MILLSTONE RIVER
EAST WELLINGTON PARK SIDE CHANNEL CONCEPTUAL DESIGN

FINAL REPORT

Prepared for:

The City of Nanaimo
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13 April 2021

NHC Ref No. 03005813

nhc

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CREDITS AND ACKNOWLEDGEMENTS

We want to acknowledge the assistance of the City of Nanaimo (CoN) staff, Snuneymuxw First Nation members, and Farm Plan BC staff for completing this project. The CoN staff included Rob Lawrance, Kirsty MacDonald, and Kevin Brydges, who provided background information and direction for the project. Snuneymuxw First Nation (SFN) members conducted the well monitoring program. Wayne Haddow of Farm Plan BC assisted with the soil stratigraphy. Walter Hughes of Island West Contracting Ltd. provided and operated the excavator for installing the monitoring wells.

The following NHC staff and subconsultants contributed to this project:

- Mel Sheng (M. Sheng Consulting), Fisheries biologist & habitat restoration specialist
- Graham Hill, P.Eng., Principal
- Nigel Lindsey, P.Eng., Hydrotechnical Engineer
- Patrick Edge B.Sc, AscT., Drafting

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1 INTRODUCTION

The City of Nanaimo (CoN) retained Northwest Hydraulic Consultants Ltd. (NHC) to determine a side channel's feasibility on the Millstone River within East Wellington Park. The project intends to restore and enhance the Millstone River's salmonid habitat and provide opportunistic enhancement of other native wildlife habitats. **Figure 1** provides an overview of the project location.

Figure 1. Overview map

1.1 Scope of Work

NHCs scope of work included the following:

- Attend a kick-off meeting to discuss the project and identify the available background information.
- Develop a Base Map and Conceputal Sketches utilizing CoN LiDAR contour data and air photos.
- Conduct a site investigation
- Install water monitoring test pipes
- Lead a water level recording training session with SFN members to demonstrate techniques to collect water level data
- Prepare a report and drawings to summarize the work

2 SITE DESCRIPTION

Located within the North Jingle Pot Neighbourhood, the 12.7 hectares East Wellington Park is currently used to cultivate hay and pedestrian use. The park is accessed via East Wellington Road near the intersection of Maxey Road. The boundaries include East Wellington Road to the north, a steep forested hillside to the east, a farmer's field to the south, and the Millstone River to the west. Located along the steep hillside's toe is a CoN sewer line scheduled for an upgrade in the coming years. **Figure 2** provides a close-up view of the park.

The riparian area along the Millstone River consists of Himalayan blackberry intermixed with various deciduous trees and shrubs that include cottonwood. The riparian zone's width on the river's eastern side is typically 20 m wide, while the western side is 10 m wide. A CoN sanitary sewer that is s scheduled for upgrades runs along the toe of the slope on the eastern side of the Park.

Figure 2. Close-up view of East Wellington Park

3 FIELD INVESTIGATIONS

A series of field investigations were conducted to document site characteristics pertinent to design development. The investigations included a site visit, monitoring well installations, soil stratigraphy investigation, water quality, and water level monitoring.

3.1 Site Visit

On 14 July 2020, the NHC project team of Graham Hill (P.Eng.), Nigel Lindsey (P.Eng.) and Mel Sheng (M. Sheng Consulting) met CoN staff Rob Lawrence, Kirsty MacDonald, and Kevin Brydges, and Wayne Haddow from Farm Plan BC at the Park to discuss the side-channel project.

The group discussion and site reconnaissance identified the monitoring well installation locations and project restoration considerations and options that included:

- Increasing the riparian area's width to a minimum of 30 m and replacing the Himalayan blackberry with native riparian area species.
- A target restoration objective to provide rearing and overwintering habitat.
- The potential water sources for the side channel include groundwater recruitment or diversion from the Millstone River.
    - A potential inlet location was identified
- There is a potential for project synergy with Farm BC. Material excavated for side-channel construction can be used for agricultural purposes, including creating elevated farm fields.

During the site visit, an existing standpipe with an unknown purpose was identified at the Park's southern extent along the fence line, approximately 40 m from the Millstone River. The pipe consists of a 2" PVC pipe with a threaded cap that extends approximately 3 m below the soil surface (**Photo 1**).

Photo 1. The existing standpipe of unknown origin is located along the southern boundary of the Park.

3.1.1 Monitoring Wells

On 13 August 2020, eight monitoring wells were installed to assess the underlying soil structure and monitor groundwater. Walter Hughes (Island West Contracting Ltd.), Mel Sheng (M. Sheng Consulting), Nigel Lindsey (NHC), and Snuneymuxw First Nation members installed the monitoring wells.

The well locations were selected to assess the groundwater parallel to the Millstone River and the hillside's toe. The wells were installed along two alignments 50 m apart with a well spacing of about 50 m. Each well consists of a perforated 100 mm PVC pipe wrapped in filter fabric. **Figure 3** provides the locations. A Hitachi EX70 excavator was used to excavate open pits for the well pipes. The pit depth's varied depending on the soil conditions and groundwater levels. The maximum pit depth, limited by the excavator's reach, was 4.3 m. The general monitoring well installation procedure was as follows:

1. Removal of the grass and surfical organic soil (**Photo 2**).
2. Exacation of the pit to approximately 0.5 meters below the presence of groundwater intrusion or excavation to a depth of 4.3 m if the water was not found.
    a. Soils of similar properties were separated and stockpiled for documentation and backfilling (**Photo 3**).
3. Measurement and photo documentation of the soil profile from the surface, documenting the thickness and types of soils encountered (**Photo 4**).
4. Measurement of the dissolved oxygen level as groundwater flowed into the pit.
5. Measurement of the depth to the top of groundwater if present.
6. An estimate of the groundwater inflow rate and water quality, if water present.
7. Installation of a cap on the PVC pipe.
8. The backfilling of the pit to the surrounding ground elevation, placing the material in the order it was excavated to maintain similar stratigraphy (**Photo 5**).
9. Survey of the top of the stand-pipe for the conversion of measurements to geodetic elevation.

