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Vedder Canal/Vedder River Phase II Emergency Works

2024 Vedder Hydraulic Assessment Report

Final Report
February 29, 2024
KWL Project No. 3427.018

Prepared for:
Ministry of Environment and Climate Change Strategy

BRITISH COLUMBIA
Ministry of Environment and Climate Change Strategy

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Executive Summary

The November 2021 atmospheric river events resulted in significant volumes of sediment and debris in the Vedder Canal and Vedder River. Though no major flooding of infrastructure was reported, deposited sediment and debris have reduced the capacity of the Vedder floodway and pose an erosion risk to bridge infrastructure and riverbanks. Based on 85 years of recorded data at the Water Survey of Canada gauge, referred to as Chilliwack River at Vedder Crossing (08MH001), the November 15, 2021 atmospheric river event is the second largest event in the recorded history of the Vedder River with an estimated 200-year return period or 0.5% annual exceedance probability.

A hydraulic assessment completed in the spring of 2022 as part of the ongoing program of biennial gravel removal program estimated 440,700 m^3 of sediment was deposited between 2020 and 2022, most of which likely occurred during the November 2021 atmospheric river events. The Vedder River Area Management Committee removed 35,130 m^3 of sediment from five sediment bar locations in August and September of 2022. The remaining sediment in the Vedder River is estimated at 405,570 m^3, or 92% of the sediment deposited from the flood event.

Kerr Wood Leidal was retained by the Ministry of Environment and Climate Change Strategy to assess options to restore the flood capacity of the Vedder River and Vedder Canal floodway for the 2024. Kerr Wood Leidal undertook the hydraulic assessment while Nova Pacific Environmental completed the environmental screening, environmental assessment, and habitat impact assessments. The Nova Pacific Environmental report entitled *Vedder Sediment Removal Project 2024 - Supporting Document for Environmental Permit Applications* should be read in conjunction with this report to address the environmental and habitat considerations.

The project team screened six (6) potential options including:

- Option A – Do Nothing
- Option B – Update to 2023 Proposed Sediment Removal (Lower Volume Yield)
- Option C – New 2024 Proposed Option (Higher Volume Yield)
- Option D – New 2024 Proposed Option (Moderate Volume Yield)
- Option E – Remove Full Nov 2021 ARE Sediment Volume
- Option F – Dike Upgrades and/or SRY Embankment Flow Capacity Increases

Option E was not recommended as sediment removal of that magnitude is not considered feasible due to constructability limitations, potential impact to fish habitat, and geomorphological risk to the stability of the river. Option F has limitations with seismic design criteria, land acquisition timelines, and Disaster Financial Assistance Arrangements funding eligibility and is best addressed in future studies and projects.

To evaluate Options A, B, C, and D the project team considered potential habitat impacts, environmental design, hydraulic effectiveness, flood risk mitigation, and geomorphology. Option A represents no sediment removal and is intended as a baseline condition. Option B represents a sediment removal at 9 sites with a total estimated volume of 205,000 m^3. Option C represents a sediment removal at 11 sites with a total estimated volume of 283,600 m^3. Option D represents a sediment removal at 12 sites with a total estimated volume of 243,400 m^3.

Hydraulic simulations were carried out for each option and the resulting flood profiles were compared against the baseline flood profile to assess the impact and effectiveness of proposed sediment removals. Option D is the most efficient sediment removal with an effectiveness coefficient of 3.5. Option C is second most efficient at 3.1 and Option B is least efficient at 2.9. Option C provides the greatest reduction in flood risk with a 15% reduction in freeboard deficient dike length and 28% reduction in freeboard deficient area. Option D provides a very similar reduction in flood risk with 14% reduction in freeboard deficient dike length and 28% reduction in freeboard deficient area. Option B provide a lesser reduction in flood risk with a 13% reduction in freeboard deficient dike length and 23% reduction in freeboard deficient area.

Channel maintenance activities, or sediment removal, could reduce the flood hazard by improving available freeboard and providing sediment traps in the upper reach to mitigate the risk of sediment transport to the freeboard-limited lower and middle reaches. The sediment removal options account for excavation of 51% (Option B), 70% (Option C) and 60% (Option D) the remaining deposited sediments from the November 2021 ARE, respectively.

It is recommended to proceed with Option D for construction in 2024 as it is the most efficient sediment removal option and preferred from a flood protection perspective. However, it is recommended to evaluate other options such as dike raising, modification of railway embankment relief structures, and others to reduce flood risk.

1. Introduction

Kerr Wood Leidal (KWL) was engaged by the Ministry of Environment and Climate Change Strategy (ENV) to undertake a detailed assessment to better understand the impact of the November 2021 atmospheric river event (ARE) on the Vedder Canal and Vedder River and provide recommendations for the removal of sediment. The mandate of the *2021 Atmospheric River Event in BC Waterway Sediment Assessment and Removal Program* is to restore and improve creek/river hydraulic capacity. The Vedder Canal and Vedder River site is identified as Site ID: S-CR-7 under the ENV Emergency Works program.

As part of this program's mandate, KWL worked in collaboration with the Vedder Task Force Group (a multi-ministry, regulators, stakeholder, and rightsholder forum) and subconsultants to assess the impact of the November 2021 ARE on the Vedder Canal and Vedder River and developed options to address flood risk. This report addresses hydraulic considerations while the Nova Pacific Environmental (NPE) report entitled *Vedder Sediment Removal Project 2024 - Supporting Document for Environmental Permit Applications*, herein referred to as the 'Environmental Permitting Report', addresses environmental and habitat impact considerations.

This report is intended to supersede the KWL *2023 Hydraulic Assessment Report* and contains updated information and analysis using the latest data.

1.1 Scope of Work

This report presents updated findings of detailed assessments into the hydraulics, geomorphology, and archaeology of proposed sediment removal on the Vedder Canal and Vedder River using the latest data and input from the Vedder Task Force Group, herein referred to as the Task Force.

This scope of work pertains to the Vedder River and Vedder Canal from the Highway 1 Bridge at the downstream end of the Vedder Canal to the Vedder Crossing Bridge at the upstream end of the Vedder River, herein referred to as the study reach.

Detailed assessments associated with this scope of work include:

- Engineering field investigations,
- Field survey and analysis,
- Environmental planning (completed by subconsultant Nova Pacific Environmental),
- Hydraulic assessment,
- Geomorphology,
- Archaeological overview assessment review and update,
- Contaminated sites screening assessment,
- Sediment removal planning, and
- Engagement and communication with the Task Force.

To accomplish the scope of work, project teams follow the phases of work shown in Figure 1-1 to screen, evaluate, and develop options to maintain the flood capacity of the Vedder floodway. These options were then presented to the Task Force Group for review and feedback prior to submission to regulators.

All works listed above and presented herein are intended to support engagement and regulatory review of the proposed sediment removal plan including information required by Fisheries and Oceans Canada (DFO) and the Water, Lands and Resource Stewardship (WLRS) in support of applications for required permits under the Fisheries Act (Section 35) and Water Sustainability Act (Section 11), respectively.

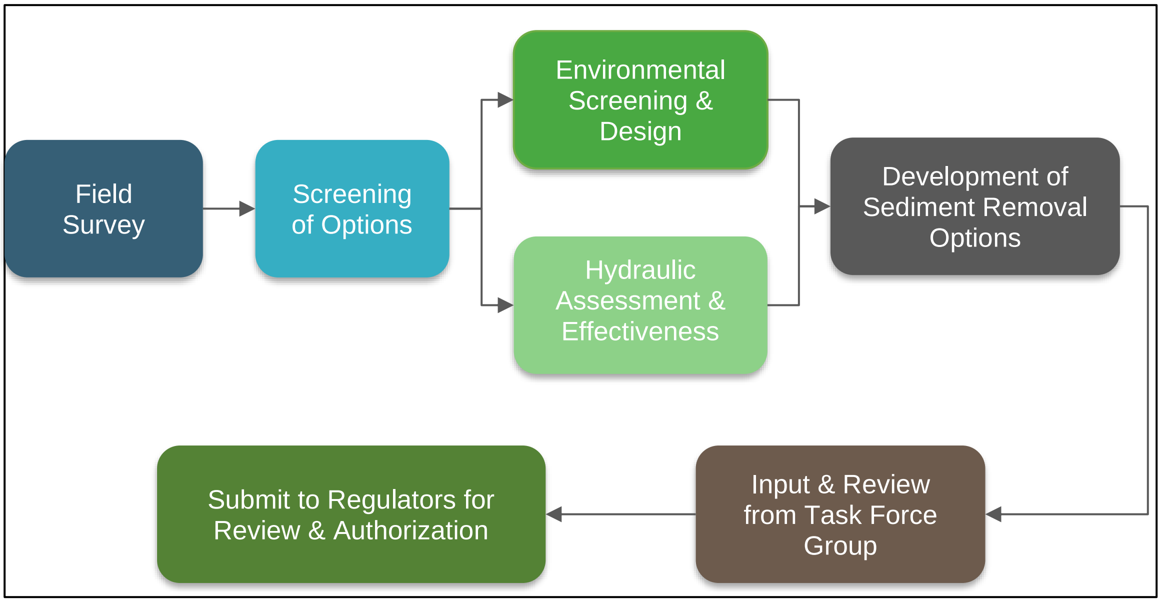

Figure 1-1: Project Phases of Work.

1.2 Background

The Vedder River and Vedder Canal are situated on the alluvial fan of the former Chilliwack River. Prior to channelization and dike works, the Chilliwack River downstream of the Vedder gap would naturally migrate across its vast alluvial fan. A major avulsion event in late 1800s caused the Chilliwack River to move from its trajectory northward directly to the Fraser River to the Vedder River to the west which flowed into former Sumas Lake[1].

