@mcelhanney.com

2221-49015-00

OQM | Organizational Quality Management Program

Certified ISO 9001:2008

September 6, 2016

City File: RFP 16-12

Our File: 2221-49015-00

City of Campbell River
301 St. Ann's Road
1st Floor Reception Desk
Campbell River, BC, V9W 4C7

Attention: Jason Hartley, P.Eng.
Manager of Capital Works

Dear Jason,

RE: RFP 16-12: OSTLER PARK FORESHORE RESTORATION PROJECT CONCEPTUAL DESIGN REPORT

Enclosed please find six [6] hard copies and a USB flash drive, of our Conceptual Design Report for the Ostler Park Foreshore Restoration Project. As discussed previously, the design includes a new 'pocket beach concept, with the associated upland park improvements to suit a design walkway elevation of 4.1m above mean sea level. Details of the stormwater system upgrades are also included.

We can schedule a review meeting at your earliest convenience.

Yours truly,

McELHANNEY CONSULTING SERVICES LTD.

Mark DeGagné, P.Eng.
Branch Manager

mdegagne@mcelhanney.com
Direct: 778-560-2001

Contents

Figures

Tables

1. Introduction

Robert V. Ostler Park (Ostler Park) is on the downtown foreshore of Campbell River and is one of the primary community parks and gathering places in Campbell River. Originally named Foreshore Park, the park was renamed The Robert V. Ostler Park in memory of the former Mayor of Campbell River. As shown on **Figure 1.1**, its location overlooks the Campbell River harbour and the Discovery Passage and the park has a significant area of waterfront which is currently armoured with rip rap. Park infrastructure includes a children's playground, picnic tables and benches, a First Nations Longhouse, flower beds and a section of the Seawalk. The Park is the host venue for a number of annual events in Campbell River including the Canada Day celebrations.

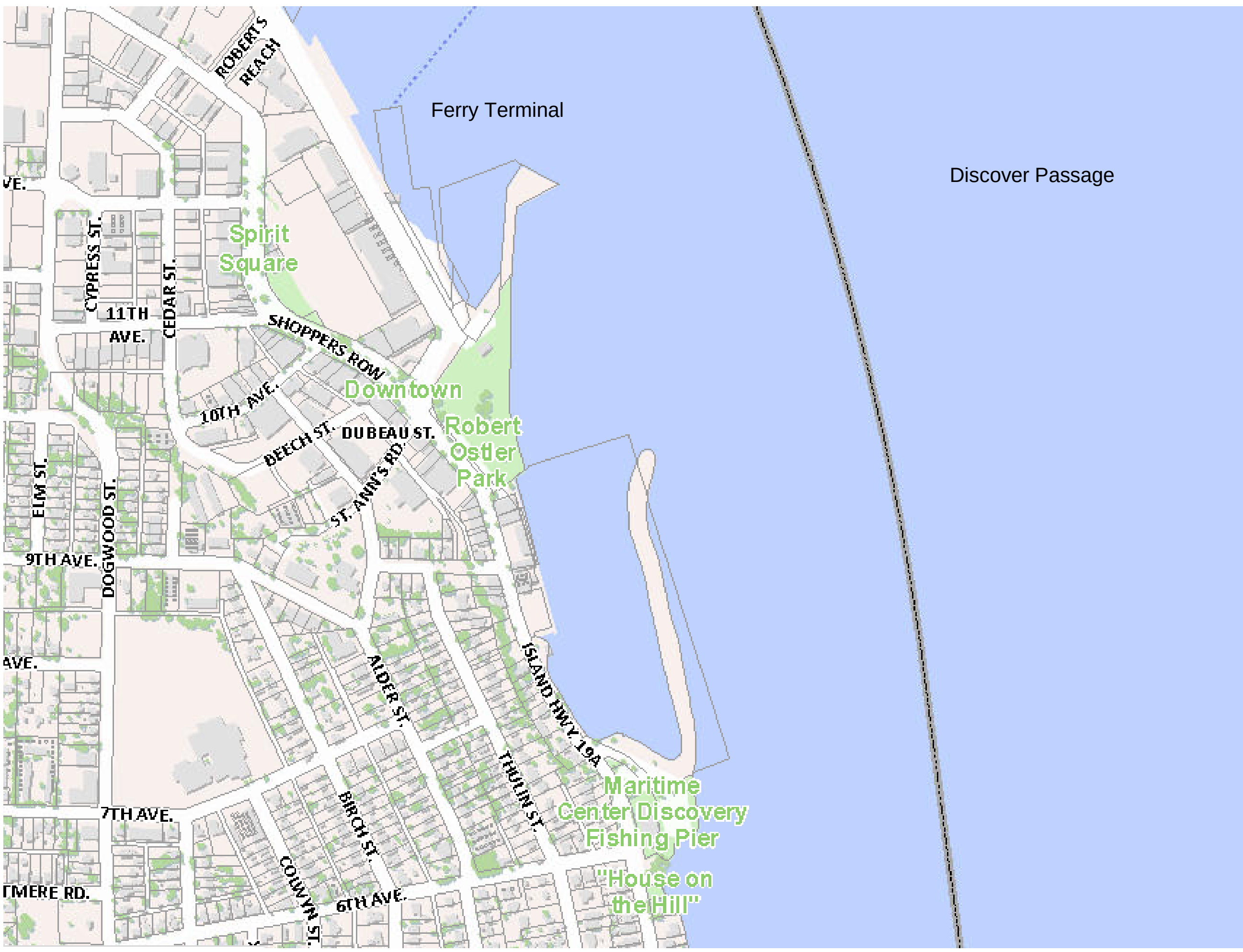


Figure 1.1: Location of Robert Ostler Park

The Campbell River area has experienced a number of severe storms over the last few years and it is anticipated that these storms will continue and may increase in frequency and intensity due to climate change. The severe wave action of the storms has undermined the rip rap on the park foreshore, causing the rip rap to slump into the water. The failure of the armouring has resulted in erosion of the bank, undermining of the adjacent Seawalk and has allowed the wave action to overtop the rip rap and throw debris and water up onto the park.

The overall damage to infrastructure at the park has been significant and will worsen if allowed to continue; infrastructure such as picnic tables and benches will continue to be destroyed, exposure to salt water will damage turf in the foreshore area of the park and undermining of the Seawalk will result in the loss of the Seawalk in this area.

In 2015, the City conducted a comprehensive public consultation process to determine a preferred option for the foreshore restoration with the two main options being: A riprap repair (status quo) or a "pocket" gravel beach (naturalization). This process resulted in the City pursuing a naturalized beach option, and has engaged the consultant team of McElhanney, Greater Pacific Consultants and JPH Landscape Architecture to complete preliminary and detailed design of the park and assist the City through to the end of construction.

1.1. History and Background for the Project

Developed in the late 1960s and early 1970s the park is "reclaimed" foreshore using imported and dredged fill and subsequently being armoured with a riprap face at the new foreshore. Along with the infill area, existing and new drainage pipes were extended to the new foreshore as part of the work. The riprap armouring is a more or less uniformly sized layer of large rocks (600-1000mm in size) placed in a 1 to 1.2 metre thick layer directly on the underlying sand fills. Wave and storm action have lead to the transport of the underlying fill material through the interstitial spaces of the riprap, which have undermined the protective layer and have left the embankment crest and upland park areas damaged.

Severe storms often result in large debris flows onto the park lawns, and have resulted in significant damage to the park furniture and other amenities **(Figure 1.2)**. The placement of debris onto the upland areas of the park are a result of the steeply sloped (2-3H to 1V) riprap face, and the lack of energy dissipation of oncoming waves causing significant overspray and/or overtopping of the armour layer.

Conversely, other sites in Campbell River, such as Dick Murphy Park, have undergone restoration transferring the armoured beaches back to a more naturalized beach using "green shores" principals, and these sites have remained very stable over the past decade. It is from this work that Pat Harrison, L.Arch., had originally suggested the idea of a beach concept for Ostler Park as part of a Shore Protection Options memo prepared for the City in 2012.

Figure 1.2: Wood debris washed up onto Ostler Park from a 2012 storm (photo courtesy Pat Harrison)

1.2. Scope of the Project

With the focus of design on creating a pocket beach at the park the City has engaged the consultant team to provide the design and construction services to implement the project. The process will follow the normal design-bid-build scenario for projects in the City, with design submissions at the preliminary, 50% and 90% stages prior to going to Tender and then construction.

The City has framed the scope of the project to focus on the Foreshore Restoration while minimizing the ancillary work to only those areas of the Park affected by the proposed beach implementation. This includes associated landscaping features and the stormwater systems running through the park that are requiring re-alignment/renewal to suit the new beach. Explicit instruction was given to the consultant team on the following items:

- Though the longhouse is in need of some repairs no work on the longhouse is to be included in the design, and the structure shall not be affected by the work.
- The adjacent parking lots are not to be affected by the project, other than that what is necessary to accomplish the storm system renewal.
- The City Parks department will re-instate the irrigation system beyond the limits of construction once the new landscape is constructed.
- Provision for light ducting maybe considered, but lighting is not part of the scope of work.

The following report summarizes the findings of the Team's investigations and analyses to-date, forming the conceptual design for the project moving forward. The following sections include the work to complete the required surveys and prepare the base plan of information to inform the design (Section 2). The technical assessments for coastal hydraulics and the stormwater system are summarized in Sections 3.0 and 4.0, respectively. The design constraints and opportunities from the landscape perspective are presented in Section 5.0, while Section 6.0 frames the recommended plan at this conceptual design stage. The associated cost estimate is provided in Section 7.0, with conclusions and recommendations as the last section of the report.

2. THE SITE

Robert V. Ostler Park (formerly Foreshore Park), a central feature in the downtown core of Campbell River, was developed as “reclaimed” land in the late 1960s and early 1970s after the Tyee Plaza was constructed. The picture to the right (1968) shows the foreshore prior to the infilling and it is possible to see the storm outfall pipe discharging to the beach. The park was filled to an elevation of about 3.0m above mean sea level, and is primarily an open space with such amenities as the First Nations Longhouse, a play structure (2016), public washrooms, and a beach head walkway that forms part of the Campbell River Seawalk. The park also has a number of public benches, tables and interpretive signs, primarily near the waterfront. There are a number of mature trees on top of sculptured land forms that are at a height of 4.5-5.0 metre elevation. The upland park is protected from wave erosion by a riprap layer, which is currently in disrepair.

2.1. Topography

Topographic and near shore bathymetric surveys were conducted by team members in June of 2016. The near shore bathymetric survey was conducted to aid the coastal hydraulics assessment for the project. Conducted by McElhanney crews, the work was completed using a single beam sounder and a global positioning system (GPS). The surveyed area revealed a gently sloping bench as shown on the attached **Figure 2.1**.

The upland survey included the breadth of the park and St. Ann’s intersection, which are characterized as relatively flat at an average elevation of +/- 3.0m. Utility locates were also completed and the topography and known subsurface infrastructure are shown on **Figure 2.1**.

2.2. Geotechnical Setting

Near shore sediment characteristics

At Ostler Park, sediments below the LWL are mainly sandy, with mean size approximately 0.2 mm (**Appendix A** - Station 3), which are relatively sheltered from strong tidal currents. However, the material of the naturally forming beach in front of the existing riprap structure, is a wide range of sediment sizes, including the presence of cobbles and gravels. The mean sediment size is 2 mm (**Appendix A** - Station 4; **Figure**).

The beach materials along natural intertidal zones of Campbell River are variable. Beach sediments typically consist of sand and gravels (classified as 'sand and gravel beaches'). An example of such a beach, south of Discovery Pier, is shown in Error! Reference source not found.. Cobble substrates, and boulders, are predominant along armoured reaches.

Figure 2.2: The beach at the south end of Ostler Park at a low tide.

Figure 2.3: Natural beach material south of Discovery Pier

Upland Geotechnical Conditions

Four test pits (see **Figure 2.1)** reveal consistent subsurface conditions characterized by loose to medium dense sandy soils with some areas of gravels and small boulders. Test Pit Logs are attached in **Appendix B**.

Piezometer tubes were installed at Test Pit #1 and #3, and continuous recordings reveal that the summer water table is low fluctuating just above mean sea level as shown on **Figure 2.4** below. As expected, the near shore test pit reveals a greater fluctuation in groundwater levels than the test pit which is about 100m from the shoreline.

A permeameter test was performed at Test Pit #3 to determine if exfiltration gallery/pit infrastructure was feasible. Exfiltration rates are very high, greater than 1000 mm/hr even at depths below 1.6m of the surface.

The results of the ground water and infiltration tests show excellent potential for stormwater infiltration during the summer months, but there is currently no information for groundwater elevations during the rainy season, and on this basis, it is recommended to complete more groundwater monitoring during the rainy season to determine if an exfiltration gallery is a worthy design element for storm water management for this project. At this juncture, an exfiltration gallery would appear to be a storm water management feature worth considering should it be required in the design.

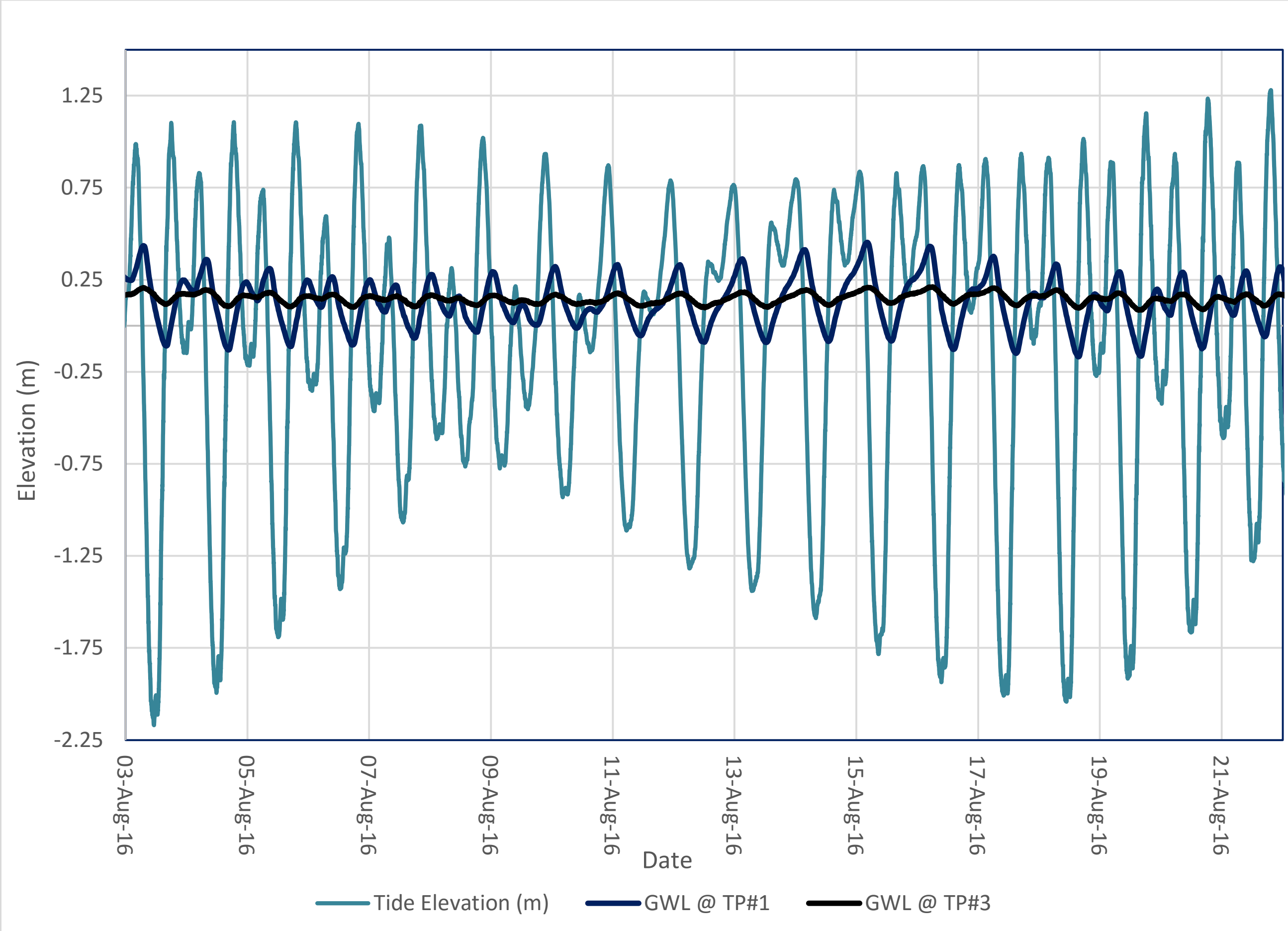


Figure 2.4: Ground Water Elevation Monitoring – August 2016

2.3. Environmental and Regulatory Permitting

A foreshore habitat survey was conducted on June 7, 2016 during low tide. The habitat survey concluded that the shallow subtidal zone consisted of gently sloped sandy sediments, with characteristic species that included eelgrass, Dungeness crab, and sand dollars. The intertidal zone was primarily steeply sloped rip-rap boulders with characteristic species that included rockweed, barnacles, limpets and shore crabs. The subtidal zone (with eelgrass) is higher value habitat; therefore, loss of this habitat should be avoided or minimized as part of the project.

The following regulatory applications were identified for the project:

- Crown Land Act – an application to BC Forests Lands and Natural Resource Operations (FLNRO) will be required in order to modify, fill, or excavate on crown foreshore.
- Fisheries Act – an application to Fisheries and Oceans Canada (DFO) will be made to confirm that serious harm will not be caused by the project. In our preliminary opinion, a Fisheries Act Authorization should not be required for the project.
- Navigation Protection Act – an application to Transport Canada (TC) to obtain an approval that the project won't create a hazard for navigation, particularly as a result of the proposed groyne structure.

2.4. Existing Infrastructure

Existing underground utilities through the park are shown on **Figure 2.1** and include:

- A 600mm diameter corrugated metal pipe (CMP) conveys stormwater across the middle of the park, and running at a depth of more than 3.0m below the ground surface. The outfall is hidden below the existing riprap and is not visible. Three other lateral storm pipes connect to this outfall at the west end of the park. Here the manhole is quite low at -0.5m. This is likely because the original beach line was at this location requiring the former pipe outfall to be at or below mean tide level.

- A second storm outfall pipe runs below the longhouse. It is a 300mm diameter CMP which drains the adjacent parking lot to the north.
- The City's main sanitary sewer interceptor runs through the park in a north-south direction. This 1050mm pipe is installed above the existing 600 CMP pipe. It appears that the CMP pipe has been damaged when the 1050mm sanitary was installed (photo right).

Other underground infrastructure includes the parks irrigation system, and several electrical lines, one of which appears to be a significant conductor for BC Hydro services.

The project requires that the storm sewer be upgraded to current standards, amalgamating the outfalls into one location with one outfall. The new outfall should be located outside the new beach area, and must accommodate the 100-year design storm to ensure that upstream flooding does not occur during extreme events, especially along Beech Street, which is a low point in the system surrounded by buildings and higher ground.

3. COASTAL HYDRAULICS ASSESSMENT

3.1. Background

The existing park foreshore consists of steeply sloped boulder rip-rap, which has experienced damage, degradation and overtopping during storm events. The rip-rap slope presents a challenge and safety hazard for the public to access the foreshore. Steep rip-rap slopes also provide different, and generally lower value habitat compared to sediment shorelines. The development of design concepts was focused on a soft sediment naturalized beach solution, or "Green Shores" approach. To pragmatically develop the design approach, a thorough understanding of marine forces and water levels over the design horizon is required.