Photo 2. Stripping vegetation and surface organics during well installation.

Photo 3. Stockpiling and sorting excavated materials.

Photo 4. Physical measurements of the soil profile and depth to water.

Photo 5. Completed well installation.

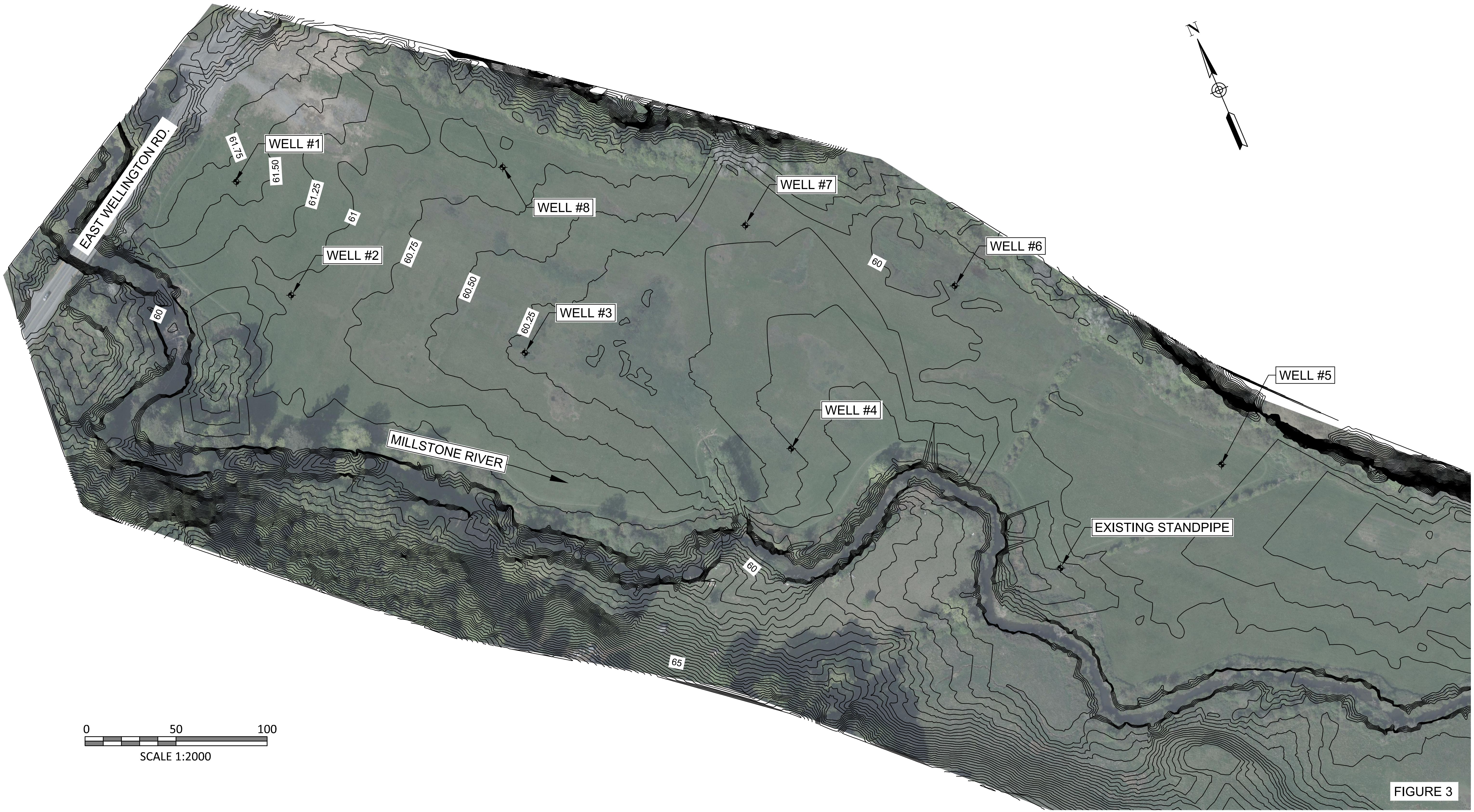
Table 1 provides the coordinates and top of pipe elevation of the installed monitoring wells and the existing stand-pipe. The coordinate system is the following:

- Horizontal Datum: NAD 83.
- Vertical Datum: CGVD 28.
- Geoid: HT V2.0.
- Projection: UTM Zone 10U
- Units: Metres.

Table 1. Coordinates and top of pipe elevations.

Well ID	Easting (m)	Northing (m)	Top of Pipe El. (m)
1	427364.065	5447969.042	61.55
2	427468.842	5447888.336	61.03
3	427468.842	5447888.336	61.03
4	427581.325	5447781.207	60.72
5	427794.256	5447678.264	60.58
6	427699.662	5447827.053	60.97
7	427607.864	5447903.709	61.23
8	427498.713	5447986.58	62.39
Existing Standpipe	427690.653	5447661.975	61.32

\\MAINFILE-NAN\PROJECTS\ACTIVE\3005813 EAST WELLINGTON PARK SIDE CHANNEL\96 CAD\3005813 EAST WELLINGTON BASE MAP R0C



12.14.2020

No.	Date	By	Revisions	Eng.

Design by: N. LINDSEY — Date: 2020-07-15
Drawn by: P.EDGE & N. LINDSEY 2020-08-14
Checked by: G. HILL 2020-08-15
Approved by

CITY OF NANAIMO
THE HARBOUR CITY

Scale: Horiz. 2000 Vert. 2000
Cost Center: 2686 — Sheet 1 of 1
Engineering File No.
Dwg No.

Project: EAST WELLINGTON PARK SIDE CHANNEL

Title: MONITORING WELL LOCATIONS

Water Level Monitoring Data

The collection of the water level data occurred from mid-September 2020 to the end of November 2020. The period's selection coincided when the water table is at its lowest post-summer drought and captures the recharge from fall rains. NHC completed the initial reading while members of the Snuneymuxw First Nation documented the remainder. The water level documentation measured the distance from the pipe's top to the groundwater's surface. Measurements were completed either by using well tape or measuring tape with the assistance of a headlamp. The groundwater elevation is determined by subtracting the measured distance from the top of the pipe's elevation. Refer to **Table 2** for the collected data.