In the early 1900s, the Sumas and Chilliwack watersheds were subject to drastic changes by settlers. Sumas Lake was drained to make way for agricultural lands and as a result, the Chilliwack/Vedder River was diverted and channelized across the Sumas Prairie[2].

Flood control works, in the form of dikes, setback dikes, and groynes, were constructed for the Vedder River and Vedder Canal following the 1975 flood event[3]. Currently, the Vedder River and Vedder Canal are confined to a narrow corridor bounded by dikes. Channel migration and sediment deposition processes are limited to this narrow corridor and sediment removal is needed to maintain the utility of the dikes (e.g., provide flood protection) and to limit changes to channel morphology over time (e.g., channel migration, bank erosion).

Management and maintenance of the Vedder floodway has been undertaken by the Vedder River Management Area Committee (VRMAC) since 1983, a committee consisting of federal, provincial, municipal, and First Nation representatives. VRMAC has managed sediment removal for flood control purposes annually from 1990 to 1997 and biennially from 1998 to present, except for 2018 and 2020 where no excavations occurred.

[1] McLean, D,G, 1975. Flood Control and Sediment Transport Study of the Vedder River. University of British Columbia. Thesis submission for partial fulfillment of degree of Master of Applied Science.
[2] Ibid
[3] The Vedder River Management Committee (1983). Vedder River Management Area Plan.

The November 2021 atmospheric river event (ARE) resulted in significant volumes of sediment and debris in the Vedder Canal and Vedder River. Though no major flooding of infrastructure or overtopping of dikes were reported, the sediment and debris continue to reduce flood conveyance capacity, posing a risk to bridge infrastructure, riverbank erosion, and dike overtopping.

A hydraulic assessment and consultation process was completed in spring of 2022 by the City of Chilliwack, the City of Abbotsford, and the Province as part of the ongoing program of biennial gravel removal. The assessment showed that much more sediment was deposited during the November 2021 ARE than the average annual sediment deposition over the last 40 years. This previous assessment compared survey data dating back to 1981 to understand long term trends in sediment movement throughout the study reach. The hydraulic assessment estimated 440,700 m^3 of sediment was deposited over 2021 and 2022, most of which likely occurred during the November 2021 ARE, based on a comparison with previous surveys. The amount of sediment deposition from the November 2021 ARE flood event was estimated to be significantly higher than the previous long-term average of 42,000 m^3/year. That assessment estimated the average annual deposition rate has increased to 55,000 m^3/year following the flood event in November 2021.

The deposition of material resulted in an increase to the flood profile and reduction in available dike freeboard in the study reach. This was most prominent in the river between Keith Wilson Bridge and Lickman Road. The critical limited freeboard zone in the Vedder River's lower reach has expanded when compared to previous years (2016-2020). Sediment removals are required to maintain flood capacity and sufficient dike freeboard.

Consistent with the biennial sediment removal approach adopted by VRMAC, the City of Chilliwack intended to remove a target volume of 110,000 m^3 for 2022. However, various limitations resulted in a reduced removal quantity of 35,130 m^3 from five (5) sediment bar locations. Additionally, the City of Chilliwack has upgraded the existing Vedder River Right Dike in 2022 by raising it for approximately one (1) km to address freeboard deficient portions. Efforts to remove sediment for flood control purposes in 2023 did not proceed due to risk to pink salmon spawning habitat and uncertainty in the permitting process and timelines.

This updated assessment takes into account the September 2023 Light Detection and Ranging (LiDAR), model calibration to the December 1, 2021 surveyed flood event, and updated screening of sediment removal sites by NPE.

1.3 Background Reports & Data

The following list summarizes background reports and information that was reviewed as part of the detailed assessment presented in this report:

- Willis Cunliffe Tait & Company Ltd. (1975). West Dyke Improvements (Issued As-Constructed).
- The Vedder River Management Committee (1983). Vedder River Management Area Plan.
- Province of British Columbia, Ministry of Environment, Lands & Parks – Water Management Division (1996). Vedder River Gravel Management Plan.
- Bland Engineering Ltd. (1998). Vedder River Set Back Dykes Left Dyke Improvements (Issued As-Constructed).
- J.W. Wedler & Associates Ltd. (2000). Vedder River Set Back Dyke – F.P.A.F. Project Number 99-02-113 (Issued as Record Drawing).
- Bland Engineering Ltd. (2000). Vedder River Hydraulic Profile.

- Bland Engineering Ltd. (2002). Vedder River Hydraulic Profile Update April 2002.
- Bland Engineering Ltd. & Northwest Hydraulic Consultants (2004). Vedder River Hydraulic Profile Update April 2004.
- Bland Engineering Ltd. (2005). Vedder River Hydraulic Profile Update June 2005.
- Bland Engineering (2008). Vedder River Hydraulic Profile 2008 Update.
- Hay & Company Consultants (2010). Vedder River Hydraulic Profile Update 2010.
- Golder Associates (2011). West Dyke Upgrade (Left Bank) Chilliwack, B.C. (Issued As-Built)
- Ministry of Environment – Water Stewardship Division (2012). Vedder River and Vedder Canal Dike (April 30, 2012 revision).
- Tetratech EBA Inc. (2012). Vedder River Hydraulic Profile Update 2012.
- Tetratech EBA Inc. (2013). Vedder River Management Area Plan Update – Analysis Phase Report.
- Tetratech EBA Inc. (2013). Vedder River Management Area Plan Update – Data Gathering Phase Report.
- Tetratech EBA Inc. (2014). Vedder River Hydraulic Profile Update 2014.
- Tetratech EBA Inc. (2015). Vedder River Management Area Plan Update.
- Kerr Wood Leidal (2016). Vedder River Hydraulic Profile Update 2016.
- Kerr Wood Leidal (2018). Vedder River Hydraulic Profile Update 2018.
- Kerr Wood Leidal (2020). Vedder River Hydraulic Profile Update 2020.
- Northwest Hydraulic Consultants (2020). British Columbia Extreme Flood Project, Regional Flood Frequency Analysis.
- Kerr Wood Leidal (2022). Vedder River Hydraulic Profile Update 2022.
- Kerr Wood Leidal (2022). Preliminary Site Assessment of Potential Areas of Immediate Concern – Site S-CR-7 Vedder Canal/ Vedder River
- Onsite Engineering (2022). West Dike Updates (Right Bank) (Issued for Construction).
- Nova Pacific Environmental (2023). Proposed 2023 Vedder River Sediment Removal Project: Environmental Assessment Report.
- Nova Pacific Environmental (2023). Construction Environmental Management Plan – 2023 Vedder River Sediment Removal Project.
- Kerr Wood Leidal (2023). Hydraulic Assessment Report.

2. Study Area

The Vedder River is located approximately 80 km east of Vancouver predominately in the City of Chilliwack with a portion of the downstream reach of the Vedder Canal located in the City of Abbotsford. This watercourse, generally referred to as the Chilliwack River upstream of Vedder Crossing Bridge and the Vedder River between the Vedder Canal and Vedder Crossing Bridge is a highly productive and diverse system that sustains fish and wildlife populations and provides ecological and recreational value.

The project study area refers to a 12.5 km reach extending from Vedder Crossing Bridge to the Highway 1 Bridge. The project area is generally divided into four (4) sub-reaches, referred to as the canal, lower reach, middle reach, and upper reach based on their unique geometries and characteristics (see Figure 2-1). Within the study area, a total of 85 established cross-section locations are surveyed on a regular (biennial) basis to assist in hydraulic modelling and quantification of the sediment deposition through the study area.

The canal reach is approximately 4.3 km in length and extends from the confluence point with the Sumas River (XS C7) to the Vedder River Lower Reach (XS C37). The canal is characterized by a low overall channel bed slope, 0.05% on average, and a uniform cross-sectional area with dikes on each bank. Channel wetted width in this reach is approximately 75 m with the maximum floodplain width of approximately 175 m, from top of right dike to top of left dike.

The Vedder River's lower reach is approximately 2.4 km in length and extends from the upstream end of the canal (XS C37) to the downstream side of the Southern Railway of British Columbia (SRY) Bridge (XS 17-1). The lower reach is characterized by a low overall channel bed slope, 0.17% on average, and a diverse channel formation with setback dikes on each bank. The Blue Heron Reserve is located on the right (north) bank and setback dikes are at their widest extent within this reach. Channel wetted width in the lower reach ranges from 40 to 60 m with the maximum floodplain width ranging from 500 to 1,000 m (due to the Blue Heron Reserve).

The Vedder River’s middle reach is approximately 2.7 km in length and extends from the upstream side of the SRY Bridge (XS 17-2) to Lickman Road (XS 35). The middle reach is characterized by a relatively higher overall channel bed slope, 0.28% on average, and a diverse channel formation with setback dikes on each bank. Channel wetted width in the middle reach ranges from 25 to 60 m with the maximum floodplain width ranging from 500 to 600 m.

The Vedder River's upper reach is approximately 3.4 km in length and extends from Lickman Road (XS 35) to the Vedder Crossing Bridge (XS 49). The upper reach is characterized by a moderate channel bed slope, 0.43% on average, and a diverse channel formation with partial setback dikes on each bank. The Right Dike ends at Webster Road (XS 38) while the Left Dike ends an additional 390 m upstream (XS 39). Channel wetted width in the upper reach ranges from 20 to 60 m with the maximum floodplain width ranging from 175 (due to a constriction near Vedder Crossing Bridge) to 500 m.