3.2. Design Intent and Horizon

The design horizon for the project was discussed to be 30 years, or the year 2050, with the understanding that further park improvements will be implemented in the future.

It is recognized that finite financial resources are available, and that the City of Campbell River's strategy to address climate change will be on an opportunistic and incremental basis. The park design is not intended to block all potential coastal flooding of the downtown area.

3.3. Datum and Bathymetry

Datums and Surveys

The topography and bathymetry of Ostler Park and related foreshore were collected in meters (m) relative to Geodetic Survey of Canada Datum (GD).

Elevations in the wave and current models were input in meters (m) relative to Chart Datum (CD), which is 2.9 m below GD datum.

Horizontal dimensions are in meters (m) to the UTM NAD83 coordinate system.

Nearshore Bathymetry

Survey data for the nearshore area and electronic nautical charts published by Canadian Hydrographic Services (CHS) for the offshore areas were compiled for numerical modelling (description presented in Section 5.2).

A bathymetric map of the project site prepared with the survey data is shown in Figure . Detailed plan and profiles of the existing park foreshore are presented in **Appendix C**. These data were used as the basis for the beach nourishment design work.

The bathymetry data shows that the shallow nearshore area extends more than 200 m offshore. The elevation of this area is found to be approximately 1 m lower than that in the nautical chart which is based on older survey data. It is not known whether the beach erosion process is responsible for this elevation difference. It was also learned that maintenance dredging was undertaken at Fisherman's

Wharf to the south of the project site. It is unknown where the depositional material originated, whether it was eroded material from the seabed immediately fronting Ostler Park, or elsewhere.

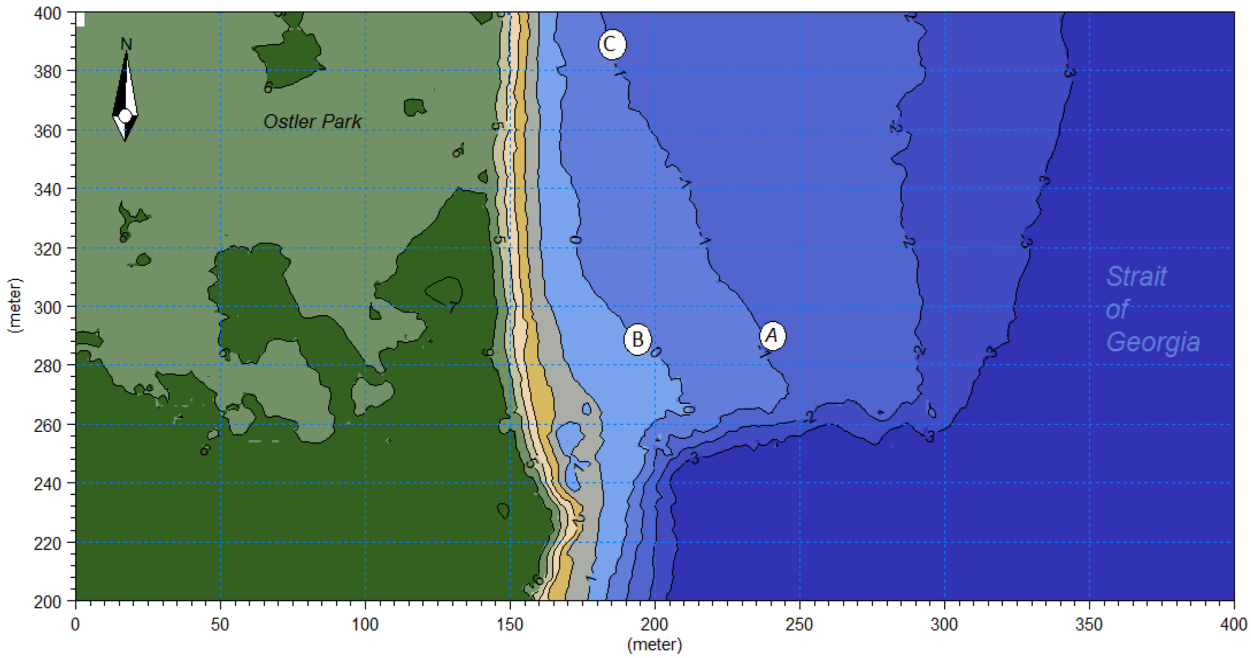


Figure 3.1: Site Bathymetry. Points A, B and C are the locations of model data extraction.

3.4. Wind Analysis

Wind data

Historical wind records were obtained from Environment Canada's online database for two weather stations: Campbell River Airport and Sentry Shoal (**Figure** 3.2 **3.2**). Although the wind station at Campbell River is closest to the project site, the data from this station does not include night time readings. Furthermore, the storm intensity at this land based station is relatively weaker than the Sentry Shoal Buoy data and; therefore, wind data from Sentry Shoal was selected for use. The wind record covered a period of 23 years, from 1994 to 2016.

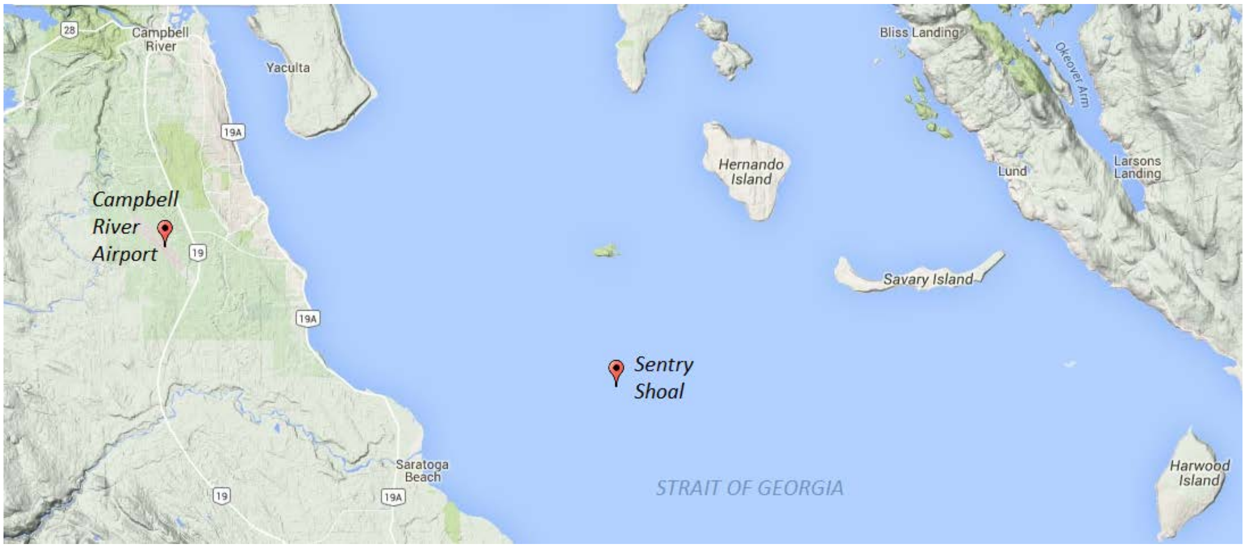


Figure 3.2: Locations of Campbell River airport station and Sentry Shoal buoy

Climate and Design condition

For modelling and analysis, the wind speed record was adjusted to 10 m elevation. A frequency table prepared with these 23 years of data is presented in **Table 3.1**. **Figure 3.3** shows the corresponding wind rose for Sentry Shoal. Winds blow relatively equally amounts of time from both southerly and northerly directions. The strongest winds are from the southeast.

Table 3.1: Occurrence of Wind from Different Directions in Hours Per Year for Sentry Shoal Buoy Station

Speed (m/s)	Number of hours per year							
	N	NE	E	SE	S	SW	W	NW
(0-2.5)	314.97	189.92	228.27	283.21	238.53	233.20	369.92	433.39
(2.5-5.0)	320.01	87.24	165.33	458.28	209.43	74.60	300.55	856.76
(5.0-7.5)	207.69	17.62	89.66	522.52	132.89	8.67	44.01	705.57
(7.5-10.0)	148.19	9.59	66.71	536.56	73.78	1.98	10.41	364.64
(10.0-12.5)	43.09	2.95	42.51	439.01	26.58	0.29	1.36	87.24
(12.5-15.0)	5.57	0.05	18.45	229.28	5.71	0.10	0.05	14.86
(15.0-17.5)	0.24	-	5.37	100.60	1.26	-	0.05	2.23
(17.5-20.0)	0.05	-	0.77	23.72	0.24	-	-	0.34
(20.0-22.5)	0.05	-	0.15	3.10	-	-	-	-
(22.5-25.0)	0.05	-	-	0.48	-	-	-	-
(25.0-27.5)	-	-	-	0.10	-	-	-	-
(27.5-30.0)	-	-	-	-	-	-	-	-
Total	1,039.91	307.37	617.21	2,596.86	688.43	318.85	726.34	2,465.03

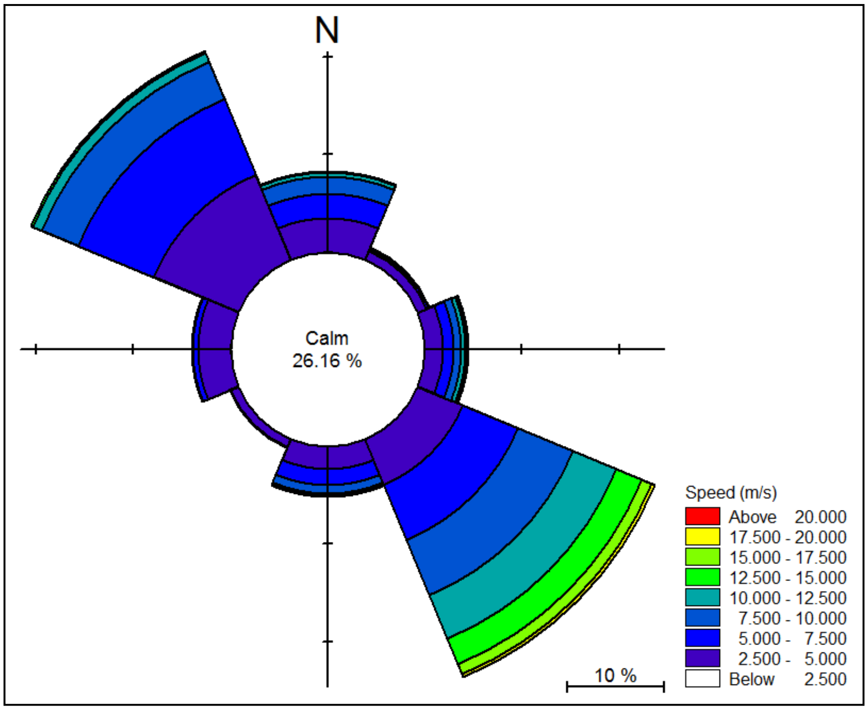


Figure 3.3: Wind rose for Sentry Shoal

An extreme wind analysis was performed using the Gumbel method to determine the design wind speeds for North, East, Southeast and all directions. The results are provided in **Table 3.2**.

Table 3.2: Design Wind Conditions for Campbell River

Return Period	Annual Exceedance Probability	Wind speed (m/s)			
		North	East	Southeast	All
1	63%	10.2	-	17.4	17.9
5	18%	17.5	18	23.1	23.3
25	4%	22.0	21.7	26.3	26.7
50	2%	23.8	23.2	27.6	28.1

3.5. Water Level and Current Analysis

Tide Levels

Tide elevations relative to chart datum (CD) from the Canadian Tide and Currents Tables (DFO 2016) are provided in **Table 3.3**.

Table 3.3: Tidal Elevations for Campbell River

Tide Levels	m, CD	m, GD
EHWL, Extreme Recorded High Water Level	5.4	2.5
HHWL, Higher High Water Level, Large Tide	4.6	1.7
HWL, High Water Level, Mean Tide	4.1	1.2
MWL, Mean Water Level	2.9	0
LWL, Low Water Level, Mean Tide	1.4	-1.5
LLWL, Lower Low Water Level, Large Tide	0.4	-2.5
ELWL, Extreme Recorded Low Water Level	-0.2	-3.1

The water level data recorded at Campbell River Station (8074) was obtained for the period of 20 years (1996-2016). A graph of water level non-exceedance (percentile) to elevation prepared with this data is presented **Figure 3.4**.

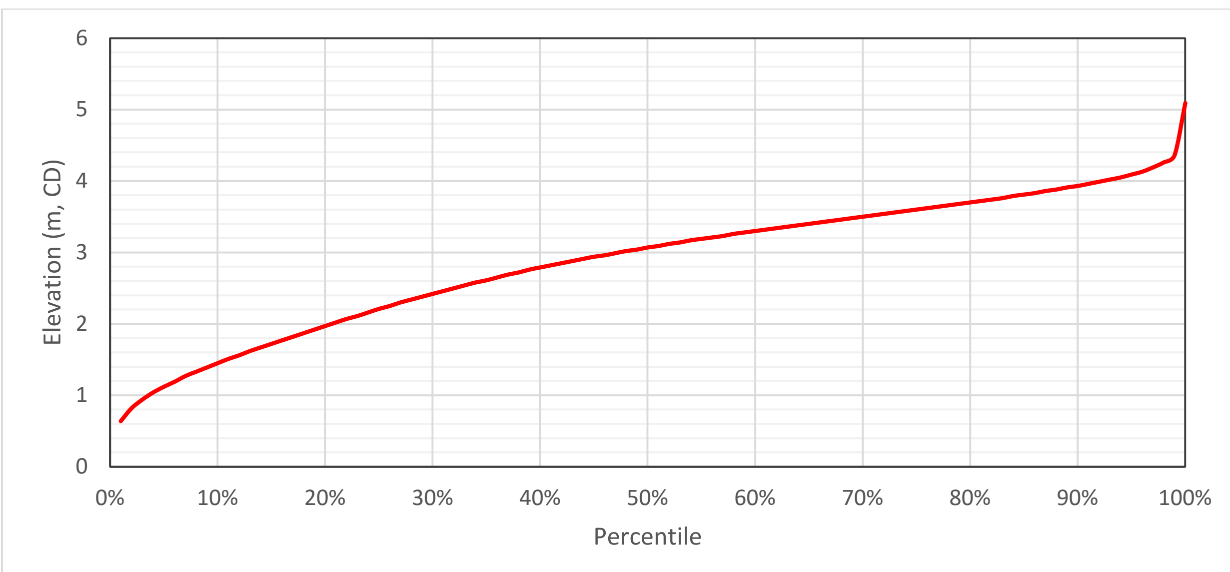


Figure 3.4: Percent of water level non-exceedance vs elevation curve

3.6. Current Data

No measured current data from the site was available. Canadian hydrographic charts indicate that the maximum tidal current at Discovery Passage reaches 6 to 7 knots (3.0 to 3.6 m/s). Ebbing flows during large spring tides create the peak currents in the channel.

It was observed during the field measurement that the shore tidal currents near the shoreline of Ostler Park are generally southward, even during ebb tide. This would be due to the formation of local eddies off the breakwater at Fisherman's Wharf during an ebb tide when the tidal stream is northward in the main channel. During a flood tide, the currents near the shoreline at Ostler Park are southward, corresponding to the southward flow in the main channel.

3.7. Hydrodynamic (Water Level and Current) Modelling

Model Set Up and Modelling Method

For assessing coastal currents and hydrodynamics at the project site, a two dimensional numerical model, MIKE 21 FMHD, developed by DHI was applied. This model also incorporates a module for sediment transport and morphological analysis and its application is presented in Section 3.9. Mike 21 FMHD utilizes a flexible mesh grid system that allows variable grid sizes within a single model domain. The methodology and results of the hydrodynamic modelling are presented in the following sections.

The model domain included the Strait of Georgia and Discovery Passage. Variable grid sizes were used to optimize the model performance. Grid sizes ranging from 20 m to 50 m were used to resolve the shoreline and nearshore bathymetry at the project site.

As no current measurement was available, the hydrodynamic model was calibrated against measured water levels at the Campbell River tidal station. Tidal modelling was performed for a period of two weeks and included a spring or large tide cycle, and a neap or small tide cycle.

Results and Baseline Circulation

Simulated mean tidal current for a period of two weeks is shown in **Figure 3.5**. The mean current is the residual component of the southward moving currents during flood tides and northward moving currents during ebb tides in Discovery Passage. The mean current flows southward along the shoreline of Ostler Park with a speed of more than 20 cm/s before turning offshore at the entrance of Fisherman's Wharf.

Simulated time series of nearshore currents at locations A, B and C (**Figure 3.6**) showed that the southward currents are dominant for most of the time and exceed 0.30 m/s for several hours each day.

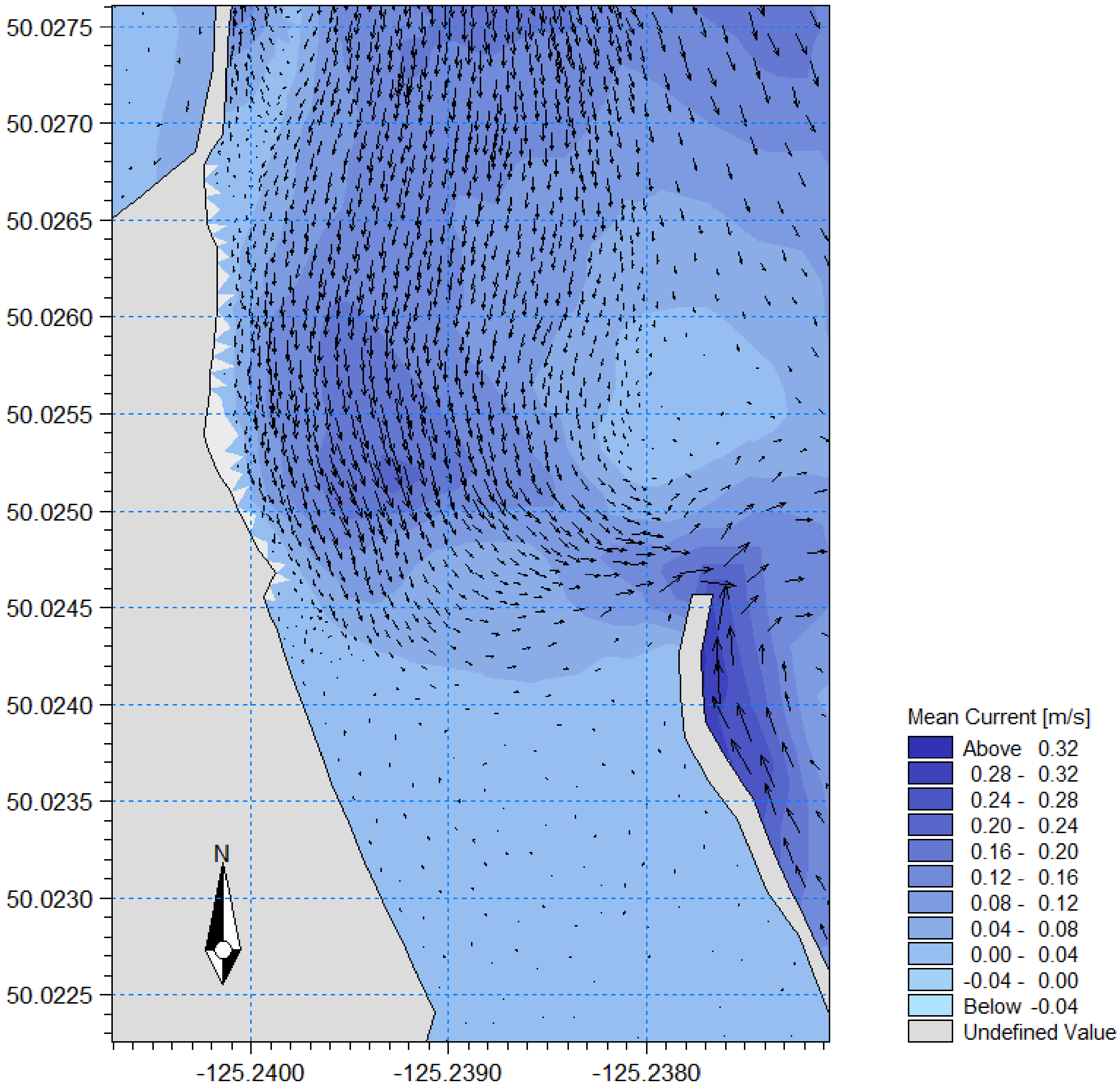


Figure 3.5: Simulated mean current, over a 2-week period, in the nearshore area

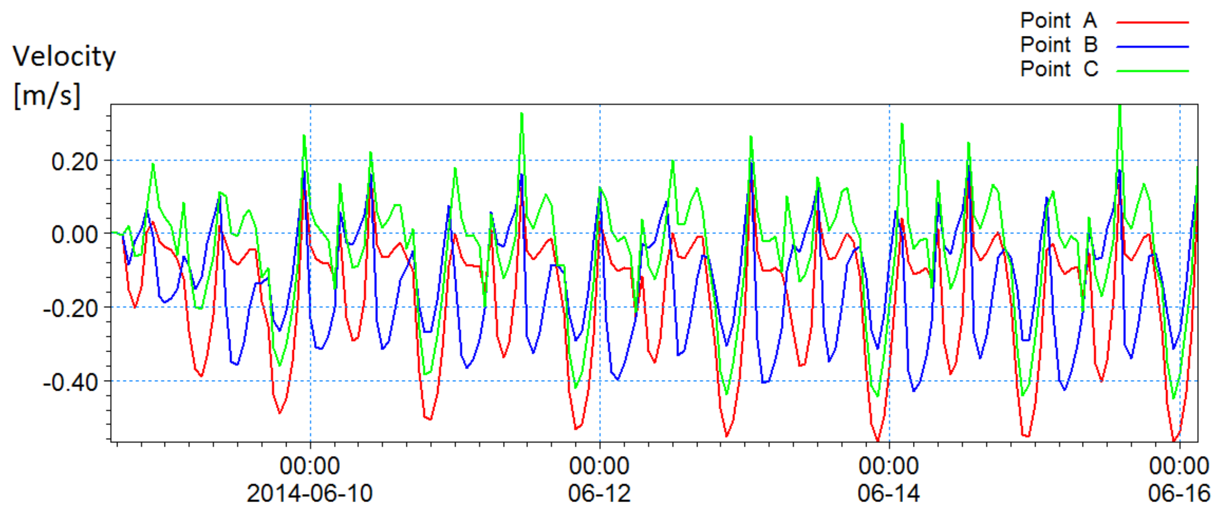


Figure 3.6: Simulated tide driven current at Points A, B and C
Negative velocities are southward and positive velocities are northward.