Table 2. The tabulated groundwater elevations at East Wellington Park from Aug – Nov 2020. Elevations are in geodetic datum (CGVD28).

Date	Groundwater Elevation (m)								
	Well #1	Well #2	Well #3	Well #4	Well #5	Well #6	Well #7	Well #8	Existing Standpipe
8/13/2020[a]	59.19	dry	dry	dry	57.68	58.77	58.23	59.79	57.82
9/11/2020	59.30	59.12	58.76	58.39	57.96	58.25	58.64	58.90	57.62
9/18/2020	59.26	58.94	58.72	58.36	57.92	58.22	58.56	58.83	57.61
10/2/2020	59.29	58.95	58.67	58.23	57.83	58.15	58.43	58.77	57.63
10/16/2020	59.74	59.27	59.23	58.74	58.05	58.88	58.81	59.03	57.25
10/30/2020	59.98	59.52	59.35	58.83	58.37	59.29	59.29	59.67	57.25
11/23/2020	61.14	60.69	60.17	60.21	59.45	59.90	60.16	60.44	59.16
Infiltration Rate[b]	Low	-	-	-	Moderate	Moderate	Moderate	Moderate	-

[a] Installation occurred on 13 August 2020

[b] Assessed during well installation

During the monitoring wells' installation, the dissolved oxygen (DO) was collected using a Pro-DSS when water was present. All wells reported a reading of < 1.5 mg/L.

3.1.2 Soil Profile

The soil profile for each monitoring well showed a similar pattern with variations in horizon thicknesses. The observed soil horizons encountered in increasing depth from the surface and their range of thickness are the following:

1. Organics, 0.3 to 0.8 m.
2. Silt Loam, 0.8 to 1.7 m.
3. Silty Clay, 1.0 to 2.4 m.

Notable irregularities and items encountered include the following:

- Well #1, sand and gravel (<=20 mm) encountered at the bottom of the excavation (**Photo 6**).
- Well #6 and #7, pieces of wood encountered in the Silty Clay horizon.

- Well #8, sand and gravel seam encountered between the Silt Loam and Silty Clay horizons (**Photo 7**).

Photo 6. Sand and gravels from the bottom of the Well #1 excavation.

Photo 7. Sand and gravel seam encountered in Well #8.

Appendix A provides the graphical representation of the soil profiles with each soil horizon's transition measured from the ground surface. If present, the depth to groundwater is depicted.

4 SIDE CHANNEL CONCEPTS

Flows within a constructed side channels are either groundwater-fed and/or delivered through a surface water diversion structure. Groundwater flow rates depend on a permeable layer, typically a gravel horizon. Constructed intakes require a water license and operate over a range of flows. However, extraction is typically restricted in the summer months to no more than 10% of the summer base flow to limit impacts for aquatic species in the main channel. Examples of intake structures include inclined-plane screens, submerged pipes with coarse trash racks, and screened boxes.

The East Wellington Park preliminary side channels concepts, were developed during a design session and were initially based upon available air photos and LiDAR contour intervals. The concept designs were refined based on the field assessment and collected data analyses. The data utilized to refine the concepts include the Millstone River's water surface profile, monitoring well water levels, soil stratigraphy, and site characteristics. **Appendix B** provides sketches of the side channel concepts.

4.1 Side Channel – Groundwater Input

A groundwater-fed side channel is envisioned along the edge of the forested slope on the park's eastern portion intercepting the higher water table. It runs in the north-south direction for 450 m then curves westward to connect with the Millstone River. The confluence is on an outside bend of the Millstone River; this will limit sediment deposition at the side channel connection. The total channel length is 550 m, with the upstream end located 30 m from the parking lot on East Wellington Road.

In cross-section, the channel has a 4 m bottom width and banks sloped at 2H:1V. The bottom of the channel is set to 0.75 m below the minimum recorded water levels in the monitoring wells. An average cut of 3.0 m below the field's surface is required, extending the excavation into the silty clay horizon. The approximate excavation volume is 18,600 m^3. A riparian area will be established with a mix of native plant species consisting of grasses, shrubs, and trees (deciduous and coniferous) along the banks and overbank extending 15 m from the top of the bank.

Excavation into the silty clay material will impact the water quality within the side channel and potentially the Millstone River. The exposed layer will be a source of fine particulates that will become suspended when disturbed, resulting in a high turbidity channel. Capping the layer with alluvial sand, gravel and cobble is required to prevent disturbing this layer.

Materials excavated can be either hauled off-site for disposal or used on-site to raise the field. Raising the field requires stripping the existing organics layer and then laying the excavated material on the exposed ground. The organics then would be spread over the excavated material. The area between the side channel and the Millstone River is 6.2 ha; the excavated volume would produce an average rise of 0.3 m.

4.2 Side Channel – Intake Pipe

The conceptual design for a side-channel fed predominately with water diverted from the Millstone River follows the same alignment, section, depth of excavation, and bank treatment as the groundwater channel. However, this concept includes an intake structure 10 m downstream of the East Wellington bridge crossing and an approximately 90 m long-buried pipeline to divert surface water to the side channel.

A river intake increases side-channel discharge, surface velocities, dissolved oxygen content and salmon use. The water surface elevation of the Millstone River is proposed to be raised by approximately 0.5 m. Two riffles that are 0.25 m high would be constructed in the river to create the water level rise.

Spawning gravel would be placed directly upstream of the riffles, further enhancing the Millstone River habitat.

The intake structure will likely be a 'wing-style' steel pipe with a coarse trash rack. The trash rack is designed to keep large objects out of the pipe but allows smaller particles such as leaves and twigs to pass without clogging. The intake will be connected to a plastic or steel pipeline trenched into the field between the river and the side channel's upstream end. The pipe will have minimal fittings to reduce hydraulic losses and to reduce the likelihood of debris lodging in the pipe. The diversion flow will be controlled with a knife gate valve.