Dikes have been constructed along the Vedder Canal and Vedder River from the confluence with the Sumas River at the downstream end to the upper reach of the Vedder River where the river is more contained by higher ground on both sides, and flood risk is reduced. The right dike, on the north side of the river, extents 9.8 km from the Sumas River to Webster Road. The left dike, on the south side of the river, extends 10.1 km from the Sumas River to tie into high ground approximately 900 metres east of Giesbrecht Road. Location and extent of the right and left dikes are represented on Figure 2-1.

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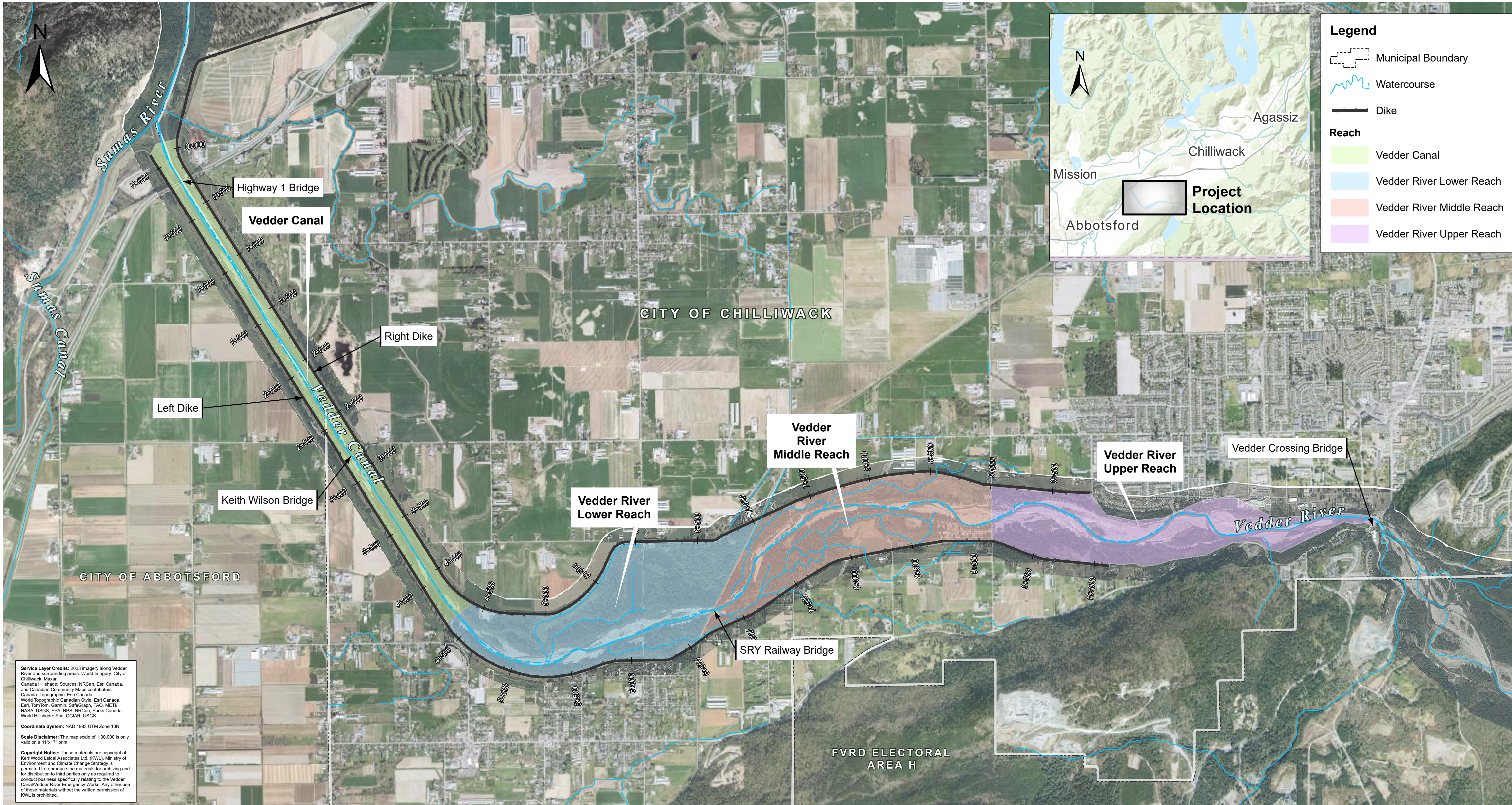

Service Layer Credits: 2023 imagery along Vedder River and surrounding areas. World Imagery: City of Chilliwack, Maxar
Canada Hillshade: Sources: NRCan, Esri Canada, and Canadian Community Maps contributors.
Canada_Topographic: Esri Canada
World Topographic Canadian Style: Esri Canada, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS, NRCan, Parks Canada
World Hillshade: Esri, CGIAR, USGS

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:30,000 is only valid on a 11"x17" print.

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2024 Hydraulic Assessment
Location Plan

Figure 2-1

3. Field Survey

There is a long history of cross-sectional surveys at established locations along the Vedder Canal and Vedder River that have been carried out for decades under the direction of VRMAC. For the purposes of this study, the 2020 and 2022 channel geometry surveys were considered to establish a pre- and post-November 2021 ARE condition. In addition to the cross-sectional data, KWL commissioned the collection of LiDAR data and an updated bathymetric and topographic survey following the summer 2022 VRMAC excavations.

All data detailed in the sections below were used to formulate an understanding of the pre- and post-November 2021 ARE conditions in the Vedder Canal and Vedder River and to support hydraulic modelling efforts to understand the impacts on the flood profile.

An updated LiDAR dataset was collected in September 2023 to record any changes due to the 2023 freshet flows. This LiDAR dataset was used in combination with the 2022 bathymetric survey to develop a baseline condition for the 2024 hydraulic modelling.

3.1 Terrain & Bathymetry

Two sets of channel survey data, from 2020 and 2022, were used to quantify changes in sediment throughout the study area and provide geometry for hydraulic modelling. These data sets spanned the entire study area, from just downstream of the Highway 1 bridge at the confluence of the Sumas River and Vedder Canal to Vedder Crossing bridge (see Figure 3-1 and Figure 3-2).

The 2020 channel geometry survey was conducted by CRA Canada Survey Inc. in February 2020. The river channel was surveyed from bank to bank with additional points on the top of the setback dikes where applicable. Additional cross sections XSC7, XSC8 and XSC9 were surveyed in the Vedder Canal from the Highway 1 Bridge to the mouth. Paired distance-elevation survey data were provided in .XLS format oriented looking downstream. Data was supplied in .DWG plan format for volume calculations.

The 2022 channel geometry survey was conducted by McElhanney between January 25 and February 10, 2022. The river channel was surveyed from bank to bank, where possible. Vegetation, large woody debris, and swift water impeded access at some locations limiting survey coverage. Where necessary KWL used 2020 survey data to fill gaps and assumed no major bank failures or avulsions occurred between the 2020 and 2022 surveys. This was verified by a KWL site inspection of select locations on April 7, 2022. Additional cross sections XSC7, XSC8 and XSC9 were surveyed in the Vedder Canal from the Highway 1 Bridge to the mouth. Paired distance-elevation survey data were provided in .XLS format oriented looking downstream. Data was supplied in .DWG plan format for volume calculations.

3.2 LiDAR & Orthoimagery

Field inspections by KWL engineers indicated significant changes had occurred along the Vedder River. Updated LiDAR terrain data and orthoimagery was requested to better understand the impact of the November 2021 ARE, as well as provide an opportunity to update the overbank (floodplain) portion of the 1D hydraulic models. Overbank areas had not been ground surveyed since the 2004 overbank survey and potential for changes resulting from flood events was likely.

A LiDAR dataset was collected on October 2, 2022 and September 15, 2023 by McElhanney and provided as ASPRS LiDAR Data Exchange Format (LAS) version 1.4. Terrain data was provided as ‘Bare Earth’ classification with all other points (for vegetation and structures) removed.

Associated orthophotos were also collected as part of the deliverables and provided in .tiff format. These orthophotos have a resolution of 10 cm which provides detail of existing sediment bars and formation of the river (see Figure 3-3).

The LiDAR terrain and orthophoto were collected when water levels in the Vedder River were low. Flow in the river at the time of the October 2, 2022 LiDAR scan was reported at the WSC 08MH001 gauge as 11.8 m^3/s to 12.1 m^3/s. Similarly, flow in the river at the time of the September 15, 2023 LiDAR scan was reported at the WSC 08MH001 gauge as 12.8 m^3/s to 13.2 m^3/s.