3.8. Wave Analysis

Peak storms from the southeast (SE) generate the largest waves in Discovery Passage. Wind generated waves interact with the strong tidal currents in the channel. To evaluate the wave conditions at the project site, a numerical model was applied. Methods and results of wave modelling are presented in the sub-sections below.

Wind Wave Modelling

Model Set Up and Methodology

A spectral wave model, SWAN, was applied to determine the wave climate and extreme conditions at the project site. The wave model was developed by covering the entire Strait of Georgia to include the dominant fetches, or the distance over open water on which waves are generated.

The wave modelling was performed for 1-year, 25-year and 50-year return periods southeasterly storm conditions. Each simulation was performed for a period of 12 hours to include the effect of flood and ebb currents on wave growth. The SWAN model calculated the wave diffraction around structures and obstructions in an indirect manner and therefore, the simulated wave parameters in sheltered areas were verified using the diffraction diagram presented in the Shore Protection Manual (USACE 1984).

Wave modelling for the storms from North and East were not performed as the corresponding fetch lengths are insufficient (less than 6 km) for producing large waves at the project site. Such storms would also have very small influence on net annual sediment transport as these are relatively less frequent.

Results and Design Wave Condition

The distribution of maximum significant wave heights that are generated by the 50-year wind from the SE is shown in **Figure 3.7**. The simulation results showed that the southern part of the park shoreline is relatively sheltered. Up to 2.4 m waves were predicted to reach the shoreline immediately north of the park along the adjacent marina breakwater.

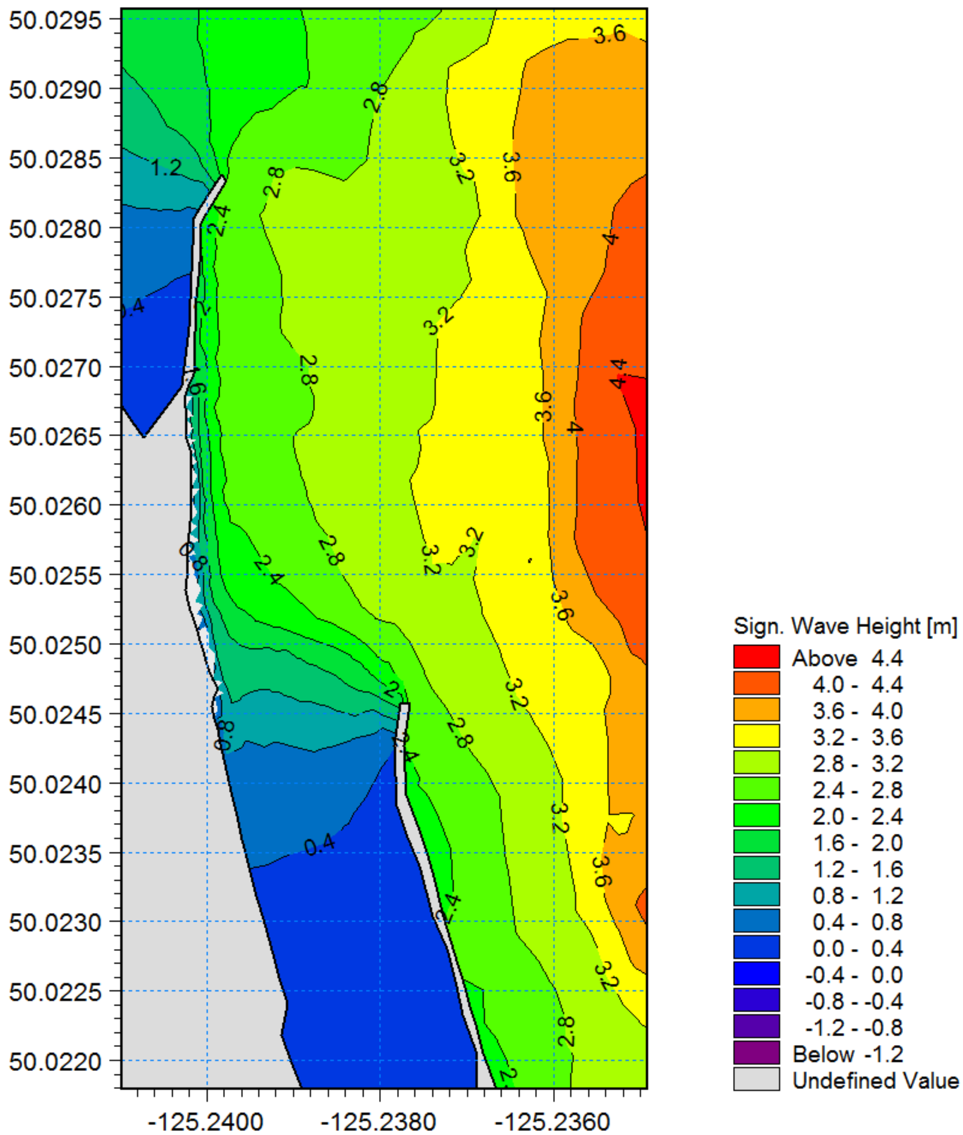


Figure 3.7: Simulated Distribution of nearshore waves simulated with 50-year wind from the SE.
See notes on Table 3.4 for definitions.

Simulated wave parameters for 1-year, 25-year and 50-year return period storms were extracted at three nearshore locations (Point A, B and C as indicated on **Figure 3.1**) and presented on **Table 3.4**.

Table 3.4: Extreme Wave Parameters at Points A, B and C

Return Period (years)	Point A		Point B		Point C	
	H_S (m)	T_P (s)	H_S (m)	T_P (s)	H_S (m)	T_P (s)
1	1.9	8.0	1.8	8.0	2.1	8.0
25	2.3	9.0	2.0	9.0	2.3	9.0
50	2.4	9.0	2.1	9.0	2.4	9.0

Notes:

1. Significant wave height, Hs, is defined as the average of the highest 33% of the waves, and the maximum wave in the sea state is about 1.85 times the significant wave height.
2. Wave height is defined as the vertical distance from trough to crest of a wave.
3. Wave period is defined as the time taken by two successive crests (one wavelength) to pass a specified point.
4. Peak spectral wave period, T_P, is defined as the wave period associated with the most energetic wave.

Wave Run-up

Wave run-up is the elevation above the still water level that the wave will reach when contacting the beach. The wave run-up level of the top 2% of waves (Ru2%) were estimated using the method presented in CIRIA (2007) for a gravel beach with the proposed beach profile (6:1 slope). The Ru2% for 50 year and 1 year return periods are as follows:

$R_{u2\%}$ for annual waves: 2.7 m

$R_{u2\%}$ for 50-year waves: 3.0 m

Design Park Crest Elevation

This section provides the components for estimating the design water level for the proposed gravel beach, and includes results of water level analysis, hydrodynamic modelling and wave modelling presented in the previous sections, as well as the Sea Level Rise analysis in the technical memorandum in **Appendix D** (GreatPacific 2016). **Table 3.5** lists the design water level components derived from the analyses.

Table 3.5: Design Water Level Components for Ostler Park Gravel Beach

Component	Height Allowance (m, GD)
Higher High Water Level from Tides	1.7
Storm Surge	0.4
Storm Wave Run-up	2.7
Local Sea Level Rise	0.3
Freeboard	-1.0 (negative means some overtopping is acceptable; beach maintenance will be provided)
Total	**4.1**

3.9. Sediment Transport Modelling

Model Set Up and Methodology

For the assessment of baseline sediment dynamics at the project site, the sand transport module of the Mike 21 FMHD model was applied. The modelling was performed using simulated waves described in Section 5.0 and also considering the presence of tidal current.

Based on the nearshore subtidal sediment size data (**Appendix A**), a single sediment type of D50= 0.2 mm was used for the entire model domain, below low water elevations. A non-erodible shoreline (rip-rapped) was utilized in the sediment transport model. Porosity of bed sediment was considered to be 40%. More detailed description of sediment transport calculation approach is presented in DHI (2014).

To consider the combined influence of currents and storm generated waves for sediment movement at the project site, the transport modelling was performed for the following three conditions:

- A tidal condition with no storm;
- An annual storm during flood tide (northward current);
- An annual storm during ebb tide (southward current);

The first case represented more than 90% of the time of a year when winds were calm or from directions of insignificant fetch and therefore the tide was the governing force. For the other two cases, storm events of 1 year return period (i.e. an annual storm event) were simulated for two different tidal phases. Storms lasting six hours with 17.4 m/s wind from SE were simulated for the cases of flood tide with currents flowing southward and ebb tide with currents flowing northward. Each simulation was performed for a full semidiurnal tidal cycle (12 hrs).

Northern and eastern storms were not considered for the sediment transport analysis as such storms with short fetches would generate smaller waves.

Results and Baseline Condition

Mean hourly rate of sediment transport for three simulation conditions are presented in **Figure 3.8** and estimated mean sediment transport rates at three locations (A, B and C in **Figure**) are also given on **Table 3.6**.

For the calm condition, the mean sediment transport is southward in the nearshore areas of Ostler Park as the direction of mean tidal current is southward.

For the annual SE storm, the direction of longshore sediment transport is northward both for the flood tide and ebb tide conditions. The SE waves generates a narrow stream of longshore current along the toe of the beach and moves sediment north. The estimated transport rates for annual storm conditions ranged 0.015 -0.042 m^3/hr/m at three nearshore locations.

As the storm frequency analysis showed that winds stronger than 12 m/s occur less than 5% of the time, the longshore sediment transport at the project site will be dominated by tidal currents with a net southward component.

Major storms also move sediments in the cross shore direction and form offshore bars. Some of these sediments return to the shore over a long period of time (Fredsøe, and Deigaard 1992). These processes tend to form an equilibrium beach profile and were beyond the current scope of modelling. More descriptions on the equilibrium beach profile are provided in the Section 6.0.

Table 3.6: Hourly Sediment Transport Rates at Locations A, B and C

Tide and Storm Condition	Sediment transport rates (m^3/hr/m)		
	A	B	C
No Wave- only Tide	0.015	0.016	0.006
SE Annual Storm during Ebb Tide	0.022	0.015	0.024
SE Annual Storm during Flood Tide	0.042	0.017	0.021

No Storm (Calm Condition), Flood Tide	SE Storm during Ebb Tide	SE Storm during Flood Tide

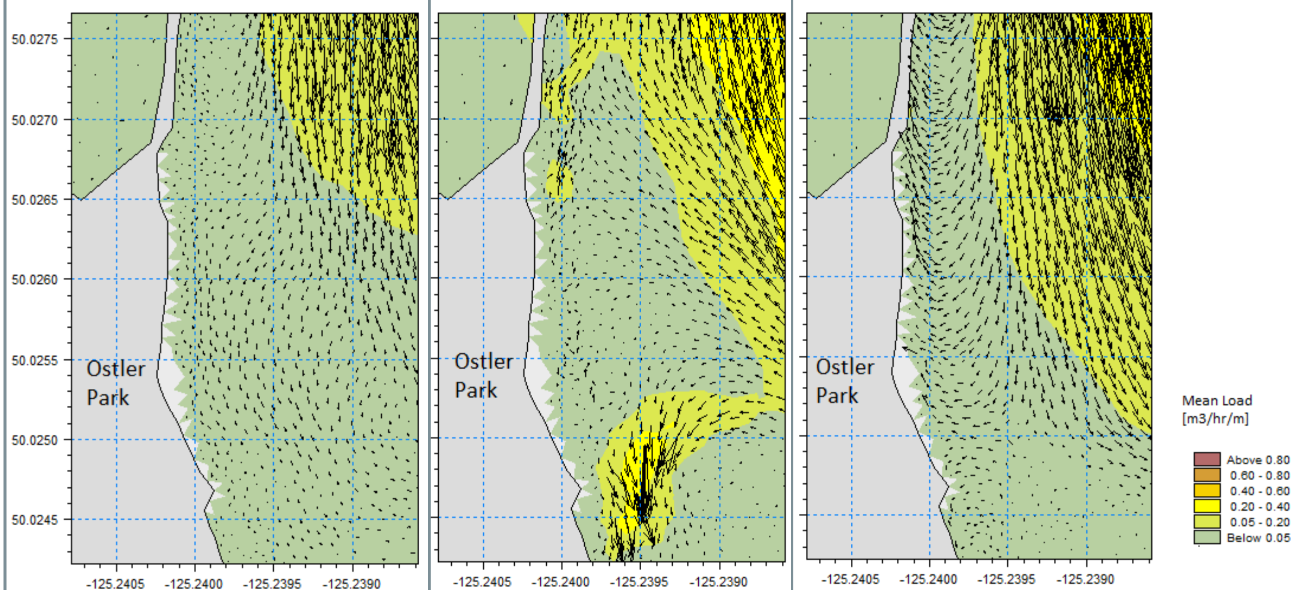


Figure 3.8: Simulated mean sediment transport pattern
Simulation is for a calm condition and an annual storm occurring in different tidal phases.

4. STORMWATER UPGRADES

A new beach will require re-configuration of the storm system, including joining the two existing outfalls into one and ensuring the stormwater is directed away from the new beach for both aesthetic and water quality reasons. Recent upstream improvements on St. Ann's included a new storm manhole at the intersection of St. Ann's and the Highway with a "knock-out" that will allow up to a 1050mm diameter pipe.

To complete a conceptual design, the previous hydrologic calculations have been reviewed and new storm water modelling has been completed to determine an optimum configuration moving forward toward the detailed design.

4.1. Drainage Area and Hydrology

The main storm outfall drains an uphill catchment of about 8 Ha as shown on **Figure 4.1**, which was derived by Highland Engineering during the St. Ann's Rd upgrade project and confirmed herewith. In addition to this upland area the adjacent parking lot portions of the highway around the St. Ann's Rd-Highway intersection also drain into this outfall, amounting to a total of 8.8Ha catchment.

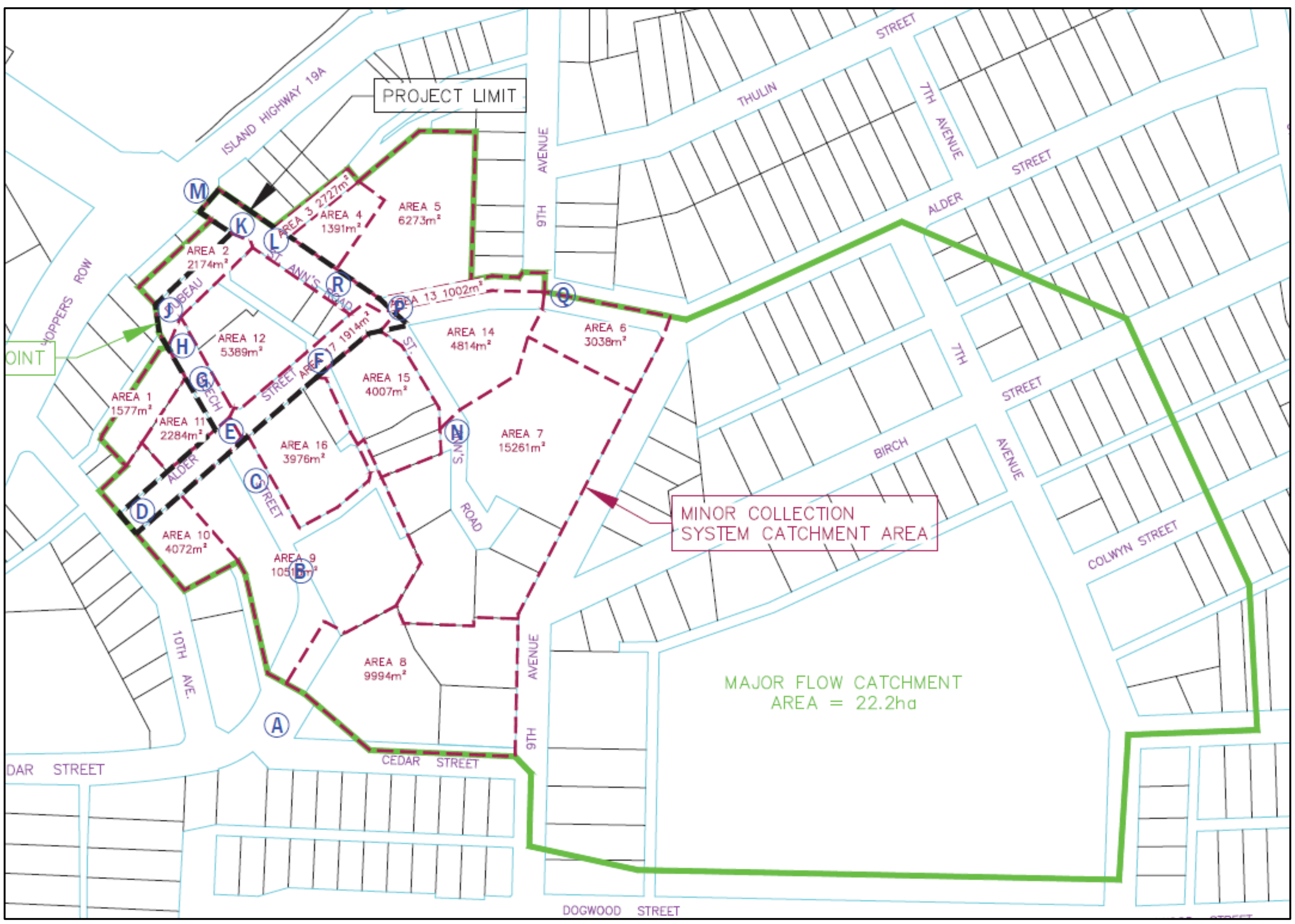


Figure 4.1: Stormwater System Drainage Catchments Upstream of St. Ann's Road

The upstream catchments are predominantly commercial development with a minor amount of multi-family apartments contained within the drainage area. On this basis, the impervious surfaces dominate the landscape with an average percent coverage of 77% impervious surfaces, including roofs and parking areas. The stormwater runoff and pipe hydraulic assessments were calculated using the EPA SWMM5 software with the following results for various design type storms.