Flow in the Millstone River is very low in the summer drought period. The diversion will likely be limited to a maximum of 10% of the Millstream River's flow. The valve will be used to throttle the flow to the side channel.

A channel with an intake will likely require a water license from the Province of BC. The water license will need to be applied for and be held by an entity such as the CoN or the Snuneymuxw First Nation. The water license holder is responsible for operating and maintaining the diversion structure.

4.3 Off Channel Pond

An alternative concept that can be constructed independently or in conjunction with a side-channel is a single or series of off-channel ponds. The pond intercepts groundwater and backwater from the Millstone River. Higher flows during the winter months will increase the depth and area of the pond.

The ponds are connected to the mainstem roughly perpendicular to the bank on outside bends. The ponds are 8 m wide, and 40 m long with bank sloped at 2H:1V. The banks and 15 m of the overbank will be planted with a mix of native plant species consisting of grasses, shrubs, and trees (deciduous and coniferous).

The pond's bottom is set to the top of the silty clay horizon, resulting in a cut of about 2.2 m. An approximate 1,200 m^3 of material is removed for each pond. To prevent turbidity issues, a well-graded sand to cobble cap will cover the exposed silty clay material.

5 COST ESTIMATE

Table 3 summarizes the Engineering Class D cost estimate to construct the side channel projects. The cost estimate is based on the conceptual designs, 2021 dollars, blue book rates, and recent experience with similar work. It includes 20% contingency and engineering design services and excludes any costs for public consultation, permitting, and taxes.

Table 3. Summary of the estimated costs to construct the proposed side channels and the off-channel ponds.

Concept	Estimated Cost
Side Channel – Groundwater Input	$ 750,000
Side Channel – Intake Pipe	$ 975,000
Off Channel Ponds (cost per pond)	$ 80,000

6 DISCUSSION

Salmonids utilize side channels for overwintering refuge, rearing, or spawning. The extent of utilization depends on water quality, substrate, food availability, and cover, with the water quality being the governing factor that dictates the extent of fish usage.

The critical water qualities for salmon use are the dissolved oxygen (DO) and temperature. DO is critical to salmonids, with their requirements varying with species and age. The optimal level for juveniles and adults with low activity is 4 mg/L below 15°C and greater than 11 mg/L for developing embryos (Chapman, 1986). Additionally, the DO level and metabolic rate depend on the water temperature. Higher water temperatures increase the fish metabolic rate, therefore, increasing their oxygen demand. However, the solubility of oxygen decreases with increasing water temperature. Therefore less oxygen is available at higher water temperatures.

The water source and flow rate in the channel impact the DO and water temperature. Channels with high flow rates typically have more stable water temperatures and are more oxygenated water. In contrast, channels with lower flow rates have more significant variability and are influenced by the mainstems backwatering. These channels are generally warmer in the summer and cooler in the winter. The DO follows the water temperature trend, with more DO available in the winter than in the summer. These channels typically offer a limited habitat near the creek's confluence, while the upstream reach is more stagnant and resembles a pond. A well-functioning groundwater channel can offer warmer water temperatures in the winter, which beneficially increases the growth rates of overwintering juvenile salmon.

Based on the field investigations, we feel it is unlikely for a groundwater-fed side-channel to have sufficient flow due to the groundwater conductivity. Furthermore, the DO was very low, and the substrate is composed of only fine material; thus, fish habitat quality will be poor, and no spawning habitat will be available. We have suggested that the exposed channel bed be capped with a mix of graded coarse sand to cobble size material; however, this marterial may sink into the silt bottom or become impacted with silt.

Table 4 provides a comparison of the restoration options. The table outlines the anticipated utilization based on the assumed flow rate and the associated DO and water temperature. Additionally, the table presents the benefits and risks or drawbacks associated with constructing the proposed options.

Table 4. Comparison of restoration options.

Option	Flow	Salmonid Utilization	Benefits	Risks/Drawbacks	Bio Productivity
Side Channel - GW Input	Low	• Overwintering refuge	• No impacts to flood levels on the Millstone River • Habitat values other than salmonid (amphibian)	• Very low flows are expected • Low DO • High water temperatures in summer • Only salmonid utilization at the confluence	• Typical wetted area during the winter season non-flood, 4,900 m^2 • <0.1 jueveniIle/m^2 (~490).
Side Channel - Intake	Low to Moderate	• Rearing • Overwintering refuge	• Water properties identical to Millstone River • Wide range of salmonid habitat values	• Low summer flows in the Millstone will limit diversion rates	• Typical wetted area during the winter season non-flood, 4,900 m^2 • 0.25 – 0.5 smolt/m^2 (~1,225 – 2,450).
Off Channel Pond	Low	•Overwintering refuge	• Functions identically to GW input channel but less cost. • Ability to implement one pond as a pilot project.	• Only functions as salmonid refuge habitat during high flows • Potential sedimentation of the inlet leading to fish stranding – Periodic maintenance may be required.	• Typical wetted area during the winter season non-flood, 480 m^2 (per pond) • 0.25 – 0.5 smolt/m^2 (~122 – 245).

A coarse decision matrix is offered to assess the options, presented in **Table 5**. Each option is assessed based on its cost, salmonid utilization, park impact, the wetted area, and bio productivity. Based on the dissolved oxygen levels measured taken during the monitoring period, a groundwater channel is expected to support very low densities of juveniles (i.e. <0.1 juvenile/m^2;pers. comm. M. Sheng) and could potentially be a detriment to the Millstone R. during low summer flows by contributing a mix of low oxygenated water and suspended silt. The side-channel intake and off channel ponds typically support 0.25 -0.5 smolt/m^2) The matrix uses a 1 to 3 scale, 1 is least preferable, while 3 is most favourable. The highest total score is the most suitable option to construct.