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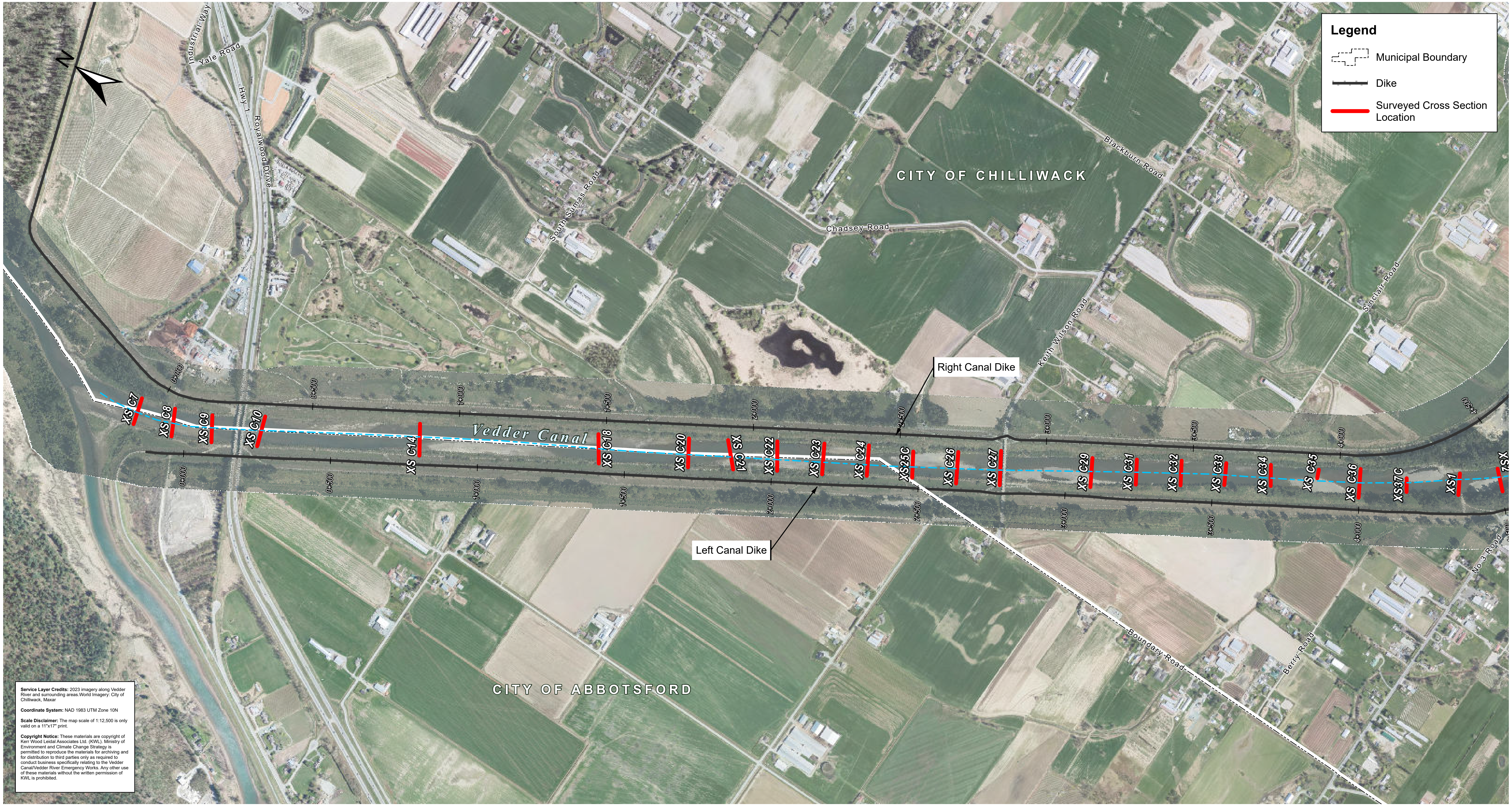

Service Layer Credits: 2023 imagery along Vedder River and surrounding areas.World Imagery: City of Chilliwack, Maxar

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2024 Hydraulic Assessment
Cross Section Survey Locations - Vedder Canal

Figure 3-1

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Vedder Canal/Vedder River Phase II Emergency Works

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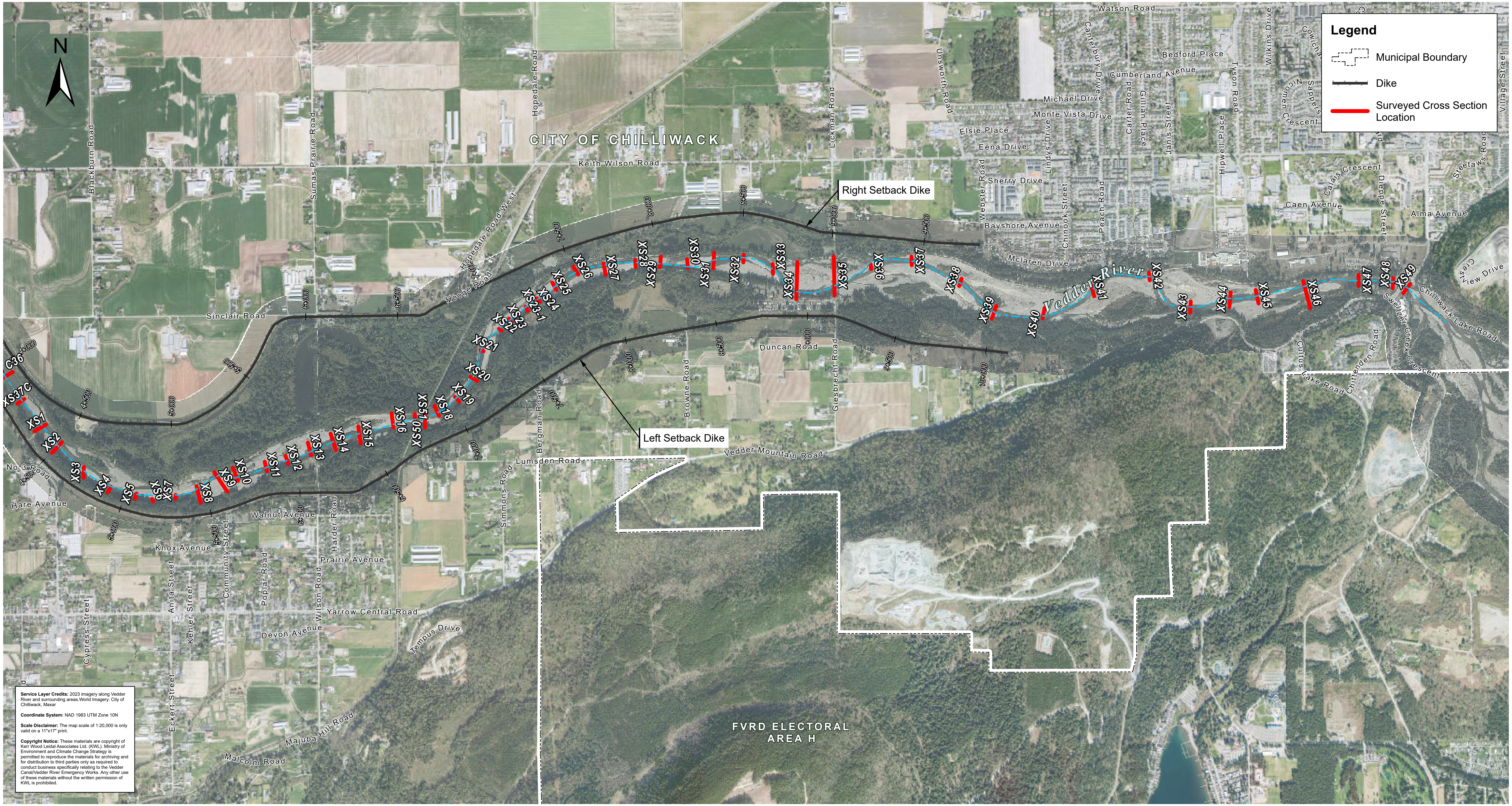

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2024 Hydraulic Assessment
Cross Section Survey Locations – Vedder River

Figure 3-2

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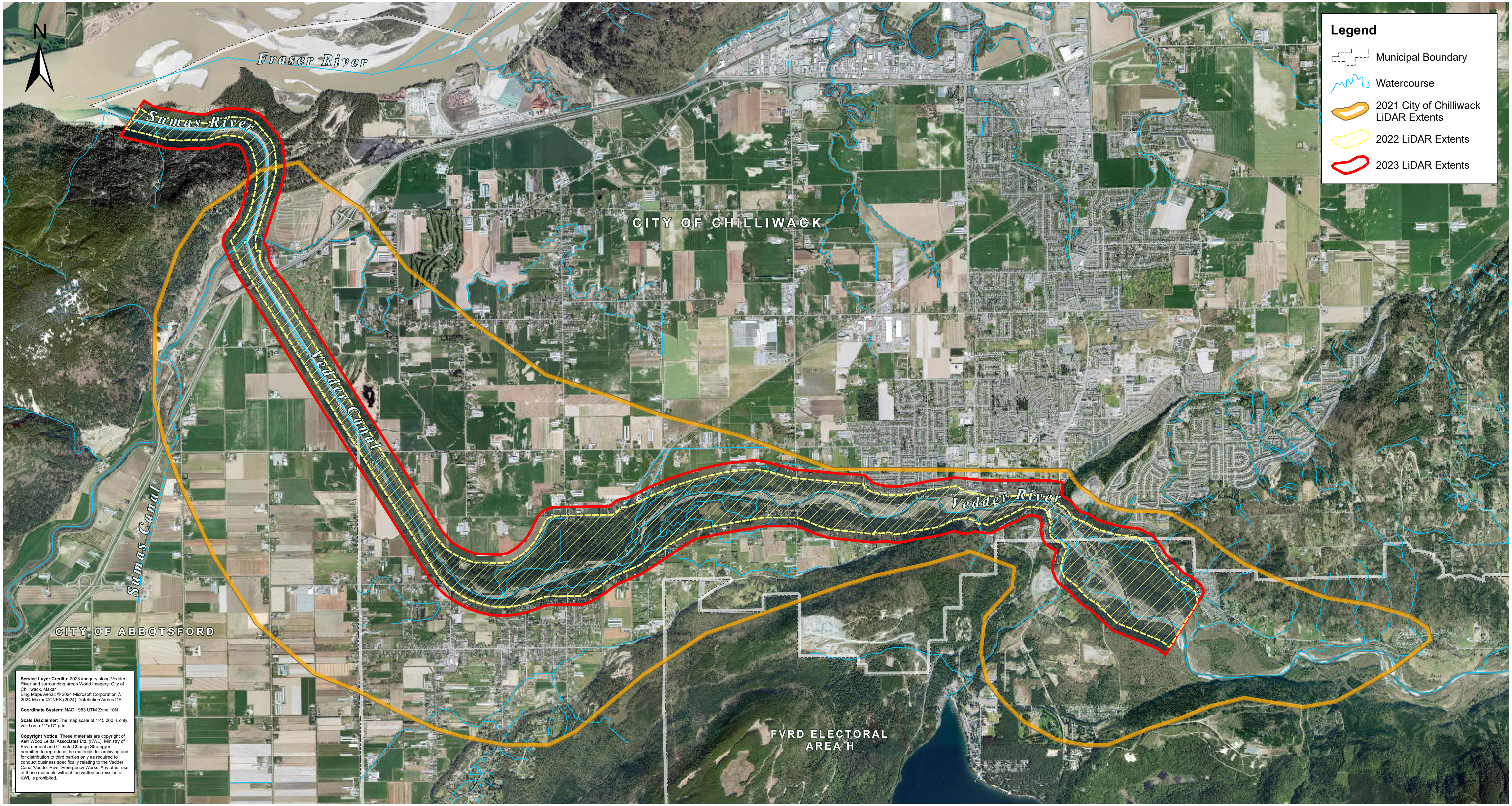