Table 4.1: Peak Runoff Rates at Ostler Park Outfall

Storm Condition	Peak Intensity (mm/hr)	Daily Rainfall Amount (mm)	Peak Runoff at the Outfall (l/s)	Runoff Volume (m^3)
Half Mean Annual Rainfall (1/2 MAR)	4.32	27.5	78.2	1840
2 Year Storm (SCS Type 1A)	9.77	62.1	177	4420
10 Year Storm (SCS Type 1A)	12.4	79.2	226	5760
100 Year Storm (Chicago Type)	99.9	100.3	1690	7370

The use of a Chicago Type Storm Distribution as a design storm is intended to represent a high intensity storm with a short 10min time of concentration for each catchment, which is consistent with Campbell River's Engineering Standards and produces the most conservative peak runoff discharges, while maintaining the same daily volume as other design storms.

4.2. Storm System Hydraulic Requirements and Conceptual Design

The existing storm system through the park is buried deep below the surface and within the tidal zone, which complicates installation unnecessarily. The discharges through the system will be governed by the tidal levels at the ocean outfall, and the depth of bury below high tides does not improve flows through the system. In addition, any new pipes to be installed have to cross the existing 1050mm diameter sanitary sewer interceptor, and undermining this pipe with a large deep excavation is both difficult and expensive to execute.

On this basis, it is recommended to look at possibly raising the outfall above the sewer interceptor and protecting the outlet at the ocean accordingly. This requires that the pipe be stepped up through the park leaving upstream sections with some level of stormwater in them at all times, unless they can be drained in some fashion that does not prove to be to costly or cause much more additional maintenance than otherwise would be required of a storm system.

A schematic profile of the proposed storm water system is depicted on **Figure 4.2**, showing the required step in the 900mm diameter pipe to gain enough elevation to clear the top of the 1050mm diameter sanitary interceptor sewer.

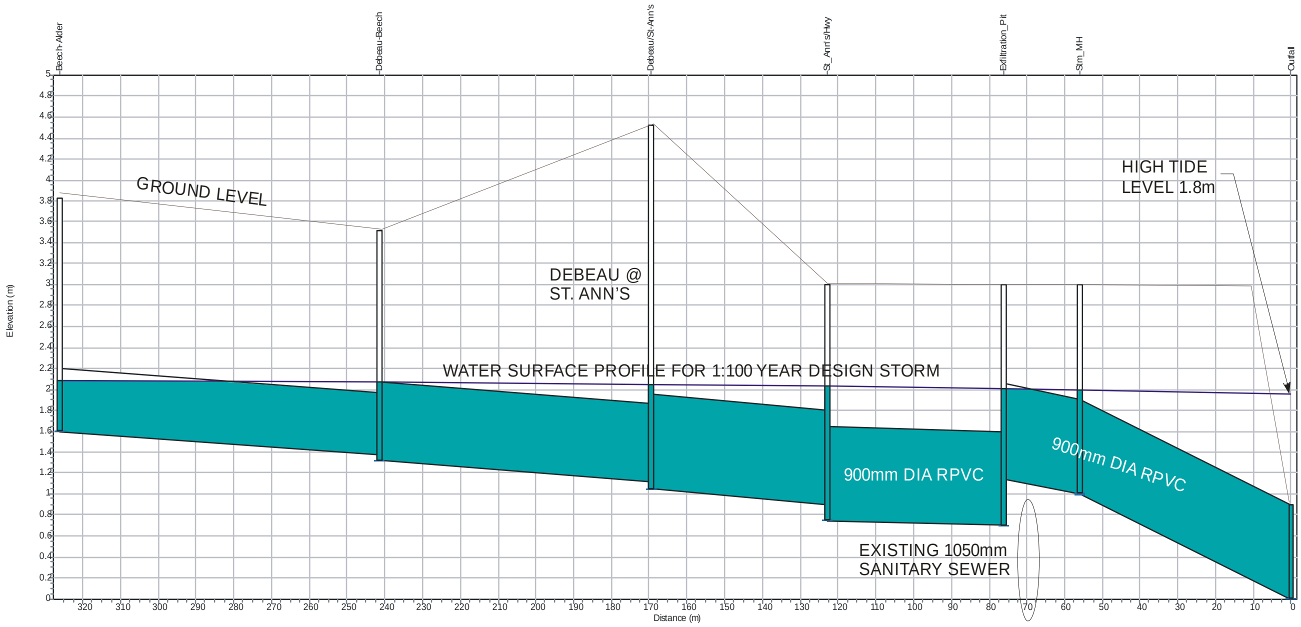


Figure 4.2: Proposed Stormwater Piping Profile

The above profile shows a 900 RPVC pipe being installed from the St. Ann's intersection with the Highway to the outfall. This size is confirmed based on the expected 1:100-year design runoff through the piping system. The proposed piping system will ensure that the area of Beech Street near the Debeau intersection will not flood as long as the tide levels remain below 2.5m.

4.3. Storm Alignment, Appurtenances and Other Considerations

Conceptual Alignments

Two possible storm system alignments are provided on the attached **Figure 4.3 and 4.4**. The first (option 1) shows an alignment below the walkway that bisects the gardens at the southeast corner of the St. Ann's-Highway intersection. This alignment would require curving a part of the sewer, which is well within manufacturer's recommendations. It also requires an additional manhole, which is a significant cost because of the size of the pipe.

The alignment keeps the beginning of the pipe run to the south of the existing 6500mm diameters CMP, but eventually crosses it to keep the outfall to the north end of the park and within the riprap zone. This alignment has other concerns associated with it, namely:

- The overall length of pipe is greater than a more direct route to the north of the garden area
- The lateral lines from the north need to be extended and they would require the invert of the manhole and final outlet pipe to be deeper.
- Connecting a new lateral pipe from the north end parking lot would also require a longer pipe.

The second option, Option 2, shows the pipes crossing within the intersection and moving the outfall pipe further north away from the large trees in the garden area. Some of the garden area would be disturbed but this can be easily re-constructed and the annual plantings can be easily re-established. This option eliminates the need for one manhole, and provides an opportunity for easier, shorter lateral connections except for the one catchbasin from the parking lot to the west of the park. This is the preferred pipe routing alternative.

Both options require that the open grated manhole on the east side of Shoppers Row west of the St. Ann's-Highway Intersection be rerouted southwest across Shoppers Row to the adjacent storm pipe. This will eliminate the need to re-construct the long deep section that intersects the main manhole in the park, allowing all elevations to be lifted, which, in turn, allows for a small step up to get the pipe system over the sanitary interceptor pipe.

Appurtenances

Previous concepts of the stormwater design and cost estimate included a provision for an oil/grit separator ahead of a dissipation chamber at the head of the beach. Since the proposed outfall is planned to be installed within the transitioning riprap to the north of the park, a dissipation chamber is not necessary for the protection of the beach. Instead the outfall pipe will be installed in a manhole with a grated lid and a flap gate to prevent sea water from entering the storm system. The system will be allowed to drain through the manhole which will have no bottom and will have a "drywell" type barrel with preformed holes throughout the perimeter. The flap gate inside the manhole will be protected from debris and wave damage, and the rim elevation will be set at a suitable elevation as to not cause upstream flooding during large events. The manhole grate will be manufactured in three sections to allow for easier access to the inside of the manhole.

Research into oil-grit separators to improve stormwater quality as it discharges to the ocean has revealed that there is only one manufacturer that has a design stated to work in a submerged "backwater" environment – Stormceptor®. Upon contacting the supplier, the required size is an STC-14000, which would remove 80% of TSS with a fine sediment distribution meeting the guidelines of the Nationwide Urban Runoff Program (NURP). The STC-14000 is two Stormceptor units in series, which will be modified to handle the submerged flows. The supplier stated that with the inlet and outlet pipe sizing and the submerged type flow, entrapment of free hydrocarbons would be very limited. The above statements support the practice that the "end-of-pipe" treatment is <u>not</u> the preferred solution, but rather sediment control should be addressed at the site level. Recent developments in the catchment include stormwater quantity and quality controls, including The Seymour Pacific Head Office Development, Chances Casino and even the Chevron Gas Station. For a fraction of the cost of the Stormceptor installation the City could purchase and install devices for the public parking lots at the park, and achieve a higher water quality discharge to the ocean. Costs for supply and installation of the STC-14000 unit has been carried in the project budget (as an optional cost) presented, but these appurtenances are not recommended for installation has the cost is high and their efficacy is questionable.

The infiltration testing concluded that there is exceptional potential for an exfiltration field in the system. It is proposed to construct an exfiltration gallery at the step-up manhole at the west edge of the park. The inlet would be equipped with a trapping hood to ensure large debris and coarse sediment do not enter the field, and cleanout manholes will also be installed for required long-term maintenance. The proposed gallery would be constructed from Stormtech® chambers for maximum storage and infiltration potential.

5. LANDSCAPE DESIGN OPPORTUNITIES AND CONSTRAINTS

5.1. Shoreline Walkway and Adjacent Features

Existing Walkway

The shoreline walkway connects a parking lot servicing the Coast Discovery Marina, and Ostler Park - to the north - with Sea Gull walk at the south end of the park.

The walkway parallels the existing rip-rapped shoreline, with a variable width (±3m, range 0-4m) grass strip between the pavement and bank top (**Figure 5.1**). This strip has been utilized for the installation of park benches and picnic tables - however it is under attack by storm waves and projectile objects such as storm-tossed logs. In its current state this marine riparian strip (dynamic zone of the marine shoreline extending landward from mean high water) is habitat-poor for shoreline ecological processes and organisms. While the current condition is not unusual for urban waterfronts, the opportunity to enhance riparian habitat values will be greatly increased with development of the proposed beach profile.

Figure 5.1: Seaward grass strip between walkway and rip-rap bank is subject to storm wave erosion.

The 3m walkway cross-section is comprised of older-style unit pavers bounded by a cast-in-place flush concrete curb. Towards the north end of the alignment, localized edges of the walkway are undergoing undermining from over-topping waves.

At either end of the walkway the connecting paths vary in width, materials and finishes (**Figure 5.2**) below.

Figure 5.2 - Connections with adjacent walkways

Sea Gull Walk (left) and at parking lot to north (right). Note abrupt grading transition at end of Sea Gull walk and difference in width. Sea Gull walk is elevated over an armoured shoreline and is therefore 'fixed'. Both walkways are exposed aggregate cast-in-place concrete. Current DFO policy does not support exposed aggregate finishing at the shoreline due to deleterious effects of washing off the surface retardant chemicals to fish habitat.

Walkway Design Implications

The proposed seashore design will require a significant portion of the existing shoreline walkway to be shifted to landward, therefore, replaced. The alignment profile will also be raised by (0.3-1m) to an elevation of approximately 4.1m geodetic:

- In order to tie-in with pathways at either end, vertically and horizontally, all of the north end and most of the southern end will need to be re-constructed
- In order to avoid a patchwork of pavements along the future alignment we suggest replacement of all of the unit pavers with a cast-in-place concrete or asphalt surface.
- All intersecting pathways should allow for wheelchair accessibility (e.g. from play area) - with vertical alignment changes to the shoreline walkway, the profiles of these pathways will require adjustment as well
- The walkway should be located 2-3m back of the top-of-beach to protect the pavement structure and to establish a riparian vegetation community
- The walkway, and connections to it, should meet accessibility design criteria with respect to maximum slopes to avoid ramps that would mandate railings.
- The pavement structure should be designed to shed water to seaward (i.e. minimum cross-pitch 1%) and to prevent damage to the surface or base during rare swash or run-up events. For example, a large storm coinciding with maximum tide height.

Site Furnishings

The CCR Parks department used regionally-made concrete benches and picnic tables as standard furnishings along its Sea Walk however the current policy is to use furnishings manufactured of recycled materials, such as at Dick Murphy Park. The existing memorial benches and tables will require replacement. Many of these are 'memorial' pieces with dedication plaques, often benches were purchased with place-specific locations in mind (e.g. views). There are currently 5 benches and 1 picnic table, mounted on cast-in-place slabs, arrayed along the seaward edge of the existing walkway alignment (**Figure 5.3**, below).

Figure 5.3 - Site furnishings require oversize concrete pads
These features effectively require 3-4m of level land at the back of the beach. In the current armoured-bank situation, some of the slabs (and benches) have been damaged by over-topping waves (red snow fence - mid-ground). A few of the benches have been damaged by hurled logs during storms. Some of the site furnishings do not have pads extending fully back to the walkway limiting accessibility of the mobility-challenged.

Site Furnishings Considerations

- For protection, and to de-clutter the sea views from items such as trash barrels, doggy-bag dispensers, signs, etc. site furnishings are better located on the landward side of the proposed walkway.
- Memorial benches should be sited in the same relative location along the walkway alignment as they may be view-specific.
- For water-oriented events (e.g. fireworks) more available seating would be beneficial
- Spacing and grouping of pads requires some rationale, rhythm and accommodation for additional units

Longhouse

The existing Wei Wai Kum - Kwiakah longhouse represents a fixed point, excluded from the proposed shoreline and associated park improvements.

At its closest point it sits roughly 6.5m from the back of the existing walkway at an elevation of approximately 2.85m - the adjacent pathway is at 3.00m.

Under existing conditions, it is prone to flooding and damage from debris being tossed over the walkway during large storms (**Figure 5.4**, right Image credit: www.campbellriver.ca).

Figure 5.4: Flooding at the Kwiakah Longhouse
Note the extent of pooling over lawn in middle ground.

With the proposed shoreline works the adjacent walkway may more be elevated, and the alignment may shift inland, closing the distance between the walkway and the SE corner column to approximately 3m.

Longhouse Considerations

- While not part of the project, ideally the structure would be elevated to 4m or so
- Nearby grades will be raised (SE and NE side). Soft landscape grading transitions should be 3:1 or less and localized drainage provisions will be required (lawn basin with connections to revised storm water system.
- An accessible access to the structure is feasible from the north however may not be from the south (main lawn area) - subject to proposed walkway grading.

Existing Treed berms: Approximately midway along the existing walkway alignment there is a pair of low landforms with mature Austrian pines at/near the top (4.15-4.85m elevation) as shown on **Figure 5.5**.

Some of the trees will be *directly* affected by the proposed walkway alignment. Unfortunately, trees grown in groups tend to reveal large bald areas on those individuals left after removal of their neighbours. Trees closer to the new playground should be unaffected.

Figure 5.5: Mid-Park Landforms with Mature Trees

Riparian Vegetation:

Currently the top of the rip-rap is mown grass. It requires mowing and edging along the rip-rap while providing virtually no habitat value to the beach. The anticipated beach would include native shoreline plantings - with specifically-designed accesses through to the lower beach face. This plant community would require infrequent maintenance - removal of invasive species and selective pruning of shrubs.

Riparian Vegetation Design Considerations

- Consideration for replacement trees (for those lost on the berms) should include native shoreline-adapted trees - to be planted in the riparian strip to seaward of the walkway - with views in mind.
- A dedicated 2-3+m width, more-or-less level, strip would accommodate upland marine riparian plantings and interpretive signage.
- Lower on the beach face (i.e. between 3m and 4.1m geodetic) salt tolerant non-woody plants should be planted in clumps amongst the drift logs in a 'lean' growing medium.
- A balance between competing objectives (views and habitat) will need to be struck through deliberate beach access design.

Built-in Flexibility for the Future Lighting:

Many, if not most, waterfront promenades allow for safe and enjoyable use after sunset through site lighting. As exists, there are no lights along the Ostler walkway, while the Sea Gull walk has them; and the parking lot to the north has standard 'cobra-head' fixtures.

While walkway lighting is beyond the scope of the current project, since the alignment will be excavated along its length, we suggest that considerations such as conduits and luminaire locations and spacing be integrated into the walkway design proactively - to avoid future site disturbance, pavement cuts and conflicts with logical light spacing posed by other proposed elements.

Lighting Considerations

- Any contemplated lighting should meet 'dark skies' criteria (minimize light trespass vertically and horizontally - i.e. full perimeter cut-off)
- Luminaires on poles are but one option, lighting can be mounted into wall faces, pilasters, bollards and other lower level structures - to provide a walkway-level wash across the pavement surface.
- Without lighting a primary CPTED (crime prevention through environmental design) principle is being missed.

5.2. Inland Park Features

Lawn: As shown previously on **Figure 5.4** the central lawn area to the west of the longhouse is both, prone to salt water inundation, and has poor surface drainage. The area is low, without a path for surface drainage to flow out and lacks drainage infrastructure such as catch basins or subsurface drain structures. Consequently, the lawn is in poor condition and the area tends to be 'boggy' during the winter and shoulder seasons.

Lawn Considerations

- Very large volumes of fill material will be excavated for construction of the beach and the walkway will generally be at elevation 4.1m.
- Subject to suitability, the excavated material could be placed and graded to:
    a) raise the low area of the lawn - directing that surface towards proposed drainage structures and
    b) create a smooth, low slope transition from the proposed (higher) walkway back into the lower upland park grades.

Play Area: The newly installed play area is not likely to be directly affected by construction.

Play Area Considerations

- Deciduous trees on the east and northeast sides will continue to provide shade.
- The newly-constructed access pathway from the play area to the existing shoreline walkway (**Figure 5.6**) will need some vertical and horizontal alignment adjustments to meet the proposed shoreline promenade re-alignment.

Figure 5.6: New Play Area constructed June-July 2016

Feature Planting Bed at Hwy 19A: The proposed storm sewer upgrades originate at the street the St Ann's Rd intersection and will need to traverse the park through its alignment to a proposed outfall at the shoreline.

A horticulturally-rich and extensive planting bed provides an aesthetic pedestrian entry point from the intersection - into the park. This bed contains some significant specimen trees and mature ornamental plants (**Figure 5.7**).

Figure 5.7: Garden Areas at St. Ann's and Highway 19A

Feature Bed/ Storm Sewer Design Considerations

- The depth and alignment of the new storm pipe should be designed to limit impacts to the major trees in this area (large oak, large beech, mature ornamental cypresses, Japanese maple etc.)
- Towards the completion of detailed design, CCR Parks staff should be advised on the confirmed route so that they can effect a plant rescue of some of the smaller, valuable specimens.

5.3. General Park Considerations

In addition to the above considerations, the existing park irrigation system will require re-design and re-installation throughout the affected areas. As well, the existing kiosks (irrigation and other services) will require protection if feasible. Replacement or relocation should consider maintenance accessibility as well as unobtrusiveness in the visual realm (i.e. avoid impacting views, seating areas and so forth).