Table 5. Concept options decision matrix

Option	Cost	Salmonid Utilization	Park Impact	Wetted Area	Bio-productivity	Total
Side Channel - GW Input	1	1	1	3	1	7
Side Channel - Intake	1	3	1	3	3	11
Off Channel Pond	3	3	3	1	2	12

7 RECOMMENDATIONS

Our opinion is that the side-channels are not suitable due to insufficient flows and costs. The groundwater-fed channel has insufficient flows, low habitat value, and could potentially be detrimental from siltation into Millstone River caused by the fine material flowing out of the channel. In comparison, the intake side-channel can have sufficient flows and good habitat and could cause more siltation into the Millstone R. because of the higher flow – it is costly.

Based on the matrix results and the above rationale, the off-channel pond is the most suitable restoration option to pursue. It has the added benefit of being implemented as a pilot project with a single pond's construction. This pilot project will explain fish usage in the area and inform the need for additional restoration activities. The ponds will provide important off-winter refuge habitats. Fish use will be low (on none) in the summer when water quality parameters are poor, and the ponds drain. Fish are expected to migrate in and out of the ponds adapting to site conditions. There is a potential for sediment accumulation at the inlet, creating a potential for stranding issues. Periodic maintenance of the inlet to remove the material may be required. In addition to the off-channel ponds', we would recommend constructing the riffles proposed in the intake-fed side-channel option. It enhances habitat but also provides the ability to construct an intake side-channel in the future.

In addition to the side-channel concepts, habitat enhancement of the Millstone River itself should be considered. Some options were discussed during the site investigation. The enhancement options include:

- restoration of the riparian area vegetation and its expansion to 30 m in width
- instream complexing features such as large woody debris
- construction of riffles and spawning gravel pads.

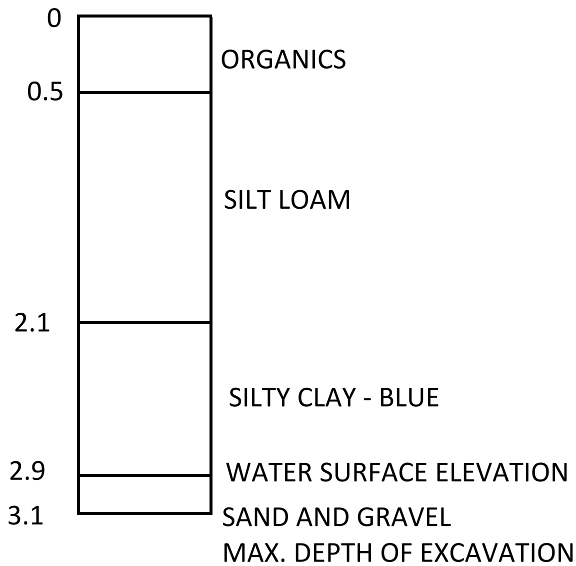
Developing habitat restoration and enhancement concepts for the Millstone River are not included in the present work scope.

8 REFERENCES

Chapman, G. (1986). *Ambient Water Quality Criteria for Dissolved Oxygen*. US Environmental Protection Agency. 46 pp.

Appendix A: Soil Profiles

Well #1



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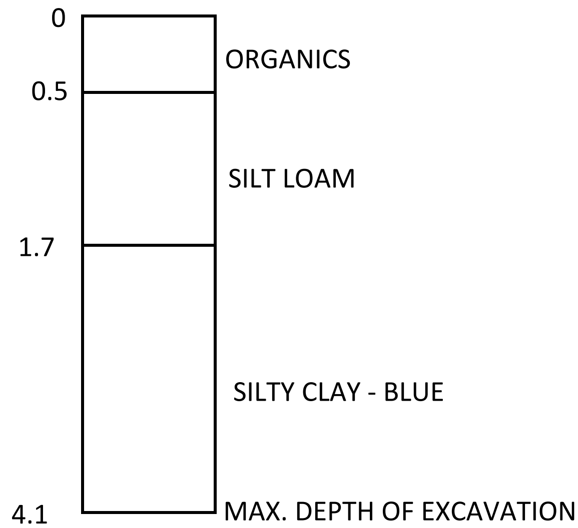

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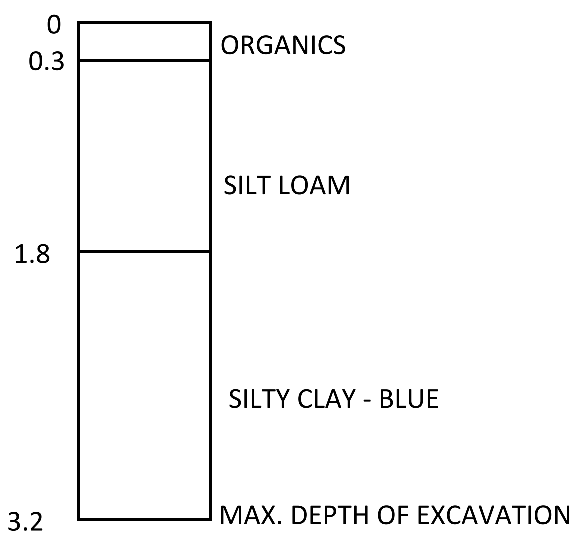

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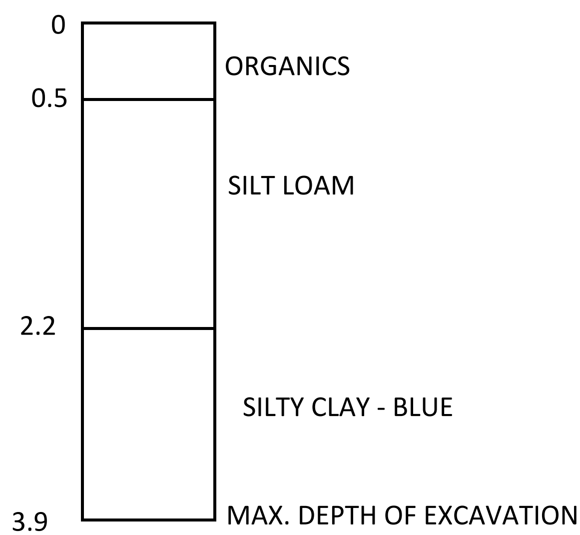