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Bing Maps Aerial: © 2024 Microsoft Corporation © 2024 Maxar ©CNES (2024) Distribution Airbus DS

Coordinate System: NAD 1983 UTM Zone 10N

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2024 Hydraulic Assessment
Vedder River/Canal LiDAR Extents

Figure 3-3

4. Flood Record

Floods have been reported and documented on the Vedder River for centuries with many of them causing inundation and damage to property bordering the river. For example, the December 1975 flood caused extensive damage to the town of Yarrow which led to the implementation of flood control works including setback dikes, groynes, and channel maintenance.

Water Survey of Canada (WSC) maintains a gauge near the Vedder Crossing bridge, referred to as Chilliwack River at Vedder Crossing (08MH001). There are 85 years of recorded data associated with this gauge spanning from 1912 to the present. The top 10 flood events, ranked by average daily discharge, are presented below in Table 4-1. Upon review of the flood record, the November 2021 ARE is the second largest event in the 08MH001 gauge history.

Figure 4-1 represents the last 20 years of gauge data showing a trend of lesser flood events over the last decade with many at or below a 2-year return period with 50% annual exceedance probability (AEP). The November 2021 ARE is by far the largest event in the last two decades with a 200-year return period or 0.5% AEP.

Table 4-1: Chilliwack River at Vedder Crossing Top 10 Flood Events.

Rank	Year	Average Daily Discharge[1] [m^3/s]	Date
1	1917	765	December 29
2	2021	719[2]	November 15
3	1989	684[3]	November 9-10
4	2003	616	October 20-21
5	1914	566	January 6
6	1921	538	December 12
7	1980	533	December 26
8	1975	530	December 3
9	1924	498	February 12
10	1928	487	January 12

Notes:
- The November 10, 1990 floods are not noted in this table as no data is currently available from the WSC Vedder River gauge (08MH001) for those events.
- Data extracted from the Environment and Climate Change Canada Historical Hydrometric Data web site (https://wateroffice.ec.gc.ca/mainmenu/historical_data_index_e.html) on March 21, 2023.

[1] Discharge values are average daily flows.
[2] Data provided as an estimate only.
[3] Flow data sourced from Hydrology of the November 1989 Chilliwack River Flood, and Some Observations on the Impact of Forest Management, Peter Jordan, March 14, 1990.

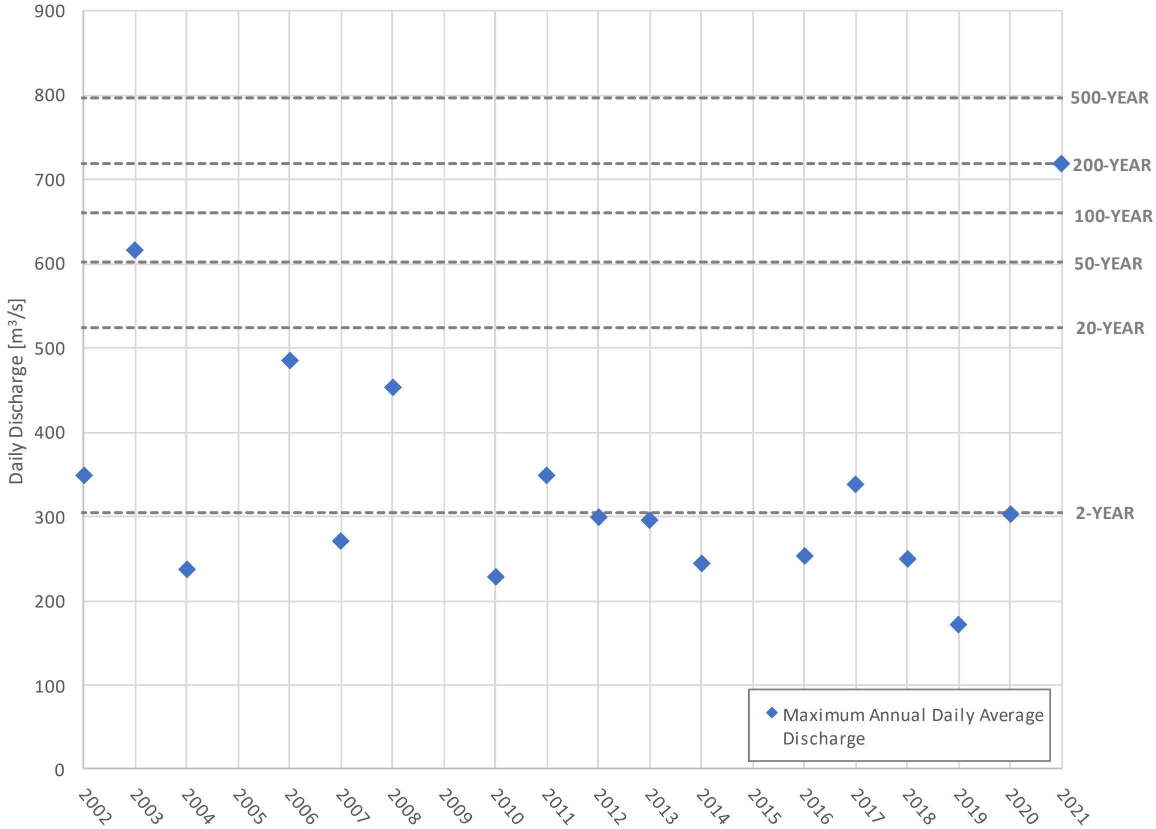

Figure 4-1: Recent Flood History (2002 to 2021) from Chilliwack River at Vedder Crossing (08MH001) with Annual Exceedance Probabilities.

Notes:
- Extracted from the Environment and Climate Change Canada Historical Hydrometric Data web site (https://wateroffice.ec.gc.ca/mainmenu/historical_data_index_e.html) on March 21, 2023.
- Return Period Flows sourced from British Columbia Extreme Flood Project, Regional Flood Frequency Analysis (NHC 2020)

5. Sediment Deposition

Channel geometry from repeated cross-sectional surveys on the Vedder River since 1981 and on the Vedder Canal since 1991 has been used to estimate changes in sediment throughout the study reach. Estimates of volume change in the river and canal are calculated using the average end area method, interpolating between cross sections. The estimated bed change between surveys, together with the known volumes of sediment excavation, were used to calculate total sediment deposition between survey periods.

To estimate sediment deposition associated with the November 2021 ARE, the 2020 and 2022 cross-sectional surveys were compared, and a volumetric bed change was calculated. No excavation of sediment occurred between the 2020 and 2022 surveys, therefore natural deposition was calculated as the difference between surveyed surfaces. Calculated changes in channel sediment quantities by reach are summarized below in Table 5-1. Between the 2020 and 2022 surveys, all reaches showed considerable aggradation with a total increase of 440,700 m^3. The Lower River reach showed the greatest accumulation at 144,900 m^3. It is likely most material deposited between the 2020 and 2022 surveys is a result of the November 2021 ARE as this was the only significant flow event (in excess of 400 m^3/s) between the 2020 and 2022 survey.

Table 5-1: Changes in Sediment Quantities by Reach Between 2020 and 2022 Surveys.

Location	Bed Change (m^3)	Excavation (m^3)	Total Natural Deposition (m^3)
Vedder Canal	84,600	0	84,600
Vedder River (Total)	356,150	0	356,150
Vedder Lower Reach	*144,900*	*0*	*144,900*
Vedder Middle Reach	*74,800*	*0*	*74,800*
Vedder Upper Reach	*136,500*	*0*	*136,500*
Totals	**440,700**	**0**	**440,700**

Based on the bathymetric survey data and information received from the City of Chilliwack, it is estimated that the 2022 VRMAC excavations removed approximately 35,130 m^3. The remaining sediment deposited from the November 2021 ARE is estimated at 405,570 m^3. Based on the mandate of this ENV project, removal of this sediment is required to restore the floodway's ability to convey future floods.

5.1 Historic Sediment Removals

Sediment removal on the Vedder River was conducted annually from 1990 to 1997 and biennially from 1998 to present, except for 2018 and 2020 when no excavations occurred. Excavation volumes have varied by year and ranged from 33,000 m^3 to 217,000 m^3. Large excavations occurred in 1990, 1991, and 2006 with volumes of 158,600 m^3, 187,500 m^3, and 212,713 m^3, respectively, following the large flood events of 1989, 1990, and 2003. The highest volume in the excavation record is 217,000 m3 which occurred in 1996. A full record of excavations by year is summarized in Figure 5-1. All excavation volume data was provided by the City of Chilliwack.