6. FORESHORE RESORATION CONCEPT

The requirements for the long term stability of the beach, and the recommendation for an interim walkway level to accommodate Sea Level Rise dictate the constraints of the beach, while the upland features of the park and the need to preserve key elements require a design to fit within the given space. The stormwater system reconfiguration can be accommodated without negative effects on the park or beach use. All these elements play into the recommended restoration concept for Ostler Park, which is shown on the attached **Figure 6.1**, and described in detail within the following section.

6.1. Beach Design

Groyne Structure

A beach nourishment concept was developed by including a groyne structure at the south end of the park shoreline as the coastal process analysis indicated that the net sediment transport is southward at the project site. The groyne will prevent the southward movement of fill material and trap finer sands transported by the net tidal current.

A configuration for a groyne was developed in a way that the structure would have an optimum size with minimal foot print on the seabed, while providing an effective barrier to the southward movement of sediment. To achieve this, a sloping crest at 4:1 was used. The total length of the structure is 45 m.

The cross-section of the groyne was developed using The Rock Manual (CERIA 2006) and the Shore Protection Manual (USACE 1984).

The mean diameter of the armour rock was 1.0 m for 1.5H:1V side slope.

Beach Nourishment

For beach nourishment projects, the grain size for the fill material should generally be based on the characterization of the beach profile, local wave climate, and projected stability of the beach. The following expression (Dean 2002), which is mainly based on the size of the beach material can be used to define the equilibrium beach profile that a natural beach would try to attain:

$$h(x) = A\,(x)^{2/3}$$

where, h is the water depth at a distance x from the shoreline and A is a profile scale parameter. A is a function of sediment fall velocity in water or, in other words, a function of the sediment size.

It was described earlier that the size of the naturally forming beach material at Ostler Park has a mean size of 2 mm, with additional presence of gravels. Ideally, the grain size of the beach nourishment material should be the same size or larger than the native beach sand to minimize erosion. Material that has a smaller diameter than the native sand can remain in equilibrium only at slopes flatter than the existing beach. If smaller diameter sand is used, the volume required to form an equilibrium offshore profile will be much greater, and consequently costlier. Beach profiles estimated for mean sediment sizes of 2 mm and 10 mm are shown in **Figure 6.2**. The equilibrium profile predicted for 10 mm material closely matches the “typical beach profile”, an estimated average profile currently at Ostler Park.

On the basis of the sediment transport analysis, and the nature of wave-current exposure at the site, a factor of safety should be applied to the assessment. This can be achieved by designing the beach with an average grain size larger than 10 mm, and/or designing a shallower slope. Since a shallower slope will either result in more park area loss, or filling beyond the lower low water mark, increasing the grain size is the preferred option for addressing a safety factor.

A beach profile of about slope 6H:1V ("Design Profile" on **Figure 6.3**) is recommended, noting that this slope is approximately parallel to the stable beach profile for a D50 of 10 mm. An average grain size of 25 mm is recommended. It is noted the City of Campbell River has a stockpile of beach gravel, that likely has an average size of approximately 25 mm, consisting of a wide gradation between sand and 75 mm gravel. A wide gradation is not recommended for the mid portion of the beach around mean sea level (approximately +/- 1 m), as finer material may be mobilized and transported towards Fisherman's Wharf.

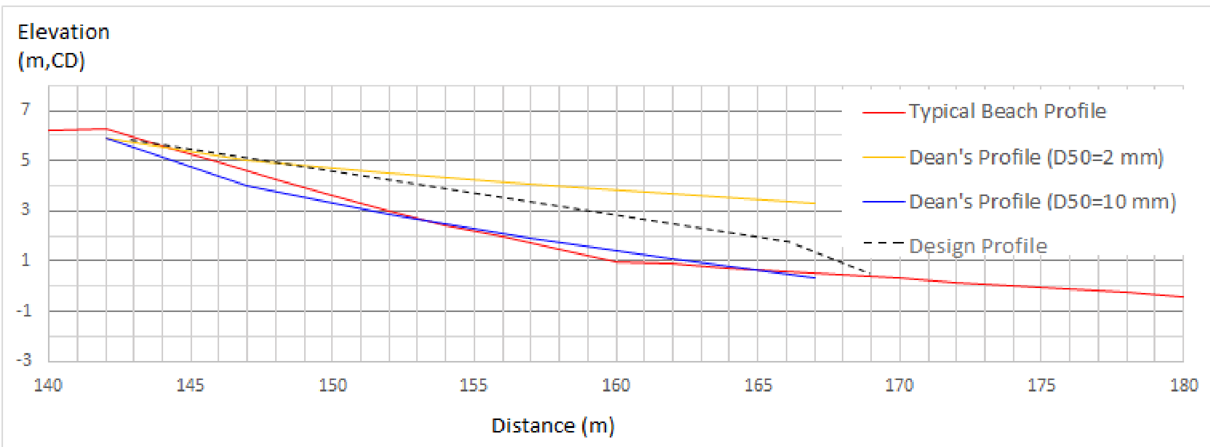


Figure 6.3: Design Beach Profile

By nature, beach sediments are moveable/erodible in storms. A recommended risk mitigation technique is to bury rip-rap (and appropriate filter rock) into the crest of the beach, so that if excessive erosion is initiated by a large storm event, the rip-rap will act as a last defence. The rip-rap could be salvaged from the existing beach armour.

General Layout

The general layout and profiles of the proposed beach are provided on **Figure 6.1**, with a section shown on **Figure 6.2**. The layout takes advantage of the natural contours of the seabed. The beach works should not need to extend below lower low water. With the proposed re-positioning of the shoreline, there is a loss of approximately 880 m^2 of upland park area. However, this will be offset by a gain of 520 m^2 of upland park area created at the groyne location.

As is evident on the preliminary design concept plan, the walkway does need to be moved farther into the park then envisioned during the conceptual design stage, which assumed that the walkway would be placed at or about 3.0m elevation. That is, very little difference in the height of the walkway than as it does today. Given the calculations for the storm and wave effects at this particular location, and considering the need to accommodate some level of potential Seal Level Rise. The walkway has to be lifted about a metre to a crest elevation of 4.1m above mean sea level. Considering the 6-7 Horizontal to 1 Vertical slope face of the beach the walkway offset from it's current location is more substantive than previously envisioned, and the proposed alignment will affect the mature tree stand in the centre of the park. The removal of some trees is necessary, but the proposed plan includes replacement trees to ensure shade space within the appropriate program areas – the playground and other resting locations.

The proposed walkway elevation and location does mean that there will likely be a better cut-fill balance between the material excavated to make the beach and the material required to form the walkway at 4.1m.

The beach will be constructed with underlying materials consistent with previous designs as shown on the **Figure 6.4** section below. The intent of the graphic is to highlight the three main elements of the beach section, and not what is shown at the top of the walkway.

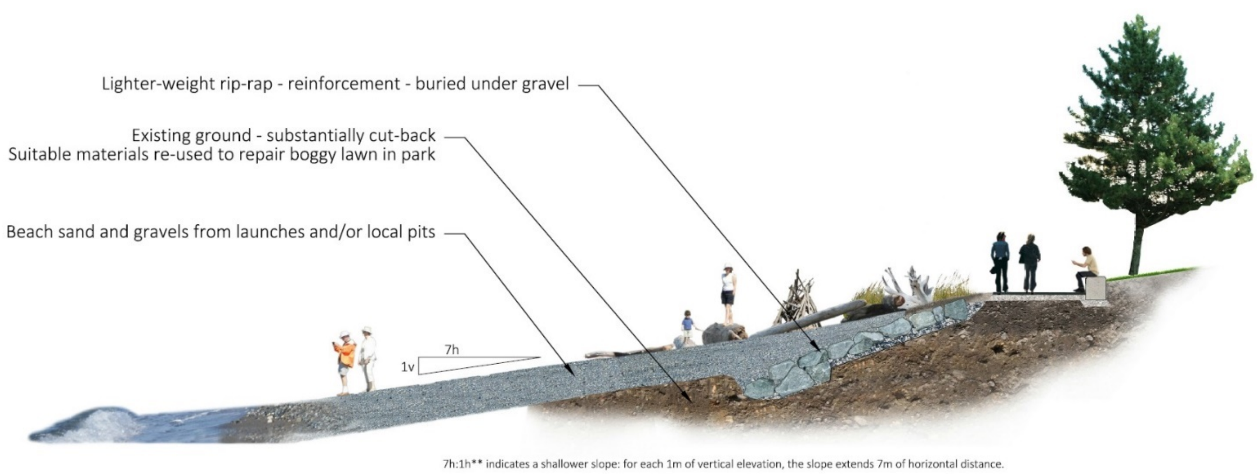


Figure 6.4: Design Beach Section

6.2. Rip-Rap Improvements

Any rip-rap armour protection of the Ostler Park shoreline remaining following the installation of the beach, particularly along the northern portion of the park shoreline, should be remediated to:

- repair damaged areas
- address areas of undersized rock
- address an insufficient crest height
- include a geotextile separator material to ensure fine material does not migrate from below the reinstated riprap

Armour rock of 1 m mean diameter is recommended, with a crest height of 5.1 m GD. Logs can be thrown higher on a rip-rap shore than a shallower sloped beach due the higher wave energy upon impact. Options to increase the height by 1 m above the proposed 4.1 m ground level could include a mounded row of rip-rap, or a concrete wall of suitable strength to withstand the impact of logs.

7. ESTIMATED CAPITAL COSTS

Capital Costs for the project are presented at the requisite Class ‘C’ level with appropriate contingencies per City policy. The cost estimate is based on recent local pricing for work of a similar scope and nature and includes soft costs such as mobilization and demobilization. The following **Table 7.1** Summarizes the cost categories, with a greater breakdown contained in **Appendix E**.

Table 7.1: Summary of Capital Cost Estimate

Item	Estimated Cost
General	$ 52,500
Removals and Base Preparation	113,200
Construct New Beach	242,700
Renew/Revise Storm Sewers	291,200
Landscaping and Final Restoration	269,275
Subtotal (rounded to nearest $1000)	969,000
Contingencies	678,000
Total	$ 1,647,000

General costs include mobilization and demobilization, traffic control, survey and environmental protection requirements, while contingencies include the following allowances:

- 25% General Contingency Allowance
- 25% Engineering, Finance and Administration
- 20% Inflation

Currently, the project is scheduled to begin after the 150th Celebration of Canada’s Birthday (July 2017). This schedule is still attainable, and it is recommended that the detailed design be initiated as soon as possible to ensure proper project implementation, providing the above budget is within the City’s appropriations.

8. CONCLUSIONS AND RECOMMENDATIONS

From the work completed to-date the following conclusions and recommendations can be made:

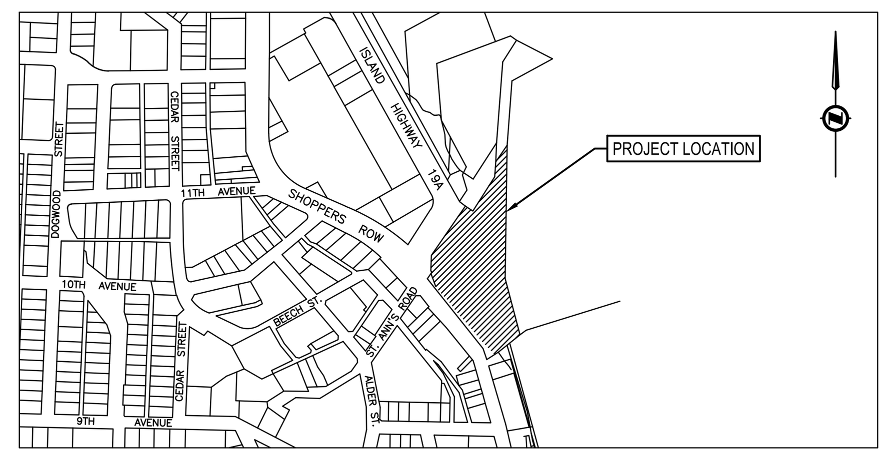
- The foreshore of Oster Park features a sediment bench of sands with a mix of finer gravels that extends a significant distance off shore.
- The existing upland areas of Ostler Park are generally at 3.0m elevation with a consistent sand fill profile with very high infiltration rates and a summer season water table just above mean sea level.
- It is recommended to complete more groundwater monitoring during the rainy season to determine if an exfiltration gallery is a worthy design element for storm water management for this project. At this time, an allowance for a gallery is included in the design to allow the storm system to drain itself.
- A habitat survey revealed a shallow subtidal zone with sloped sandy sediments, with characteristic species that included eelgrass, Dungeness crab, and sand dollars. The subtidal zone (with eelgrass) is higher value habitat, and loss of this habitat should be avoided or minimized as part of the project.
- The new storm sewer must meet current standards and amalgamate all storm lines with one outfall, located outside the new beach area. The system needs to accommodate the 100-year design storm to ensure that upstream flooding does not occur during extreme events.
- The design horizon for the project was agreed to be 30 years, or the year 2050, and locally, the sea is estimated to rise by 0.3m by the year 2050.
- Wave run-up is the elevation above the still water level that the wave will reach when contacting the beach. From the analysis conducted Annual Waves (top 2% during an annual storm) will run up 2.7m, while waves from a storm with a 50-year return period will run-up 3.0m.
- After adding the estimated Sea Level Rise and Storm Surge and Storm Run-up Allowances to the existing high high water level from tides a design water level of 5.1m is calculated, but this would require raising the current walkway by more than 2m. On this basis, it is recommended to lower the design water level by 1.0m to allow some over-topping and some beach maintenance. The design water level is, therefore, 4.1m above the current mean sea level.
- The drainage catchment contributing storm water to the outfall at Ostler Park is estimated to be 8.8Ha, producing a peak runoff for a 1:100-year design storm of approximately 1690 litres per second. This requires a 900mm diameter storm pipe through the park. It is recommended to re-configure the storm system so that it is lift over the existing 1050mm diameter sanitary sewer pipe. It is also recommended to fit the outfall with a flap gate to prevent the ocean from backing up into the storm sewer.
- The recommended alignment for the storm sewer is to the north of the gardens at the St. Ann's – Highway 19A intersection with the outfall being placed within the riprapped transition zone at the north end of the beach. The depth and alignment of the new storm pipe should be designed to limit impacts to the major trees in this area (large oak, large beech, mature ornamental cypresses, Japanese maple etc.).

- An oil-grit separator unit is not recommended due to the high cost, and the expected poor performance of the unit given the tidal influence and the size of the pipes required to convey the flow through the system.
- The sandy infill soils provide excellent infiltration capacity and it is recommended to consider an exfiltration gallery at the manhole where the storm system requires lifting. This will allow the upstream system to drain between storm events.
- The existing walkway is too low and requires significant re-configuration. The following recommendation are made to improve the overall aesthetic of the design:
    - In order to avoid a patchwork of pavements along the future alignment we suggest replacement of all of the unit pavers with aa asphalt surface.
    - All intersecting pathways should allow for wheelchair accessibility (e.g. from play area) - with vertical alignment changes to the shoreline walkway.
    - The walkway should be located 2-3m back of the top-of-beach to protect the pavement structure and to establish a riparian vegetation community
    - The pavement structure should be designed to shed water to seaward (i.e. minimum cross-pitch 1%).
- City of Campbell River Parks Department is moving toward the use of park furniture made from recycled materials, the following recommendation are made in respect to the architecture of these features:
    - For protection, and to de-clutter the sea views from items such as trash barrels, doggy-bag dispensers, signs, etc. site furnishings are better located on the landward side of the proposed walkway.
    - Memorial benches should be sited in the same relative location along the walkway alignment as they may be view-specific.
    - For water-oriented events (e.g. fireworks) more available seating would be beneficial
    - Spacing and grouping of pads requires some rationale, rhythm and accommodation for additional units.
- Park Trees will be affected by the new alignment and new, natural beach planting need to be considered. In this regard, the following recommendations are made:
    - Consideration for replacement trees (for those lost on the berms) should include native shoreline- adapted trees - to be planted in the riparian strip to seaward of the walkway - with views in mind.
    - A dedicated 2-3+m width, more-or-less level, strip would accommodate upland marine riparian plantings and interpretive signage.
    - Lower on the beach face (i.e. between 3m and 4.1m geodetic) salt tolerant non-woody plants should be planted in clumps amongst the drift logs in a 'lean' growing medium.
    - A balance between competing objectives (views and habitat) will need to be struck through deliberate beach access design.

- The design will include accommodation for future lighting requirements.
- The upland park space will require regrading to accommodate the new walkway at 4.1m. This is likely to require additional drainage structures to capture and convey stormwater while mitigating ponding within the park.
- To mitigate sediment transport of beach material southward, and into the adjacent boat basin, a groyne structure is required at the south end of the proposed ‘pocket” beach.
- A beach profile of about slope 6H:1V is recommended, noting that this slope is approximately parallel to the stable beach profile for a D50 of 10 mm. An average grain size of 25 mm is recommended for the beach gravels.
- Any rip-rap armour protection of the Ostler Park shoreline remaining following the installation of the beach, particularly along the northern portion of the park shoreline, should be remediated to repair damaged areas; address areas of undersized rock; address an insufficient crest height, and include a geotextile separator material to ensure fine material does not migrate from below the reinstated riprap. Armour rock of 1 m mean diameter is recommended, with a crest height of 5.1 m above men sea level.
- The preliminary design culminates in a recommended general arrangement drawing attached as Figure 6.1. The plan includes all required improvement to form the new ‘pocket’ beach; re-configure the park and its various program spaces; and upgrade the storm utility. The estimated cost for the project is $1,647,000, which includes contingencies and allowances in accordance with the City’s capital project estimating policy (Class C).

Figures

City of Campbell River



SITE LOCATION PLAN
(NTS)

McElhanney
McElhanney Consulting Services Ltd.
1307 SHOPPERS ROW PH (250) 287-7799
CAMPBELL RIVER, B.C.
V9W 2C9

JPH CONSULTANTS INC
LANDSCAPE ARCHITECTURE
PARK PLANNING AND DESIGN
ARBORICULTURE
434 Milton St Nanaimo BC V9R 2L1
Phone: 250-754-5857

GREATPACIFIC
ENGINEERING & ENVIRONMENT

FOR INFORMATION ONLY

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONTRACTOR SHALL EXPOSE LOCATIONS OF ALL EXISTING UTILITIES AND ADVISE THE ENGINEER OF POTENTIAL CONFLICTS.

THIS DRAWING HAS BEEN PREPARED FOR THE CLIENT IDENTIFIED, TO MEET THE STANDARDS AND REQUIREMENTS OF THE APPLICABLE PUBLIC AGENCIES. McELHANNEY CONSULTING SERVICES LTD., ITS EMPLOYEES, SUBCONSULTANTS AND AGENTS ACCEPT NO RESPONSIBILITY TO ANY OTHER PARTY, INCLUDING CONTRACTORS, SUPPLIERS, CONSULTANTS AND STAKEHOLDERS, OR THEIR EMPLOYEES OR AGENTS, FOR LOSS OR LIABILITY INCURRED AS A RESULT OF THEIR USE OF THESE DRAWINGS.

0 1:500 25

BC 1 CALL
1-800-474-6886

CITY OF CAMPBELL RIVER

OSTLER PARK FORESHORE RESTORATION
BASE PLAN

CAMPBELL RIVER, B.C.