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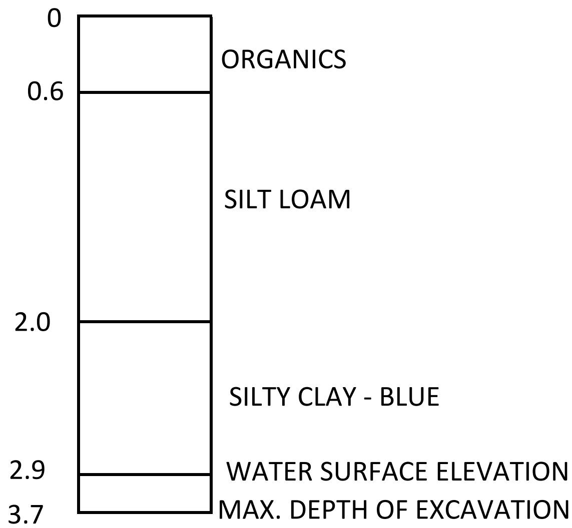

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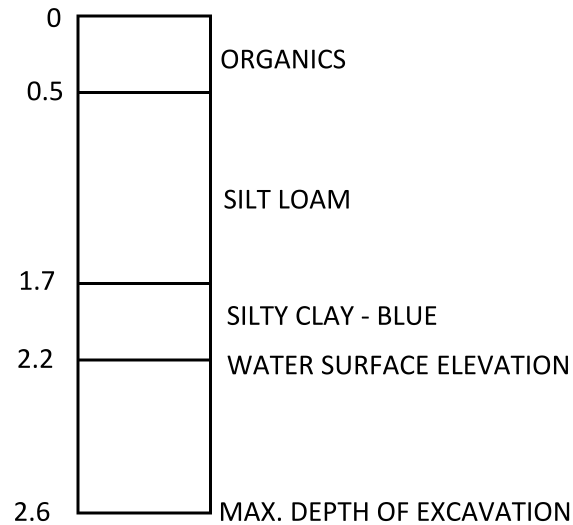

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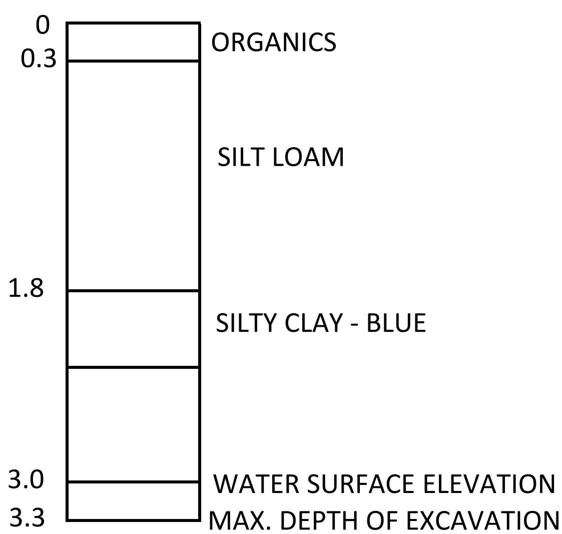

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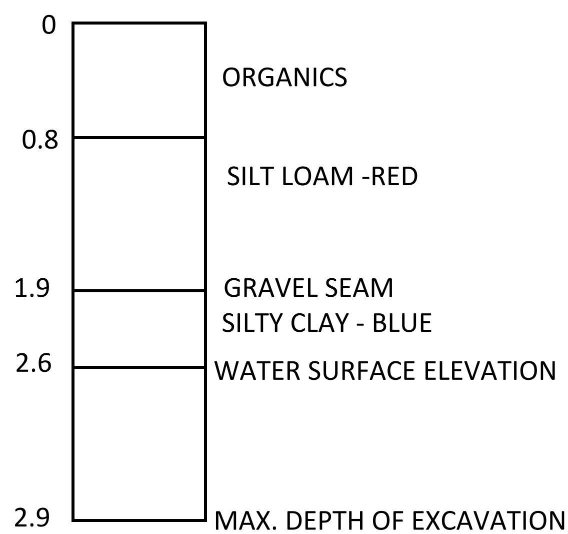
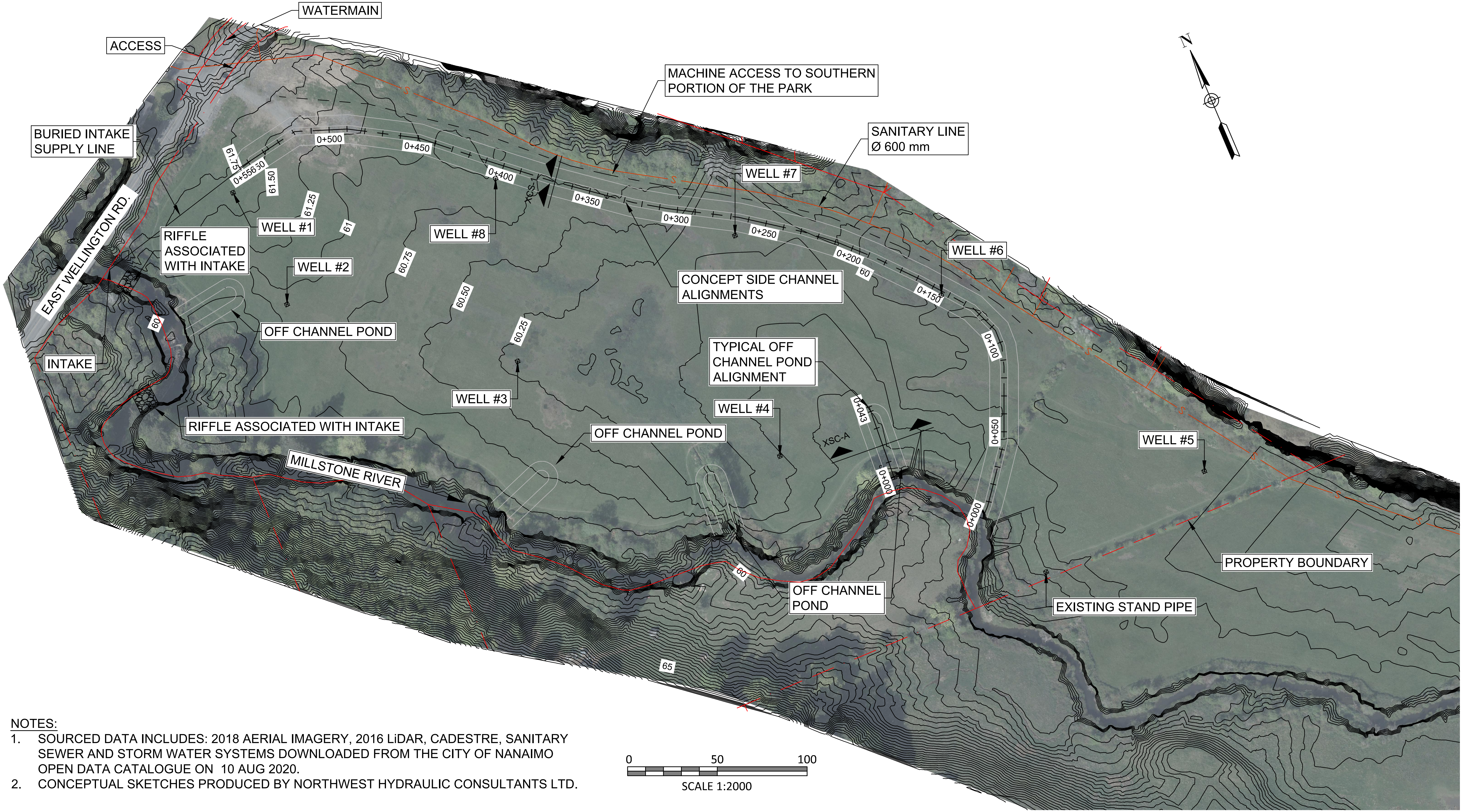