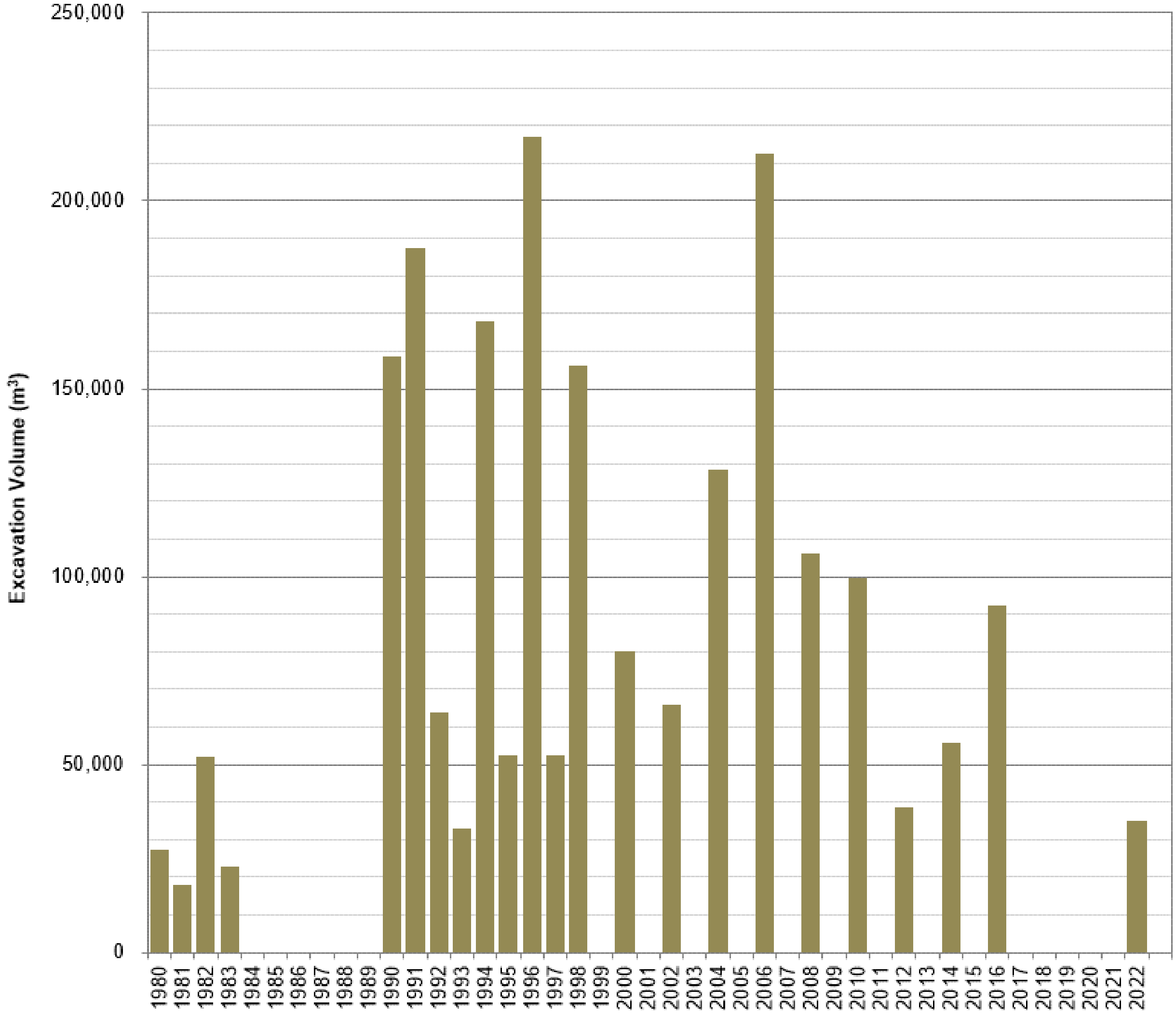

Figure 5-1: History of Sediment Removal Volumes on the Vedder River and Canal by Year.

6. Hydraulic Modeling

Hydraulic modeling of the Vedder River was completed by KWL with US Army Corps of Engineers (USACE) HEC-RAS v 6.3.1 software[4]. The HEC-RAS model was used to estimate the water level for a design flow of 1,470 m^3/s, the 200-year return period flood (0.5% annual exceedance probability) maximum instantaneous peak flow. This value differs from ranked flood and AEP flows presented in Section 4 as those values are averaged daily flow as opposed to instantaneous peak flow.

6.1 2022 Model Calibration

The calibration model was built from the 2022 bathymetric and LiDAR model which best represents the condition of the river at the time of calibration. The recorded river water level data was provided by City of Chilliwack for December 1, 2021 at various locations along study reach as shown in Figure 6-1. The downstream water level used in the model is from Barrowtown PS, Fraser level, representing the water level on the downstream side of the Barrowtown Dam which is governed by the water level at the Vedder-Sumas confluence. Table 6-1 shows the location, water level, flow and the corresponding downstream water level used in the model for calibration.

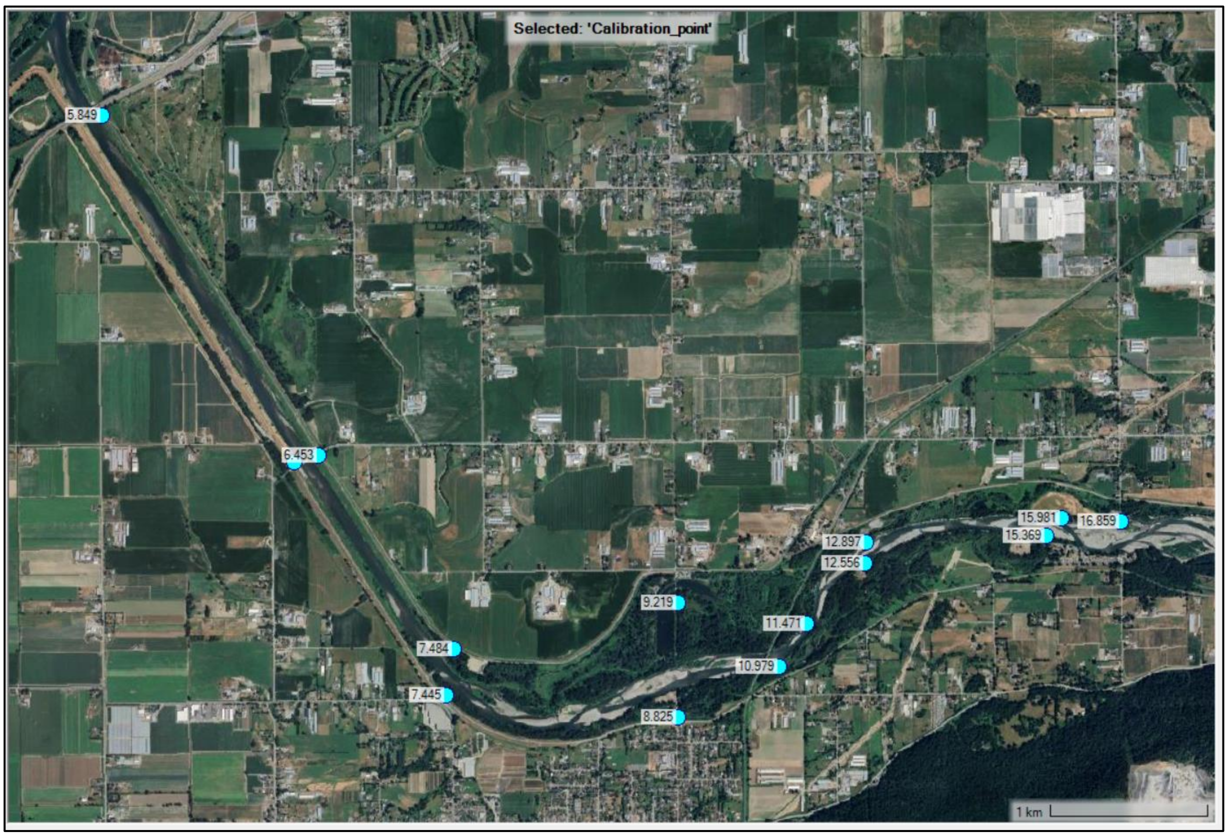

Figure 6-1: Observed Water Surface (meters) for December 1, 2021 Flood Event from City of Chilliwack.

[4] US Army Corp of Engineers, HEC-RAS 6.3.1 Hydraulic Model [Computer Software]. Washington, DC.

Table 6-1: Flow and water level data used for calibration.