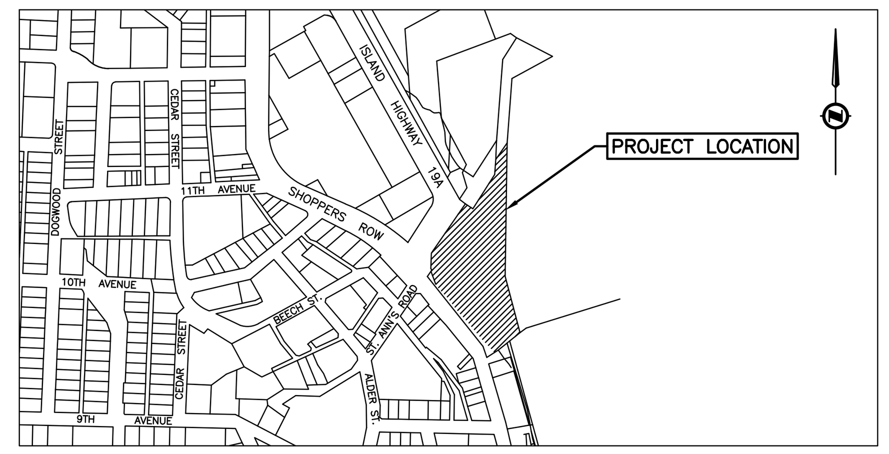
FIG. 2.1

PROJECT:
2221-49015-0

DRAWING PATH: C:\Users\EMullen\appdata\local\temp\AcPublish_8136\49015-ROBERT OSTLER DESIGN.dwg Tab FIGURE 2.1 Sep 05, 2016 10:21:50pm

DESTROY PRINTS OF PREVIOUS REVISION

City of Campbell River



SITE LOCATION PLAN

McElhanney
McElhanney Consulting Services Ltd.
1307 SHOPPERS ROW
CAMPBELL RIVER, B.C.
V9W 2C9
PH (250) 287-7799

JPH CONSULTANTS INC
LANDSCAPE ARCHITECTURE
PARK PLANNING AND DESIGN
ARBORICULTURE
434 Milton St Nanaimo BC V9R 2L1
Phone: 250-754-5857

GREATPACIFIC
ENGINEERING & ENVIRONMENT

FOR INFORMATION ONLY

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONTRACTOR SHALL EXPOSE LOCATIONS OF ALL EXISTING UTILITIES AND ADVISE THE ENGINEER OF POTENTIAL CONFLICTS.

0 1:500 25

BC 1 CALL 1-800-474-6886

CITY OF CAMPBELL RIVER

OSTLER PARK FORESHORE RESTORATION
STORM DRAIN UPGRADE – OPTION 1

CAMPBELL RIVER, B.C.

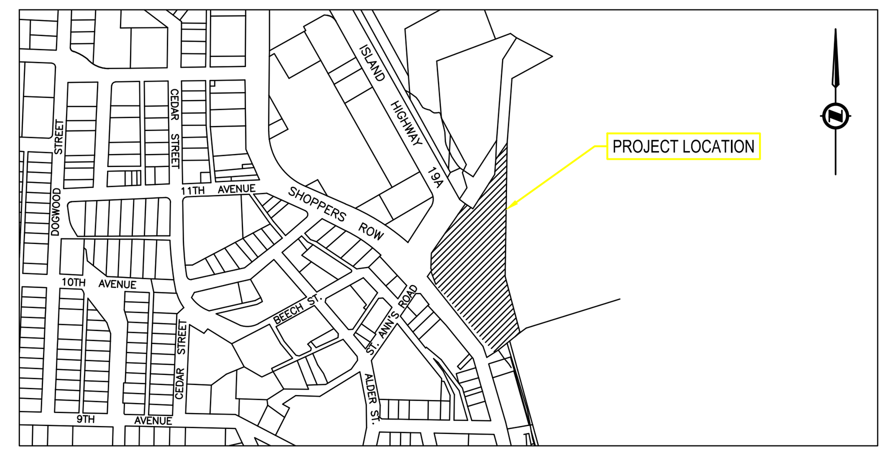
FIG. 4.3

PROJECT: 2221-49015-0

DRAWING PATH: C:\Users\EMullen\appdata\local\temp\AcPublish_8136\49015-ROBERT OSTLER DESIGN.dwg Tab FIGURE 4.3 Sep 05, 2016 10:22:16pm

DESTROY PRINTS OF PREVIOUS REVISION

City of Campbell River



SITE LOCATION PLAN
(NTS)

McElhanney
McElhanney Consulting Services Ltd.
1307 SHOPPERS ROW PH (250) 287-7799
CAMPBELL RIVER, B.C.
V9W 2C9

JPH CONSULTANTS INC
LANDSCAPE ARCHITECTURE
PARK PLANNING AND DESIGN
ARBORICULTURE
434 Milton St Nanaimo BC V9R 2L1
Phone: 250-754-5857

GREATPACIFIC
ENGINEERING & ENVIRONMENT

FOR INFORMATION ONLY

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONTRACTOR SHALL EXPOSE LOCATIONS OF ALL EXISTING UTILITIES AND ADVISE THE ENGINEER OF POTENTIAL CONFLICTS.

0 1:500 25

BC 1 CALL
1-800-474-6886

CITY OF CAMPBELL RIVER

OSTLER PARK FORESHORE RESTORATION
STORM DRAIN UPGRADE – OPTION 2

CAMPBELL RIVER, B.C.

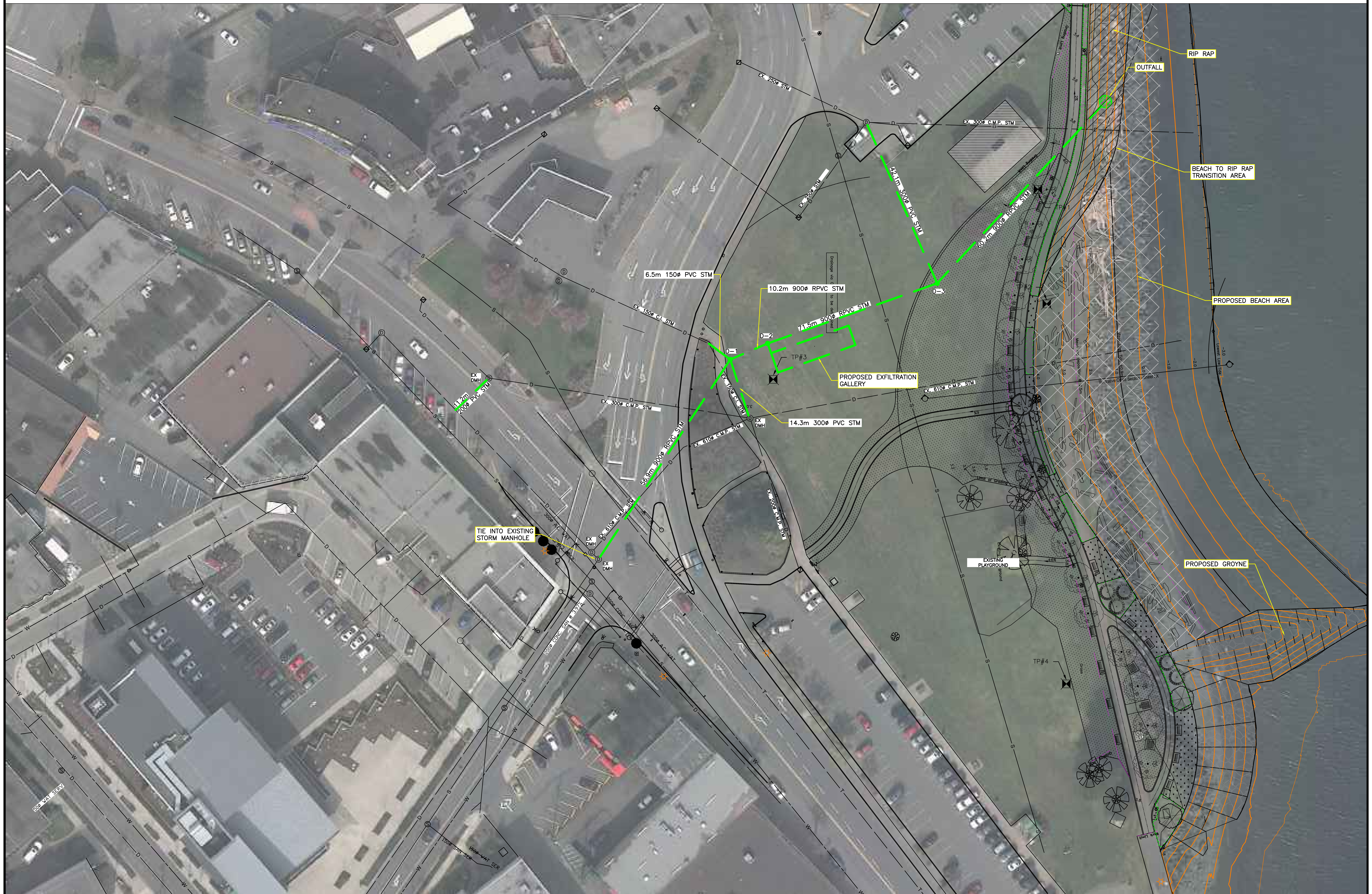
FIG. 4.4

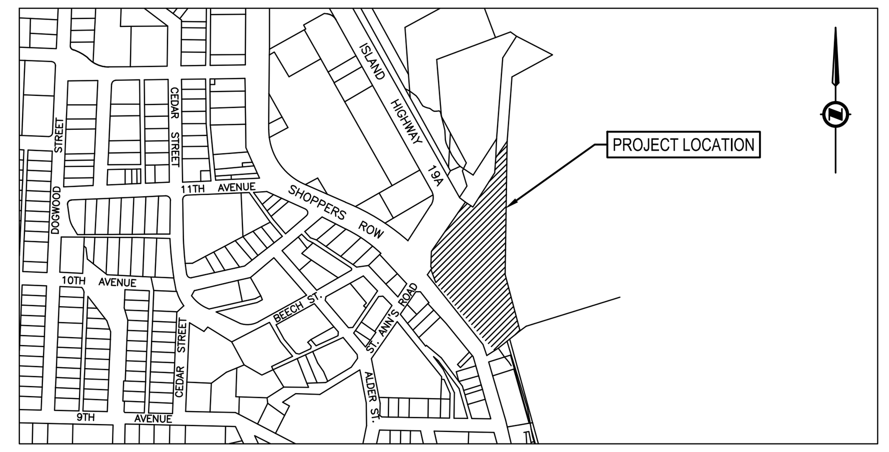
PROJECT:
2221-49015-0

DRAWING PATH: C:\Users\EMullen\appdata\local\temp\AcPublish_8136\49015-ROBERT OSTLER DESIGN.dwg Tab FIGURE 4.4 Sep 05, 2016 10:22:43pm

DESTROY PRINTS OF PREVIOUS REVISION

City of Campbell River





SITE LOCATION PLAN
(NTS)

McElhanney
McElhanney Consulting Services Ltd.
1307 SHOPPERS ROW PH (250) 287-7799
CAMPBELL RIVER, B.C.
V9W 2C9

JPH CONSULTANTS INC
LANDSCAPE ARCHITECTURE
PARK PLANNING AND DESIGN
ARBORICULTURE
434 Milton St Nanaimo BC V9R 2L1
Phone: 250-754-5857

GREATPACIFIC
ENGINEERING & ENVIRONMENT

FOR INFORMATION ONLY

0 1:500 25

BC 1 CALL
1-800-474-6886

CITY OF CAMPBELL RIVER

OSTLER PARK FORESHORE RESTORATION
CONCEPTUAL DESIGN

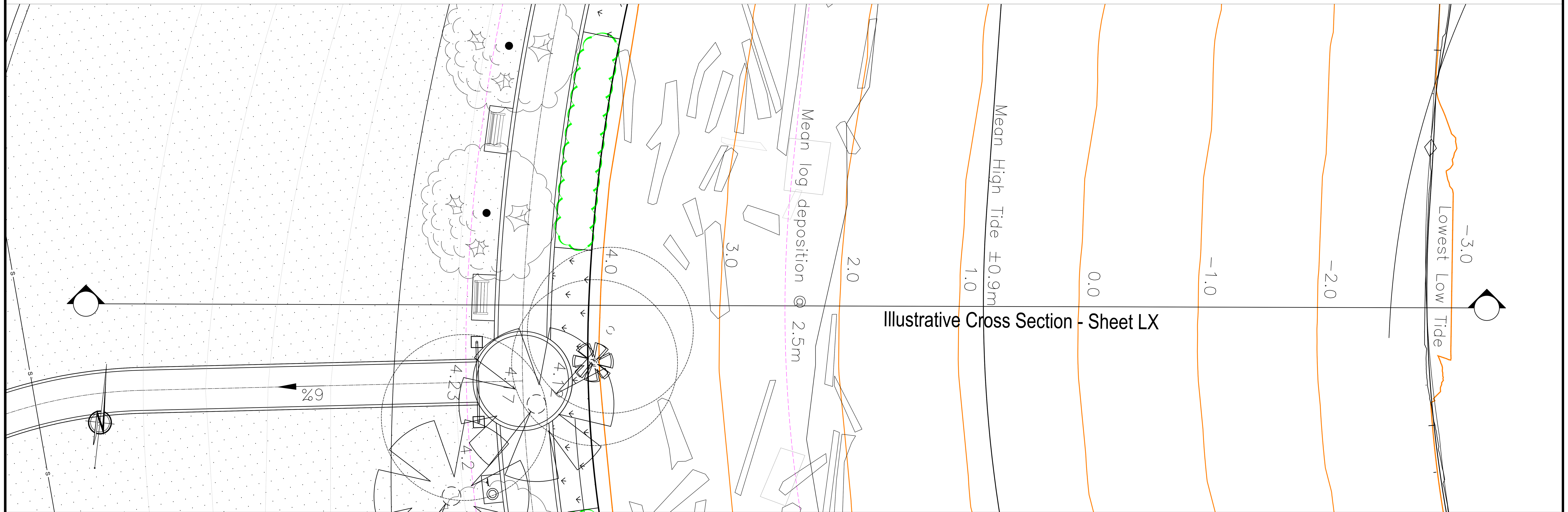
CAMPBELL RIVER, B.C.

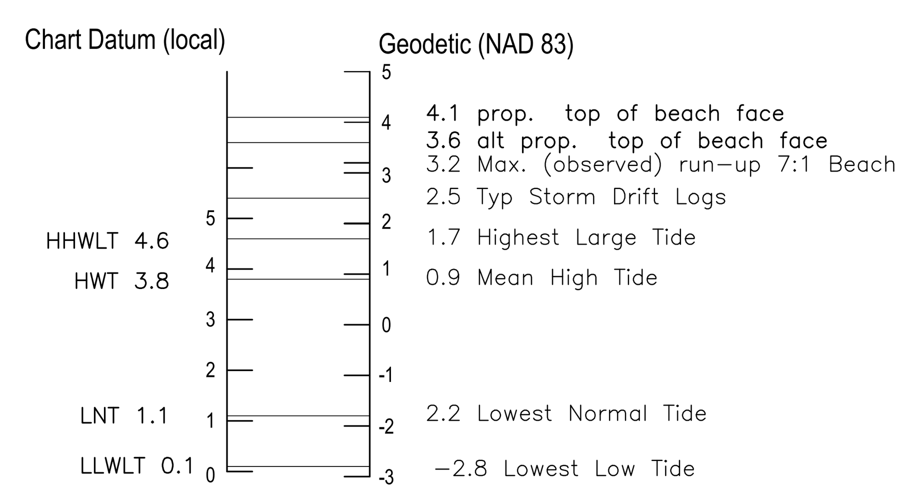
FIG. 6.1

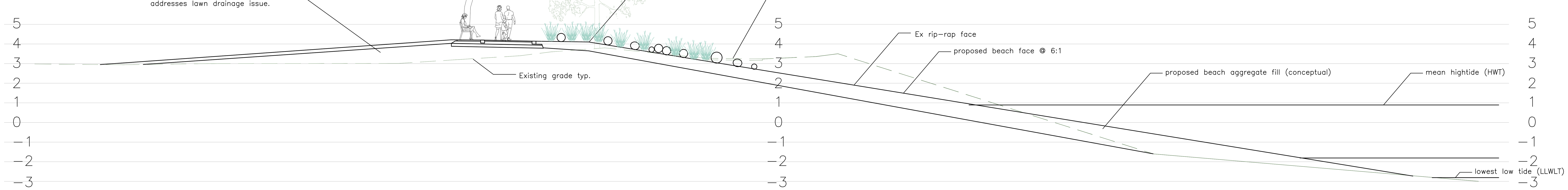
PROJECT:
2221-49015-0

DRAWING PATH: C:\Users\EMullen\appdata\local\temp\AcPublish_8136\49015-ROBERT OSTLER DESIGN.dwg Tab FIGURE 6.1 Sep 05, 2016 10:23:14pm

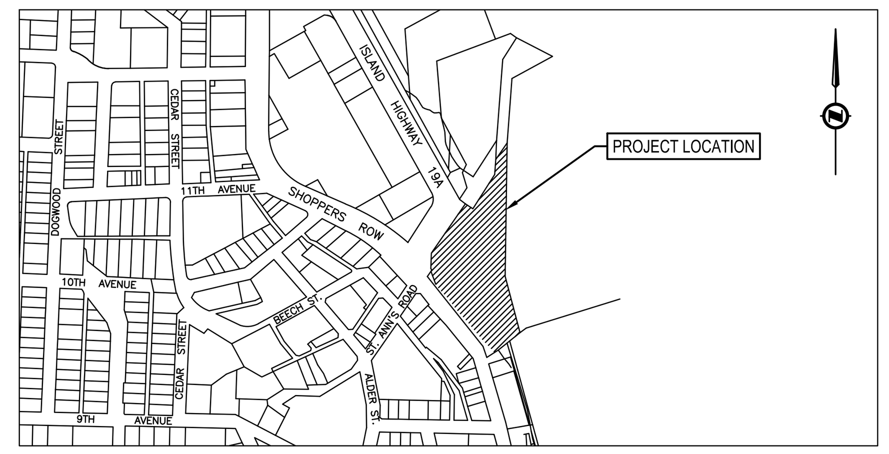
DESTROY PRINTS OF PREVIOUS REVISION







City of Campbell River



SITE LOCATION PLAN

McElhanney
McElhanney Consulting Services Ltd.
1307 SHOPPERS ROW
CAMPBELL RIVER, B.C.
V9W 2C9
PH (250) 287-7799

JPH CONSULTANTS INC
LANDSCAPE ARCHITECTURE
PARK PLANNING AND DESIGN
ARBORICULTURE
434 Milton St Nanaimo BC V9R 2L1
Phone: 250−754−5857

GREATPACIFIC
ENGINEERING & ENVIRONMENT

FOR INFORMATION ONLY

0 1:500 25

BC 1 CALL 1-800-474-6886

CITY OF CAMPBELL RIVER

OSTLER PARK FORESHORE RESTORATION
ARCHITECTURAL BEACH SECTION

CAMPBELL RIVER, B.C.

FIG. 6.2

PROJECT: 2221−49015−0

DRAWING PATH: C:\Users\EMullen\appdata\local\temp\AcPublish_8136\49015−ROBERT OSTLER DESIGN.dwg Tab FIGURE 6.2 Sep 05, 2016 10:24:02pm

DESTROY PRINTS OF PREVIOUS REVISION

Appendix A – Near Shore Sediment Sieve Analyses

McElhanney Consulting Services Ltd.
495 Sixth Street
Courtenay, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2221-49015
CLIENT City of Campbell River
C.C.