Appendix B: Concept Sketches



NOTES:

1. SOURCED DATA INCLUDES: 2018 AERIAL IMAGERY, 2016 LiDAR, CADESTRE, SANITARY SEWER AND STORM WATER SYSTEMS DOWNLOADED FROM THE CITY OF NANAIMO OPEN DATA CATALOGUE ON 10 AUG 2020.
2. CONCEPTUAL SKETCHES PRODUCED BY NORTHWEST HYDRAULIC CONSULTANTS LTD.

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SCALE 1:2000

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3.30.2021

No.	Date	By	Revisions	Eng.
1	03-30-2021	NCL	ISSUED FOR REPORT	NCL
0	02-08-2021	NCL	ISSUED FOR COMMENT	NCL

	Date
Design by N. LINDSEY	2020-07-15
Drawn by P.EDGE / N. LINDSEY	2021-02-01
Checked by G. HILL	2021-02-01
Approved by	

CITY OF NANAIMO
THE HARBOUR CITY

Scale Horiz. 2000 Vert. 2000

Cost Center

Sheet 1 of 3

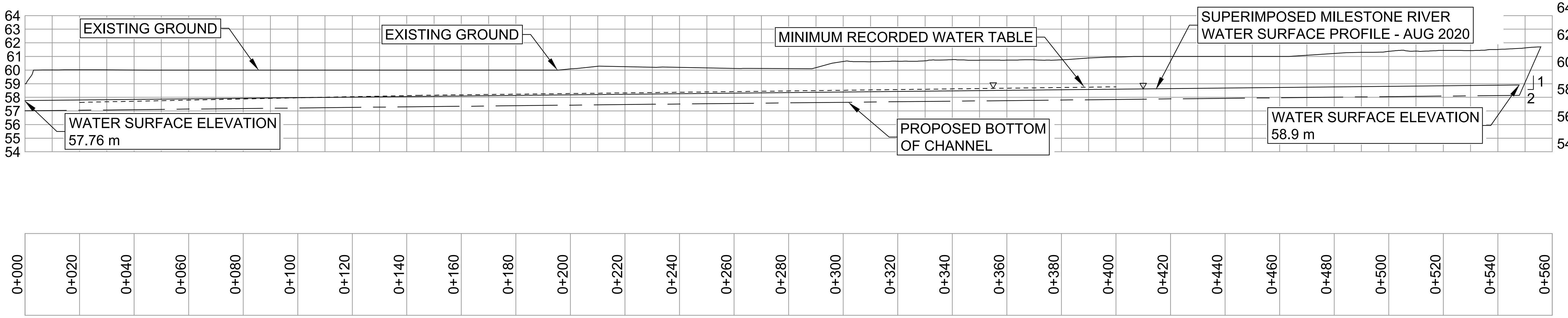
Engineering File No.

Dwg No.

Project
EAST WELLINGTON PARK SIDE CHANNEL

Title
CONCEPUTAL SIDE CHANNEL AND OFF CHANNEL POND
PLAN VIEW

Side-Channel Concept



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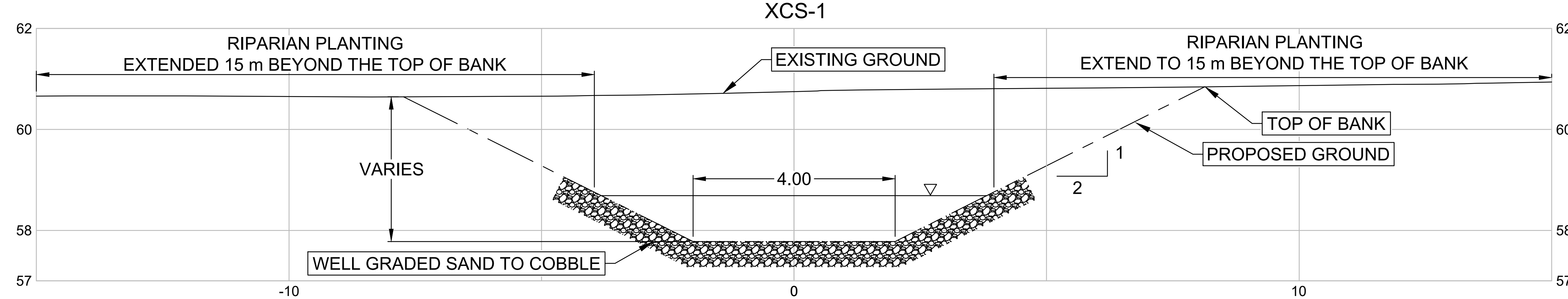