Date	Time	UTM Northing	UTM Easting	Flow [m³/s]	Water Level (m)	Barrowtown Water Level (m)
2021-12-01	10:28:00 AM	5438797.59	575633.35	411	32.254	5.18
2021-12-01	10:39:00 AM	5438791.92	574755.63	439	27.664	5.21
2021-12-01	10:59:00 AM	5438843.82	573965.98	429	23.695	5.22
2021-12-01	11:09:00 AM	5438939.23	572493.04	398	16.859	5.25
2021-12-01	11:21:00 AM	5438958.21	572120.20	395	15.981	5.24
2021-12-01	11:38:00 AM	5438807.13	570875.22	414	12.897	5.27
2021-12-01	12:01:00 PM	5438286.85	570499.32	381	11.471	5.23
2021-12-01	12:27:00 PM	5438418.66	569690.57	398	9.219	5.28
2021-12-01	12:38:00 PM	5438131.46	568265.17	383	7.484	5.24
2021-12-01	1:01:00 PM	5439356.14	567408.78	373	6.453	5.23
2021-12-01	1:12:00 PM	5441503.98	566042.43	352	5.849	5.24
2021-12-01	3:51:00 PM	5438751.02	575614.43	312	31.229	5.12
2021-12-01	3:01:00 PM	5438843.49	572021.45	291	15.369	5.14
2021-12-01	2:27:00 PM	5438671.08	570871.19	332	12.556	5.15
2021-12-01	2:05:00 PM	5438016.79	570325.47	333	10.979	5.18
2021-12-01	1:46:00 PM	5437696.03	569690.00	339	8.825	5.18
2021-12-01	1:35:00 PM	5437834.99	568222.71	355	7.445	5.2
2021-12-01	1:22:00 PM	5439311.88	567261.21	371	6.4	5.2

Calibration of the model included:

- adjusting the channel roughness values,
- introducing partial blockages at bridge location to represent observed debris on bridge piers,
- introducing ineffective flow areas (portions of cross sections that store water but do not convey flow), and
- introducing skewness to railway bridge.

In addition, the calibration model was extended to the Sumas-Vedder confluence. The Highway 1 bridge was represented in the model as cross sections with partial blockages (observed debris) for calibration purposes.

With multiple iterations of calibration, the model now closely simulates the observed water level at multiple locations. There were surveyed water levels on one side of the river that appeared to contradict the surveyed levels on the other side of the river. Therefore, some calibration data could not be matched by the model. The observed and simulated water surface elevation of the calibrated model is tabulated in Table 6-2.

The model is calibrated for a flow event between 291 to 439 m3/s. No data, surveys, or observations of high-water marks were collected during higher flows associated with the November 2021 ARE. Relative to the design flood of 1,470 m3/s, the calibration flow is relatively low. Therefore, the calibrated model has an uncertainty when it comes to accurately representing the design flow event. It is recommended to collect high water mark surveys for any flood events greater than 400 m3/s, with particular interest and value in larger events to allow for better calibration of the hydraulic model.

Table 6-2: Water surface elevation results from calibrated model.

River Station	Discharge (m^3/s)	Observed WSE (m)	Modelled WSE (m)	Difference (m)
13075 XS 49	411	32.25	32.64	0.39
13075 XS 49	312	31.23	32.15	0.92
12237 XS 45	439	27.66	27.60	-0.07
11217 XS 41	429	23.7	23.46	-0.24
9639 XS 35	398	16.86	16.92	0.06
9241 XS 33	395	15.98	16.08	0.10
9067 XS 32	291	15.37	15.09	-0.28
7883 XS 24	414	12.9	12.83	-0.07
7804 XS 23-1	332	12.56	12.29	-0.27
7302 XS 20	381	11.47	11.55	0.08
7032 XS 18	333	10.98	10.95	-0.03
6441 XS 14	398	9.22	9.35	0.13
6304 XS 13	339	8.82	8.88	0.06
4785 XS 2	355	7.45	6.98	-0.47
4580	383	7.48	7.01	-0.47
3107 XS C271	373	6.45	6.44	-0.01
3089 XS C27	371	6.4	6.35	-0.05
583 XS C10	352	5.85	5.86	0.01
Average Difference of Observed vs. Modelled WSE				**-0.01**
Average Difference of Absolute Observed vs. Modelled WSE				**0.21**

6.2 2023 Model Topographic Surfaces

The topography in the model consists of merged datasets from the latest LiDAR (September 2023) with bathymetric surveys (January and February 2022), as described in Section 3.

A Digital Elevation Model (DEM) of the channel and floodplain portion of the study area was created by merging the LiDAR with bathymetric data at locations where the LiDAR did not penetrate the water surface. This merged terrain is further modified by interpolating the bathymetric data between the cross-section locations, thereby creating a singular two-dimensional surface to allow cross sections to be sampled for the 1D modelling. To accurately capture site details, the surface was created at a horizontal resolution of 1 m and a vertical accuracy of +/-0.08 m.

6.3 Cross Section & Bridge Crossings

The calibration model was used as a baseline to the develop the new model by incorporating the 2023 LiDAR. The modelled area includes approximately 13.5 km of river length from just upstream of the Highway 1 bridge to just upstream of the Vedder Crossing bridge, using 85 surveyed cross section locations with an elevation drop of 30 m. The model also includes three (3) bridges in the study area, namely, Vedder Crossing bridge, SRY bridge, and Keith Wilson bridge. Bridge dimensions and parameters from the calibration model were used in the study, but debris blockages were removed. In addition to the existing cross sections of the previous model, new cross-sections were introduced to better represent the geometry of the river and allow for accurate representation of bar excavations (in the excavation scenarios), bringing the total number of cross-sections to 201 more precisely.

6.4 Roughness Values

Manning's n values used in the calibration model was adopted for each simulation and for newly introduced cross sections, the Manning's values were interpolated with the closest cross sections. The range of Manning's n values used in the model are as follows.

- Channel n = 0.030 to 0.045
- Overbank n = 0.030 to 0.200

6.5 Boundary Conditions

The design flow of 1,470 m3/s, representing the 200-year (0.5% annual exceedance probability) maximum instantaneous peak flow is used as the upstream boundary condition. The boundary condition at the downstream end of the model is a water surface elevation of 7.4 m. This water surface elevation is a best estimate of the downstream water level, based on regression analysis of peak levels recorded downstream at Barrowtown Pump Station corresponding to the maximum instantaneous peak flows recorded at the WSC gauge Chilliwack River at Vedder Crossing[5].

In addition to the upstream and downstream boundary conditions listed above, a flow split at the SRY bridge was adopted for this study based on Bland's assumption in the 2008 Hydraulic Update Report[6]. It was assumed that 200 m^3/s leaves the main channel on the right bank between XS21 and XS22 and 150 m^3/s leaves the main channel just downstream of XS18 on the left bank under the design flood conditions. Overbank flow travels through the left bank trestle structure and the right bank relief opening and culvert through the railway embankment. The split flows were assumed to rejoin the main channel at XS13.

6.6 Baseline Model

The baseline model was developed from the calibrated model discussed in Section 6.1. The model is updated with the new surface developed using the 2023 LiDAR as discussed in Section 6.2. Any assumptions for blocked flow areas around the bridges in the calibration model were removed in the baseline model, assuming debris has been removed and flow is unobstructed in the design flood event. Additionally, some cross-sections were introduced to capture important details in the surface, such as potential excavations and changes in terrain between two cross sections.

[5] Schlumberger Water Services Report, March 2010, Vedder River Dike Breach Modelling.
[6] Bland Engineering (2008). Vedder River Hydraulic Profile 2008 Update.

This model represents the 2023 conditions to assess potential flood hazards associated with limited freeboard. This model does not predict or account for any changes to the morphology of the river resulting from Fall 2023 storm events or Spring 2024 freshet flows.

6.7 Existing Flood Protections

The setback dikes on the Vedder River were constructed in the early 1980s based on a flood flow of 1,250 m^3/s and a dike freeboard of 0.75 m. During 1998-2000, the setback dikes were upgraded by raising critical sections about 0.4 m above the 1984 as-built profile to provide 0.6 m freeboard over the 1996 flood profile (1,330 m^3/s). The left setback dike was further raised in 2010 corresponding to the increased design flood of 1,470 m^3/s and to meet the provincial standard for Fraser River flood protection, based on the 2008 NHC Fraser River Hydraulic Model. The raised sections are between Keith Wilson Bridge on the Vedder Canal and XS14 in the Vedder River on the left (south) side. Additional raising of the right dike was completed in 2022 to an elevation of 11.5 m between the Greendale Stockpile and Blue Heron Reserve (XS 6 to XS 14).

Dike crest elevations were obtained from a review of engineering drawings provided by the City of Chilliwack and compared against the recent (2023) LiDAR topography. For the purposes of detailed review of potential freeboard deficiencies in the study reach, KWL has used the latest LiDAR data for dike crest elevations.

6.8 Model Limitations

The following limitations are associated with the current 1D hydraulic model:

- The current flow split at the railway embankment is based on a 2008 assessment and may not consider potential for embankment overtopping in the design flood. This is the largest limitation of the 1D model which would cause a localized impact upstream of the railway.
- The current 1D model does not represent designed sediment removal pit openings or lateral flow at pit locations.
- The model with proposed excavations is representative of conditions immediately post-excavation. It is expected that sediment will redistribute during the first and subsequent higher flow events. Water levels at individual cross sections may increase of decrease but the average freeboard or freeboard deficiency is expected to remain the same.
- The shallow overbank flow areas are largely assumed to be continuous (upstream to downstream) between cross sections. If the areas are not continuous, this would tend to underestimate peak water levels. A 2D model would better represent overbank flows.
- The current 1D model results are interpolated between cross sections to generate dike freeboard figures which introduces some uncertainty in the freeboard analysis. This uncertainty is inherent to all 1D models. A 2D model would be needed to quantify the uncertainty.
- No floating debris accumulation at bridge piers is incorporated into the design flow models (only in the calibration model) because the amount of debris during a design flood is variable. Debris buildup on bridges may raise upstream water levels by 0.5m or more as shown by the recorded water levels during the calibration event.

Updating the model to 2D for next year's assessment, including collecting 2D bathymetric LiDAR to capture the full topography of the channel bed, would address most of the above limitations (except the debris blockage and the sediment redistribution issues).

7. Baseline Flood Profile Analysis

Flood profiles are computed water surface elevations (WSE) used to understand the risk of flooding within the study area. For the purposes of this assessment, the baseline model represents current conditions based on a combination of the latest LiDAR from September 2023 and previous bathymetric cross-sectional surveys from January and February 2022 to fill gaps where the LiDAR survey reflected from the water surface.