TO
City of Campbell River
301 St. Ann's Road
Campbell River, BC
V9W 4C7

ATTN: Clinton Crook

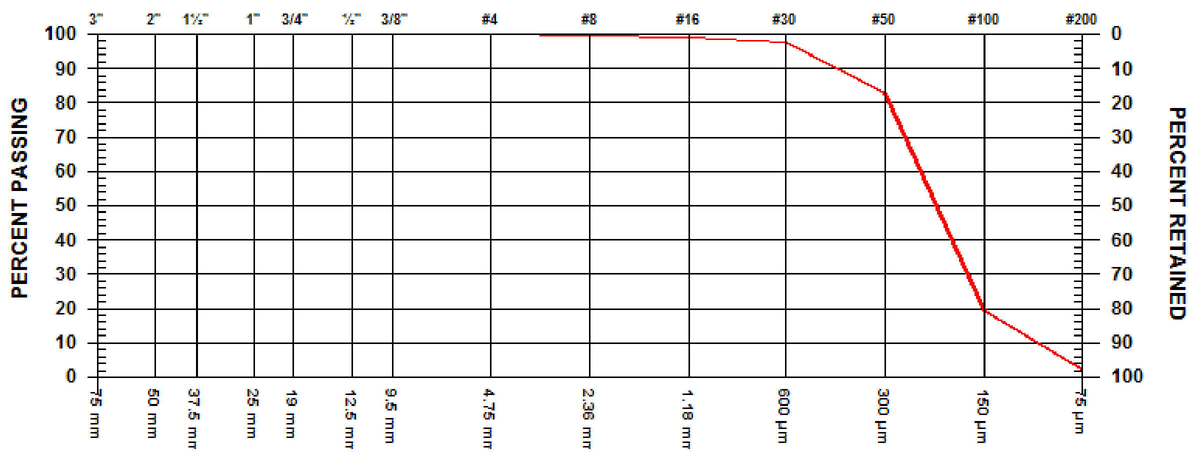
PROJECT RFP 16-12 Ostler Park Foreshore Project Ostler Park
Materials Testing Services Campbell River

CONTRACTOR

SIEVE TEST NO. 5 DATE RECEIVED 08-Jun-2016 DATE TESTED 17-Jun-2016 DATE SAMPLED 07-Jun-2016

SUPPLIER N/A
SOURCE Station #3
SPECIFICATION
MATERIAL TYPE In-situ Ocean Material

SAMPLED BY Client
TESTED BY PMD
TEST METHOD WASHED



GRAVEL SIZES	PERCENT PASSING	GRADATION LIMITS
3" 75 mm		
2" 50 mm		
1 1/2" 37.5 mm		
1" 25 mm		
3/4" 19 mm		
1/2" 12.5 mm		
3/8" 9.5 mm		

SAND SIZES AND FINES	PERCENT PASSING	GRADATION LIMITS
No. 4 4.75 mm	100.0	
No. 8 2.36 mm	99.6	
No. 16 1.18 mm	99.1	
No. 30 600 µm	97.8	
No. 50 300 µm	82.8	
No. 100 150 µm	19.5	
No. 200 75 µm	2.3	

MOISTURE CONTENT 47.1 %

COMMENTS
Client sampled this material
Marine deposits found in sieve

 17-Jun-2016 McElhanney Consulting Services Ltd. PER.

McElhanney Consulting Services Ltd.
495 Sixth Street
Courtenay, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2221-49015
CLIENT City of Campbell River
C.C.

TO
City of Campbell River
301 St. Ann's Road
Campbell River, BC
V9W 4C7

ATTN: Clinton Crook

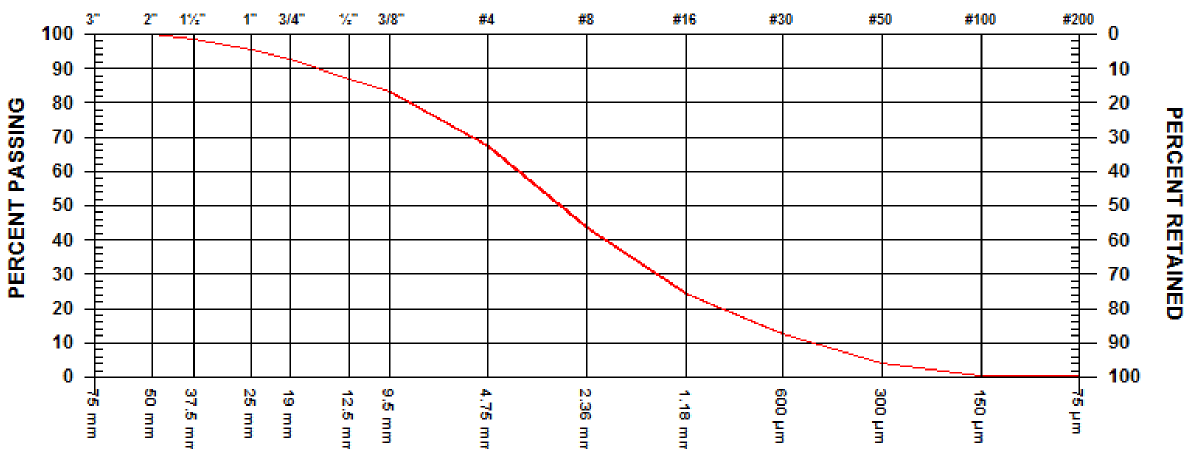
PROJECT RFP 16-12 Ostler Park Foreshore Project Materials Testing Services — Ostler Park, Campbell River

CONTRACTOR

SIEVE TEST NO. 1 DATE RECEIVED 08-Jun-2016 DATE TESTED 16-Jun-2016 DATE SAMPLED 07-Jun-2016

SUPPLIER N/A
SOURCE Station #4
SPECIFICATION
MATERIAL TYPE In-situ Ocean Material

SAMPLED BY Client
TESTED BY PMD
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm	100.0	
2"	50 mm	100.0	
1 1/2"	37.5 mm	98.6	
1"	25 mm	95.7	
3/4"	19 mm	92.9	
1/2"	12.5 mm	86.9	
3/8"	9.5 mm	83.3	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	67.6	
No. 8	2.36 mm	43.6	
No. 16	1.18 mm	24.1	
No. 30	600 µm	12.7	
No. 50	300 µm	4.2	
No. 100	150 µm	0.6	
No. 200	75 µm	0.3	

MOISTURE CONTENT 7.1 %

COMMENTS
Client sampled this material
Marine deposits found in sieve

 17-Jun-2016 McElhanney Consulting Services Ltd. PER.

Appendix B – Test Pit Logs

CLIENT	City of Campbell River	**PROJECT NAME**	Ostler Park Foreshore Restoration
PROJECT NUMBER	2221-49015-00	**PROJECT LOCATION**	Campbell River
DATE STARTED	7/25/16 **COMPLETED** 7/25/16	**GROUND ELEVATION**	**TEST PIT SIZE** Excavator bucket
EXCAVATION CONTRACTOR	Bernie V.	**GROUND WATER LEVELS:**	
EXCAVATION METHOD	JD 75 Excavator	**AT TIME OF EXCAVATION**	3.30 m
LOGGED BY	R. Hache **CHECKED BY** K. Barth	**AT END OF EXCAVATION**	---
NOTES		**AFTER EXCAVATION**	---

DEPTH (m)	SAMPLE TYPE NUMBER	GRAPHIC LOG		MATERIAL DESCRIPTION
			0.10	ORGANIC; SAND and GRAVEL; rootlets, loose, black, dry
			0.25	FILL; SANDY SILT; trace cemented sand, trace gravel, medium dense, tan, dry
0.5				FILL; SAND; well graded, some gravel, grey brown, dry to moist
1.0				
1.5			1.70	
2.0				SAND and GRAVEL; trace to some cobbles, medium dense, light grey, moist Cobble up to 200 mm in diameter
2.5			2.70	
3.0				SAND; fine to medium grained, trace gravel, light grey, moist to wet Wet @ 3.2 m Light seepage @ 3.3 m
3.5			3.50	

Bottom of test pit at 3.50 meters.

McElhanney

CLIENT	City of Campbell River	**PROJECT NAME**	Ostler Park Foreshore Restoration
PROJECT NUMBER	2221-49015-00	**PROJECT LOCATION**	Campbell River
DATE STARTED	7/25/16	**COMPLETED**	7/25/16
GROUND ELEVATION		**TEST PIT SIZE**	Excavator bucket
EXCAVATION CONTRACTOR	Bernie V.	**GROUND WATER LEVELS:**	
EXCAVATION METHOD	JD 75 Excavator	**AT TIME OF EXCAVATION**	3.30 m
LOGGED BY	R. Hache	**CHECKED BY**	K. Barth
AT END OF EXCAVATION	---	**AFTER EXCAVATION**	---
NOTES			

DEPTH (m)	SAMPLE TYPE NUMBER	GRAPHIC LOG		MATERIAL DESCRIPTION
				ORGANIC; SAND and GRAVEL; rootlets, loose, black, dry
			0.10	FILL; SANDY SILT; trace cemented sand, trace gravel, medium dense, tan, dry
			0.20	FILL; SAND; well graded, trace to some gravel, loose to medium, grey, moist
0.5				
1.0				
			1.30	FILL; SAND; fine to medium grained, trace gravel, medium dense, light grey, moist to wet Wet @ 3.3 m
1.5				
2.0				
2.5				
3.0				
3.5			3.50	

Bottom of test pit at 3.50 meters.

CLIENT	City of Campbell River	**PROJECT NAME**	Ostler Park Foreshore Restoration
PROJECT NUMBER	2221-49015-00	**PROJECT LOCATION**	Campbell River
DATE STARTED	7/25/16 **COMPLETED** 7/25/16	**GROUND ELEVATION**	**TEST PIT SIZE** Excavator bucket
EXCAVATION CONTRACTOR	Bernie V.	**GROUND WATER LEVELS:**	
EXCAVATION METHOD	JD 75 Excavator	**AT TIME OF EXCAVATION**	2.60 m
LOGGED BY	R. Hache **CHECKED BY** K. Barth	**AT END OF EXCAVATION**	---
NOTES		**AFTER EXCAVATION**	---

DEPTH (m)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION
0.10			ORGANIC; SAND and GRAVEL; rootlets, loose, brown / black, dry
0.20			FILL; SILTY SAND; loose, light brown, dry
3.20			FILL; SAND; fine to medium grained, trace gravel, medium dense, grey brown, moist to wet Wet @ 2.6 m Note: lenses of Sand and Gravel up to 0.5 m thick

Bottom of test pit at 3.20 meters.

McElhanney

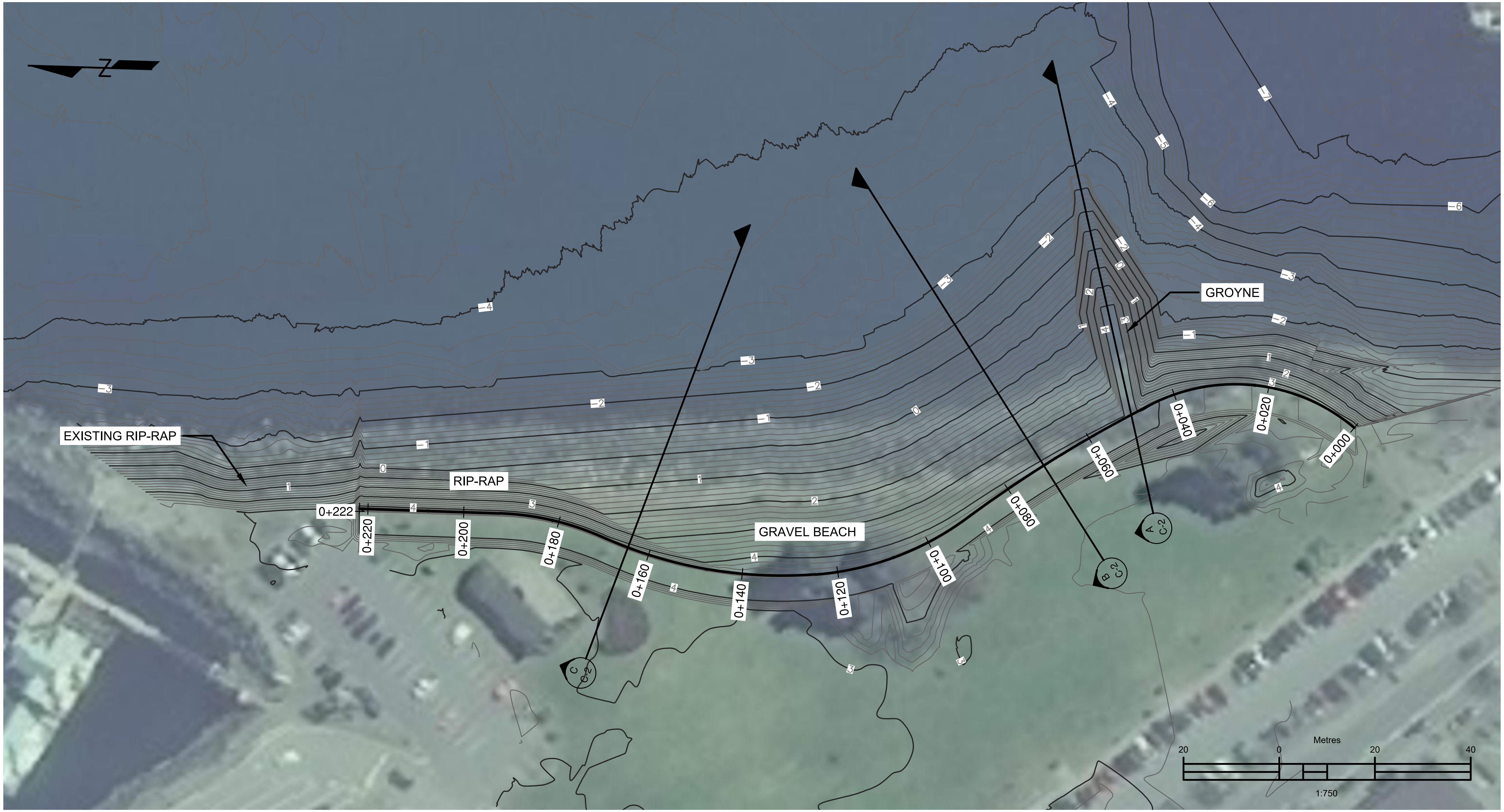
TP16-04

CLIENT	City of Campbell River	**PROJECT NAME**	Ostler Park Foreshore Restoration
PROJECT NUMBER	2221-49015-00	**PROJECT LOCATION**	Campbell River
DATE STARTED	7/25/16	**COMPLETED**	7/25/16
GROUND ELEVATION		**TEST PIT SIZE**	Excavator bucket
EXCAVATION CONTRACTOR	Bernie V.	**GROUND WATER LEVELS:**	
EXCAVATION METHOD	JD 75 Excavator	**AT TIME OF EXCAVATION**	---
LOGGED BY	R. Hache	**CHECKED BY**	K. Barth
AT END OF EXCAVATION	---	**AFTER EXCAVATION**	---
NOTES			

DEPTH (m)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION
			ORGANIC; SAND and GRAVEL; rootlets, loose, brown / trace black, dry
		0.10	FILL; SAND; fine to medium grain, trace gravel, loose, light grey brown, dry
0.5			
		0.70	FILL; SAND; medium to coarse grained, trace gravel, loose to medium dense, dark grey, dry 1.3 - 1.4 m lenses of fine grained sand occur (light brown in colour) Also in this zone there are some lenses of silt/ very fine grained sand Gravel content increases @ 1.8 m
1.0			
1.5			
2.0			
		2.20	FILL; SAND; fine to medium grained, trace to some gravel, medium dense, light grey, moist
2.5			
3.0		3.00	

Bottom of test pit at 3.00 meters.

Appendix C – GPC General Layout and Profiles



GREATPACIFIC
ENGINEERING & ENVIRONMENT

GREATPACIFIC CONSULTING LTD
202–2780 VETERANS MEMORIAL PARKWAY
VICTORIA, BC V9B 3S6
778–433–2672
www.greatpacific.ca

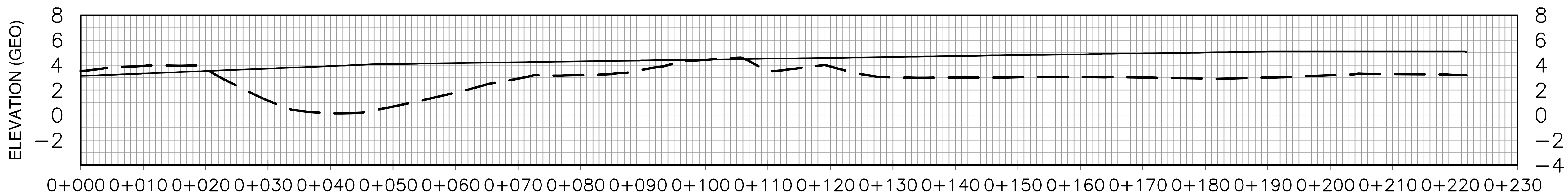
PERMIT/STAMP/NOTES:

CLIENT:
CITY OF CAMPBELL RIVER

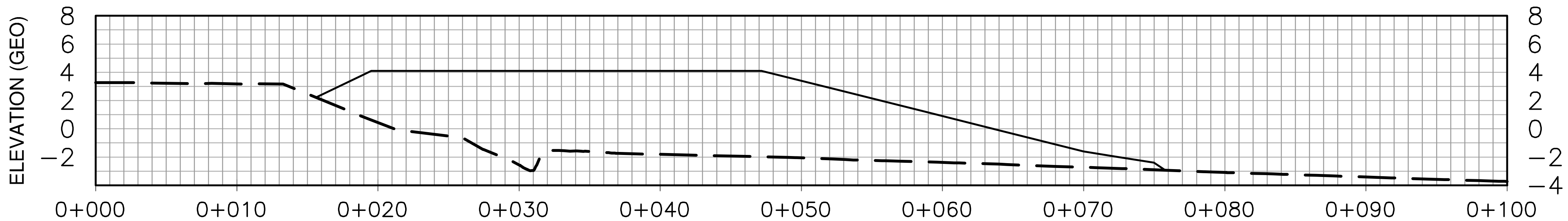
OSTLER PARK
FORESHORE RESTORATION
PLAN

DRAWING NUMBER:	C–1
PROJECT NUMBER:	1016–003
SCALE:	1:750
REV:	A

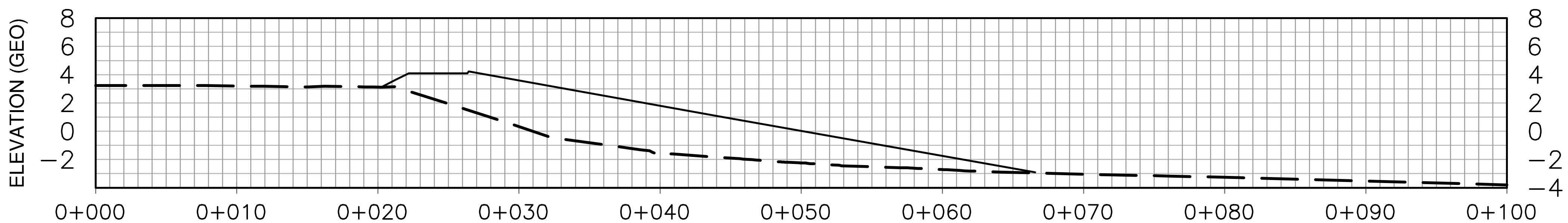
FILE: \\GPSERVER\PROJECTS\1016–003 – MCELHANNEY – OSTLER PARK\DRAWINGS\1016–003 – MCE – OLSTER PARK – MAIN – CUTFILL – 20160817.DWG



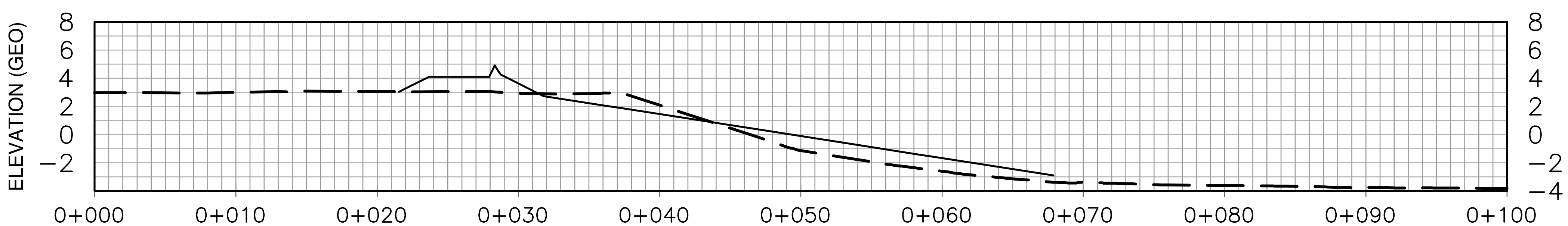
PROFILE
Scale: 1:750
C-1



SECTION A
Scale: 1:400
C-1



SECTION B
Scale: 1:400
C-1



SECTION C
Scale: 1:400
C-1

GREATPACIFIC
ENGINEERING & ENVIRONMENT
GREATPACIFIC CONSULTING LTD
202–2780 VETERANS MEMORIAL PARKWAY
VICTORIA, BC V9B 3S6
778–433–2672
www.greatpacific.ca

PERMIT/STAMP/NOTES:	
CLIENT:	CITY OF CAMPBELL RIVER
PROJECT NUMBER:	1016–003
	OSTLER PARK FORESHORE RESTORATION PROFILES & SECTIONS
DRAWING NUMBER:	C–2
SCALE:	AS SHOWN
REV:	A

FILE: \\GPSERVER\PROJECTS\1016-003 - MCELHANNEY - OSTLER PARK\DRAWINGS\1016-003 - MCE - OLSTER PARK - MAIN - CUTFILL - 20160817.DWG

Appendix D – GPC Technical Memorandum on Sea Level Rise

GREATPACIFIC
ENGINEERING & ENVIRONMENT

202-2780 Veterans Memorial Parkway
Victoria, BC V9B 3S6
Phone: 778.433.2672
Web: www.greatpacific.ca
Email: gpinfo@greatpacific.ca

August 18, 2016

McElhanney Consulting Ltd.
307 Shoppers Row
Campbell River, BC V9W 2C9

Attention: Mr. Mark DeGange

Technical Memorandum 1: Ostler Park – Preliminary Climate Change Sea Level

1 Introduction

Coastal properties are subject to effects from the water bodies they are adjacent to. Developments on coastal property should consider future changes in sea level, or sea level rise (SLR). Quantification of future SLR, appropriate for the design horizon of a development will help determine what measures are necessary to protect life, property, and infrastructure.