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No.	Date	By	Revisions	Eng.
1	03-30-2021	NCL	ISSUED FOR REPORT	NCL
0	02-08-2021	NCL	ISSUED FOR COMMENT	NCL

Design by: N. LINDSEY	Date: 2020-07-15
Drawn by: P.EDGE / N. LINDSEY	2021-02-01
Checked by: G. HILL	2021-02-01
Approved by	

CITY OF NANAIMO
THE HARBOUR CITY

Scale: Horiz. 1500 Vert. 300

Cost Center | Sheet 2 of 3

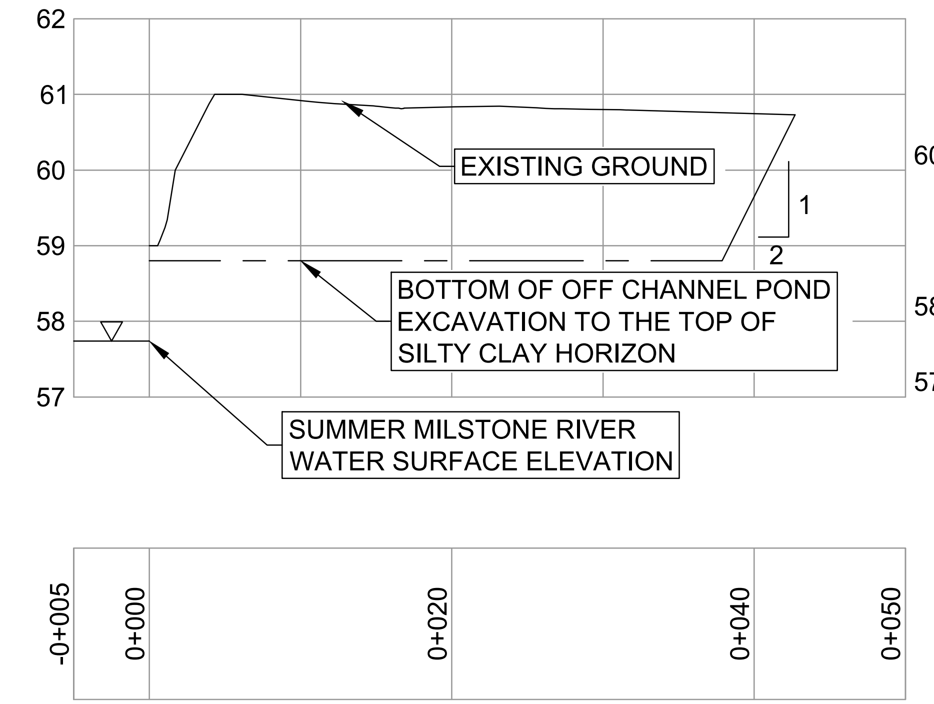
Engineering File No.

Dwg No.

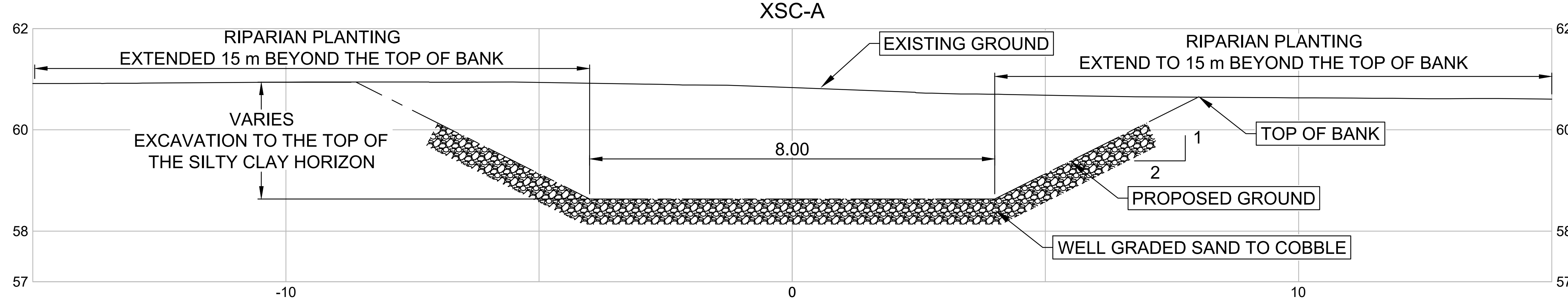
Project: EAST WELLINGTON PARK SIDE CHANNEL

Title: CONCEPT SIDE CHANNEL PROFILE AND TYPICAL SECTION VIEW

TYPICAL OFF CHANNEL POND PRFOILE



XSC-A



0 1 2 3 4 5

SCALE 1:100

NOTES:

1. SOURCED DATA INCLUDES: 2018 AERIAL IMAGERY, 2016 LiDAR, CADESTRE, SANITARY SEWER AND STORM WATER SYSTEMS DOWNLOADED FROM THE CITY OF NANAIMO OPEN DATA CATALOGUE ON 10 AUG 2020.
2. CONCEPTUAL SKETCHES PRODUCED BY NORTHWEST HYDRAULIC CONSULTANTS LTD.

\\MAINFILE-NAN\PROJECTS\ACTIVE\3005813 EAST WELLINGTON PARK SIDE CHANNEL\96 CAD\3005813 EAST WELLINGTON CONCEPT-R1A

3.30.2021

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Scale Horiz. 500 Vert. 100
Cost Center
Sheet 3 of 3
Engineering File No.
Dwg No.

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Title: CONCEPT OFF CHANNEL POND TYPICAL PROFILE AND SECTION VIEW