The critical inputs used to develop a location-specific water elevation are: Eustatic SLR, tidal range, land movement (uplift or subsidence), storm surge (frequency and intensity), wave effects, and freeboard allowance. Determination of several of these inputs is relatively straight forward from existing literature (e.g. Coastal Floodplain Mapping – Guidelines and Specifications), while more complex methods may be needed to estimate wave effects and the allowance appropriate for the substrate conditions and type and level of importance of the asset.

The purpose of this document is to define the future water level and design horizon to which the beach improvements at the park will be designed to.

1.1 Background

The City of Campbell River has committed to developing a conceptual design for potential foreshore restorations at Ostler Park in Campbell River, BC. The development of concepts will involve the evaluation of two restoration options including hard reinforcing such as Rip Rap versus a soft reinforcing described as "Naturalized Beach" or "Green Shores". To pragmatically develop the pertinent aspects of each optional restoration approach, a thorough understanding of marine forces and water levels over the design horizon is required.

1.2 Design Intent and Horizon

The design horizon for the project was discussed to be 30 years, or the year 2050, with the understanding that further park improvements will be implemented in the future.

It is recognized that finite financial resources are available, and that the City of Campbell River's strategy to address climate change will be on an opportunistic and incremental basis. The park design is not intended to block all potential coastal flooding of the downtown area.

2 Water Level Characterization

2.1 Tide Levels

Tide elevations relative to chart datum and geodetic datum are provided in the following table (from the Canadian Tide and Currents Tables, Volume 6, Canadian Hydrographic Service, Fisheries and Oceans Canada, 2016):

Table 1. Tidal Elevations for Campbell River

Tide Levels	m, CD	m, GD
EHWL, Extreme Recorded High Water Level	5.4	2.5
HHWL, Higher High Water Level, Large Tide	4.6	1.7
HWL, High Water Level, Mean Tide	4.1	1.2
MWL, Mean Water Level	2.9	0
LWL, Low Water Level, Mean Tide	1.4	-1.5
LLWL, Lower Low Water Level, Large Tide	0.4	-2.5
ELWL, Extreme Recorded Low Water Level	-0.2	-3.1

Water level data recorded at Campbell River Station (8074) was obtained for the period of 20 years (1996-2016). A graph of water level non-exceedance (percentile) to elevation prepared with this data is presented in Figure 1.

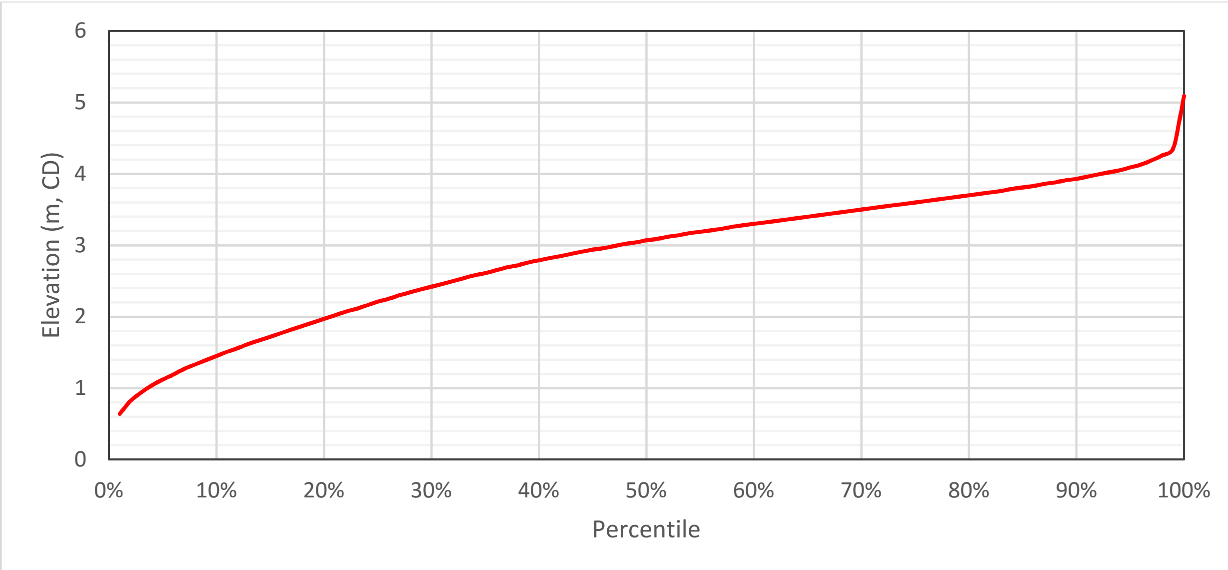


Figure 1. Percent of water level non-exceedance vs elevation curve

2.2 Sea Level Rise

2.2.1 Year 2100 Eustatic SLR

The eustatic change in sea level can be defined as a globally universal change in water elevation that results primarily from a change in the quantity of water in the oceans as a whole. Global warming results in the heating of the planet causing land-based ice to melt and drain into the oceans, thus raising the water levels across the planet. The eustatic increase in sea level has been generally accepted to be on the order of 1.0 m by the year 2100 (Figure 2; MFLNRO Coastal Floodplain Mapping Guidelines and Specifications), when initiated from the year 2000. The annual rate of rise is predicted to accelerate over time. On average, the rate of sea level rise was estimated to be 10 mm per year as shown below (Ausenco Sandwell, 2011a).

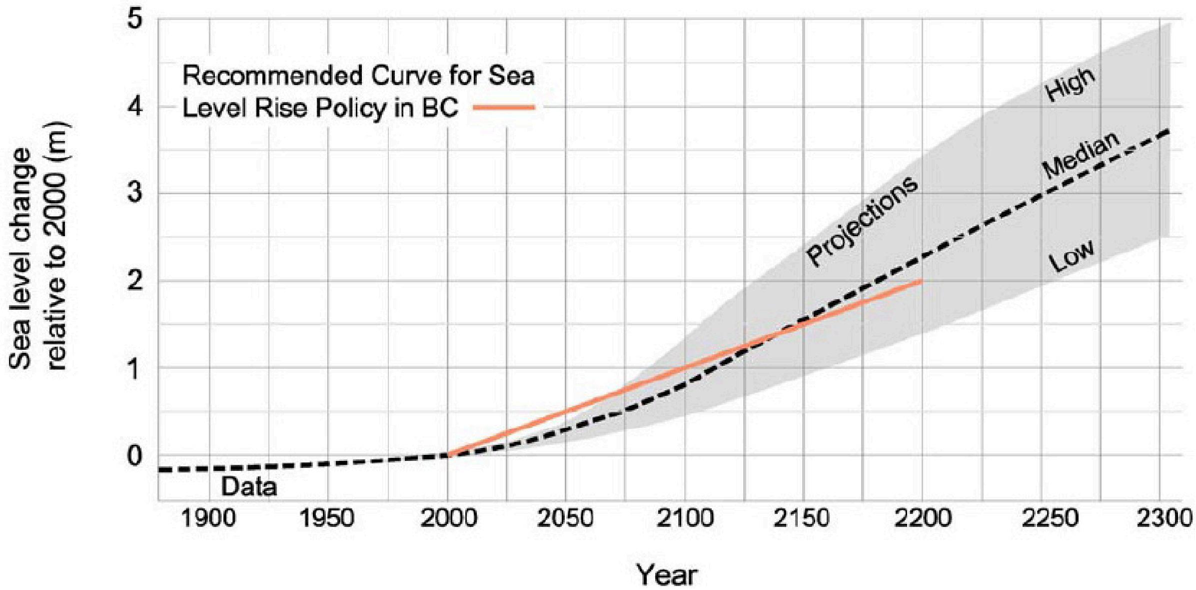


Figure 2. Sea level rise projections

2.2.2 Land Movement

Land masses are also moving relative to ocean levels. Tectonic plate effects, earthquakes and decompression from the last ice age are causes for land to move either up or down. The land in the Campbell River area is reported to be rising at a rate of 4.1 mm per year (Ausenco Sandwell 2011b).

2.2.3 Net Sea Level Rise

The net change in sea level, relative to land movement at Campbell River, at the year 2050 is estimated to be:

SLR = (Year 2000 – Year 2050) * (0.010 m – 0.0041 m) = 0.295 m

2.3 Storm Surge

Storm surge has been calculated on the basis of MIKE21 hydrodynamic model results and by considering the influence of atmospheric pressure changes as recommended by the Canadian Tide Table. The design storm surge for a 50 year return period was estimated to be 0.6 m. For shorter return periods, 0.4 m design storm surge is recommended.

2.4 Wave Runup

Wave runup is the elevation above the still water level that the wave will reach when contacting the beach. The wave runup level of the top 2% of waves ($R_{u2\%}$) were estimated using the method presented in CIRIA (2007) for a gravel beach at Ostler Park with the proposed beach slope of 6:1. The $R_{u2\%}$ for 50 year and 1 year return periods are as follows:

$R_{u2\%}$ for annual waves: 2.7 m
$R_{u2\%}$ for 50-year waves: 3.0 m

Riparian plantings, and debris that naturally accumulates on the beach may provide some resistance to the water flow and limit the extent of wave run-up.

2.5 Freeboard

Freeboard is used as a buffer between the highest water level and the construction level and is generally associated with the construction of inhabited buildings or other important infrastructure. Since Ostler Park is not an inhabited structure, the park can accommodate minor inundation events; therefore, in the interest of minimizing construction costs, no freeboard allowance was allocated.

2.6 Tsunami

The design is not intended to accommodate a tsunami event.

2.7 Total Water Level and Shoreline Crest Elevation

The objective of designing an appropriate park crest elevation is to prevent significant large woody debris deposits, such as occurred during a winter storm in 2012. . The design park crest elevation for the year 2050 was determined by adding the tidal elevation, storm surge, top 2% wave runup and long term sea level rise. To account for the joint probability of simultaneous occurrence of high tide and a peak storm event, two different tidal conditions, i.e., HWL and HHWL, were taken into consideration. For a combined occurrence of HWL and a 50 year storm, the design crest elevation was estimated to be 8.0 m, CD (+5.1 m geodetic datum, GD). For a combined occurrence of HHWL and an annual storm also provided an estimated elevation of 8.0 m, CD (+5.1 m GD). Therefore, 5.1 m GD is recommended as the design shoreline crest elevation, which is about 2 m above the present park elevation.

Other factors such as views and site lines that allow park users to see the waters of Discovery Passage are also important.

If minor overtopping and maintenance can be tolerated, then crest elevations of between 7.0 m and 8.0 m are recommended, with more importance of a higher crest at the northern portion of the park, where wave exposure is higher and the beach steepens, compared to the southern portion of the park which is more protected from the Fisherman's Wharf breakwater.

3 Potential Risks

Gravel beaches are moveable by nature. The Ostler Park beach has natural sediment supply processes interrupted by historic shoreline modifications, and the new design will not fully restore these processes. There will be residual potential for minor inundation of water and debris over the top of the beach crest. Periodic maintenance should be expected with some beach re-nourishment estimated approximately every 5 years.

4 Closure

We trust this memo provides suitable documentation for your records. If you have any questions or require further details, please contact the undersigned.

Sincerely,

Hammad Mir, Ph.D., P. Eng.
Coastal Engineer

Review By,

Jason Clarke, P.Eng.
Director

5 References

Ausenco Sandwell. 2011a. Climate change adaptation guidelines for sea dikes and coastal flood hazard land use. Guidelines for management of coastal flood hazard land use. Prepared for BC Ministry of Environment.

Ausenco Sandwell. 2011b. Climate change adaptation guidelines for sea dikes and coastal flood hazard land use. Draft Policy Discussion Paper. Prepared for BC Ministry of Environment.

CIRIA (2007) The Rock Manual: The Use of Rock in Hydraulic Engineering. By Construction Industry Research & Information Association, CUR Centre For Civil Engineering , CETMEF, June, 2007.

Fisheries and Oceans Canada. 2016a.Canadian Tide and Currents Tables, Volume 6, Canadian Hydrographic Service.

Fisheries and Oceans Canada. 2016b. Observed Water Levels CAMPBELL RIVER, B.C. Available online at http://www.pac.dfo-mpo.gc.ca/science/charts-cartes/obs/index-eng.html. Accessed July 2016.

MFLNRO (Ministry of Forests, Land and Natural Resources Operations). 2011. Coastal Floodplain Mapping- Guidelines and Specifications.

Appendix E – Class 'C' Capital Cost Estimate

OSTLER PARK FORESHORE RESTORATION PROJECT 2221-49015-00
Capital Cost Estimate - Class 'C' September 1, 2016

	Quantity	Unit	Estimated Unit Price	Amount
General				
Mobilization/Demobilization	1	LS	$ 25,000	$ 25,000
Traffic Control	1	LS	$ 8,500	$ 8,500
Erosion, Sediment Control and Water Control	1	LS	$ 12,500	$ 12,500
Survey Layout	1	LS	$ 6,500	$ 6,500
			Subtotal	$ 52,500
Removals and Base Preparation				
Remove existing riprap (stockpile on site)	5500	CM	$ 10	$ 55,000
Remove/Haul Existing Pavers	540	SM	$ 18	$ 9,720
Remove Exsiting Park Furniture and Deliver to PW Yard	1	LS	$ 2,500	$ 2,500
Common Excavation and Slope Grading	5000	CM	$ 7	$ 35,000
Decommission Irrigation and Power Circuits in Work Area	1	LS	$ 1,500	$ 1,500
Prepare Landscape Sub-grade	3800	SM	$ 3	$ 9,500
			Subtotal	$ 113,200
Construct New Beach				
Geotextile	1610	SM	$ 4	$ 6,440
Re-Use existing Rip Rap for Toe and Small Groyne	3800	CM	$ 15	$ 57,000
Re-Use existing Rip Rap for Backing and End Transitions	1190	CM	$ 20	$ 23,800
Import Beach Gravels	2930	CM	$ 50	$ 146,500
Fine Grading of Beach Face	1	LS	$ 5,000	$ 5,000
Import Logs	1	LS	$ 4,000	$ 4,000
			Subtotal	$ 242,700
Revise Storm Sewers and Outfall				
900 Dia. RPVC Storm Pipe	190	LM	$ 750	$ 142,500
300 Dia. PVC Storm Pipe	58	LM	$ 235	$ 13,630
200 Dia. PVC Storm Pipe	12	LM	$ 195	$ 2,340
New Manholes 1800mm Diameter	4	EA	$ 7,500	$ 30,000
Supply and Install 900mm Dia. Fiberglass Flap Gate	1	EA	$ 12,500	$ 12,500
New CBs	3	EA	$ 2,250	$ 6,750
Exfiltration Gallery (Allowance)	200	SM	$ 280	$ 56,000
CDF Existing 600mm below Interceptor	1	LS	$ 10,000	$ 10,000
Restore Garden Area at St. Ann's Road	1	LS	$ 17,500	$ 17,500
			Subtotal	$ 291,200
Landscaping and Final Restoration				
Import Planting Medium	1080	CM	$ 40	$ 43,200
Fine Grading and Soil Placement	7250	SM	$ 1.50	$ 10,875
#1 Shrubs and Perennials	700	EA	$ 10	$ 7,000
2m Conifer or 4m Deciduous Trees	23	EA	$ 300	$ 6,900
Extruded Curb for Walkway	275	LM	$ 82	$ 22,550
New Asphalt Seawalk (50mm thickness)				
Subbase	820	SM	$ 15	$ 12,300
Base	820	SM	$ 12	$ 9,840
Asphalt	820	SM	$ 28	$ 22,960
Road and Parking Lot Repairs (100mm thickness)	150	SM	$ 105	$ 15,750
Feature Walkway Structure at Gateways (Allowance)	3	EA	$ 5,000	$ 15,000
Irrigation System Replacement	1	LS	$ 35,000	$ 35,000
New Electrical Conduit and Connections	1	LS	$ 15,000	$ 15,000
Dog/People Fountains	1	EA	$ 4,500	$ 4,500
Wishbone Picnic Tables	3	EA	$ 2,000	$ 6,000
Litter Receptacles	5	EA	$ 500	$ 2,500
Benches - Wishbone with LED Lighting	5	EA	$ 2,000	$ 10,000
Concrete seating wall	45	LM	$ 400	$ 18,000
Lawn Areas Hydroseeding	6800	SM	$ 1.75	$ 11,900
			Subtotal	$ 269,275
Construction Cost Subtotal (rounded to nearest $1000)				$ 969,000
General Contingency Allowance (25%)				$ 242,000
Allowance for engineering, legal, construction, financial and administration costs (25%)				$ 242,000
Contingency allowance for inflation (20%)				$ 194,000
Total Construction Cost Estimate				**$ 1,647,000**
Optional Work				
Supply & Install New Oil/Grit Separator (Stormtech STC-14000)	1	EA	$ 175,000	$ 175,000