To understand areas with the highest risk of flood impact, computed water surface elevations are compared against dike crest elevations to identify areas where limited freeboard was present. The target freeboard in the study area is 0.75 m. Areas, where the computed water surface elevation is within 0.75 m of the adjacent dike crest, are freeboard deficient.

The baseline flood profile was interpolated between model cross sections and translated to the adjacent dikes using flood contours anticipated during the design flood event. The WSE is then compared to dike elevations from the September 2023 LiDAR to estimate freeboard along the length of the dikes. A comparison of the baseline flood profile and crest elevations of the left and right dikes with associated freeboard deficiencies are presented in Figure 7-1 and Figure 7-2, respectively. Figure 7-3 is a plan view of freeboard deficient segments of the dikes colour coded to the magnitude of freeboard deficiency. A summary of freeboard deficiency is provided in Table 7-1 for both the left and right dikes.

Table 7-1: Baseline Freeboard Deficient Statistics by Dike.

Dike	Length of Freeboard Deficient Dike (m)	Length x Freeboard Deficiency of Freeboard Deficient Dike (m^2)
Left Dike	3,304	910
Right Dike	2,700	741
Total	**6,004**	**1,651**

There are two segments of the right dike, from chainage 7+073 to 7+098 and from 7+607 to 7+645, with an estimated freeboard deficiency greater than 0.75 m. In these areas there is a risk of the dike overtopping in the design flood event.

A table of results for the baseline flood profile, left and right dike crest elevations, and freeboard deficiencies are provided in Appendix A.These flood profiles should not be used for dike upgrade design until other conveyance mitigation options are explored (e.g., increasing conveyance through the SRY railway embankment).

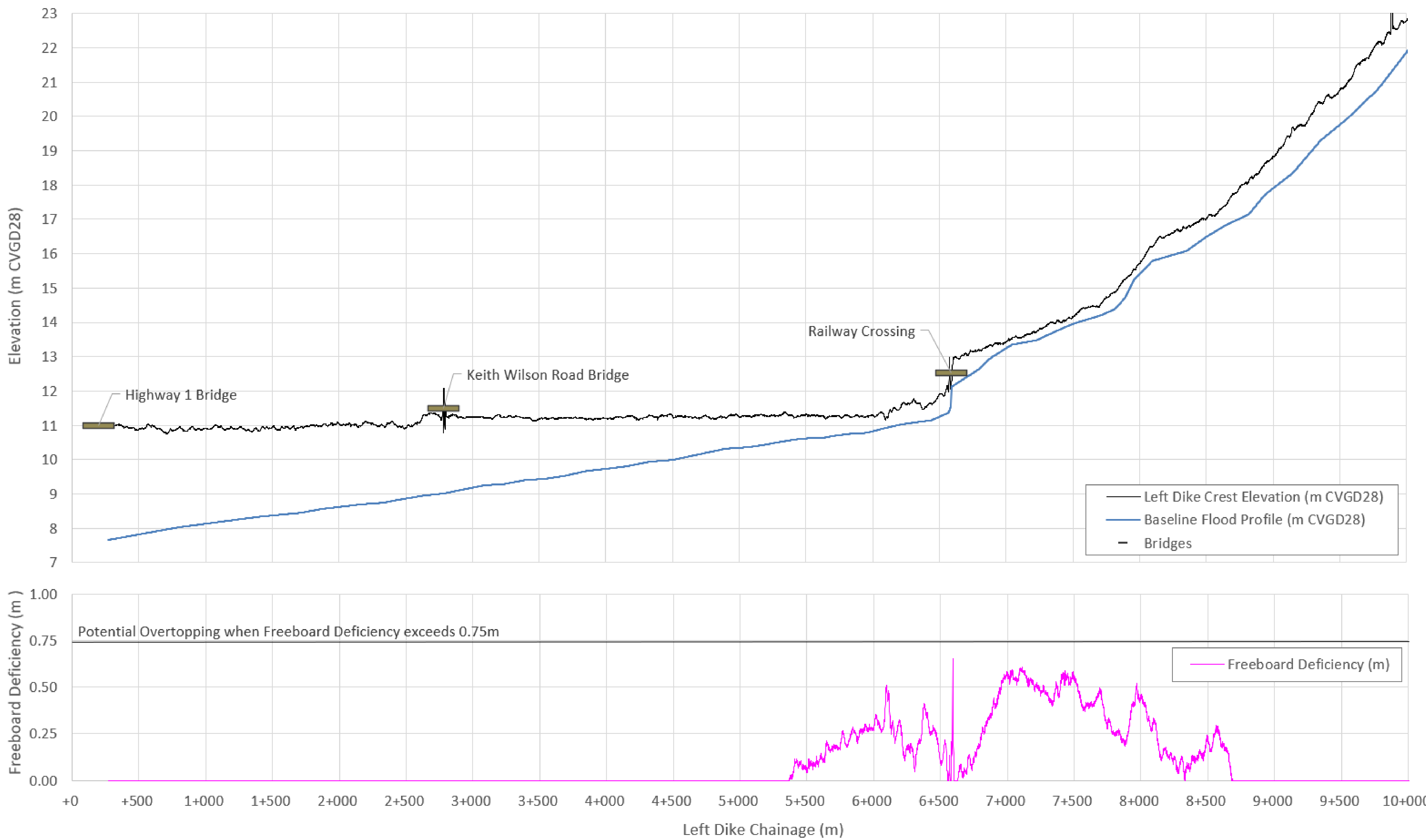

Figure 7-1: Left Dike Elevation and Baseline Flood Profile including Left Dike Freeboard Deficiency.

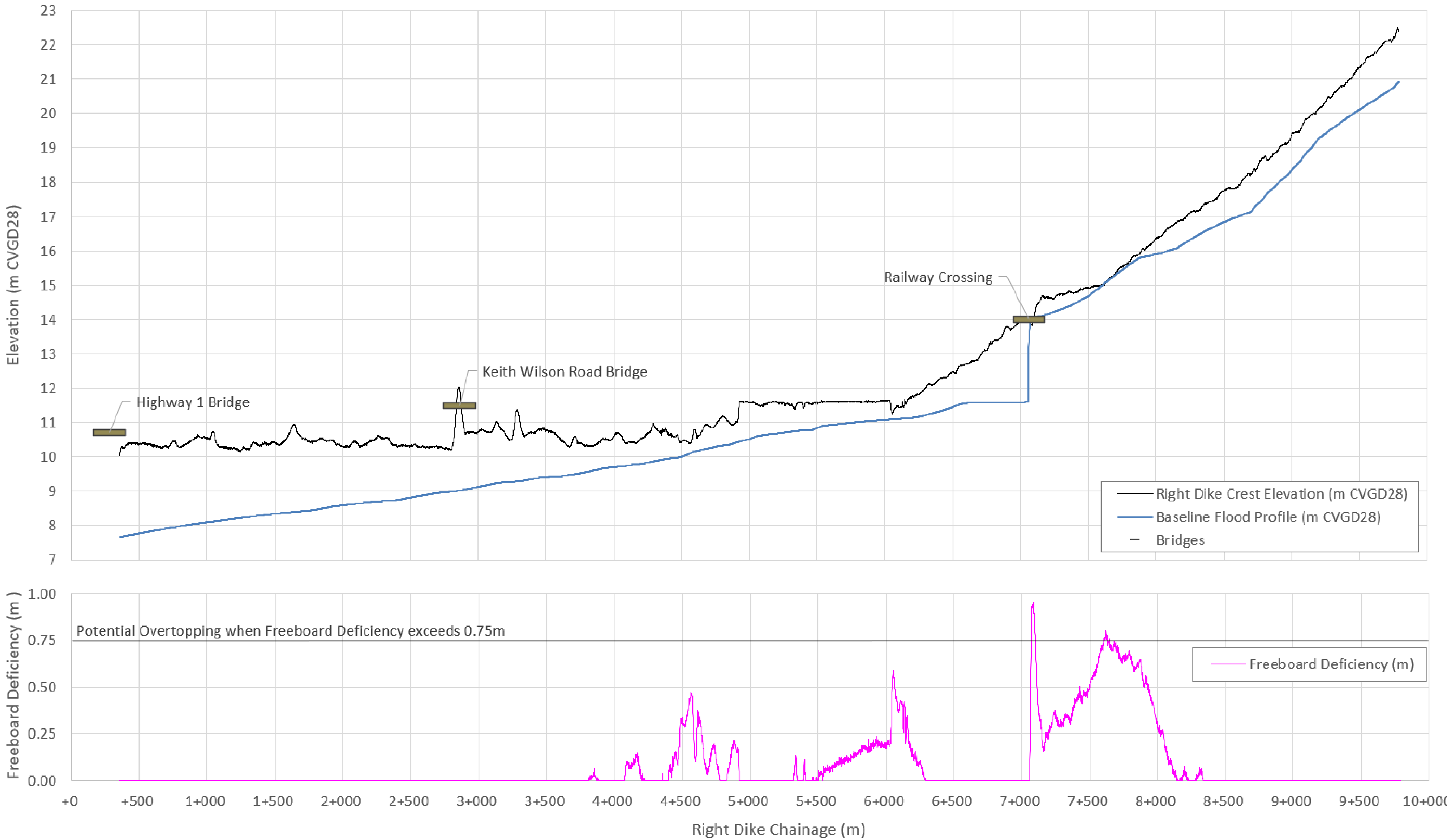

Figure 7-2: Right Dike Elevation and Baseline Flood Profile including Right Dike Freeboard Deficiency.

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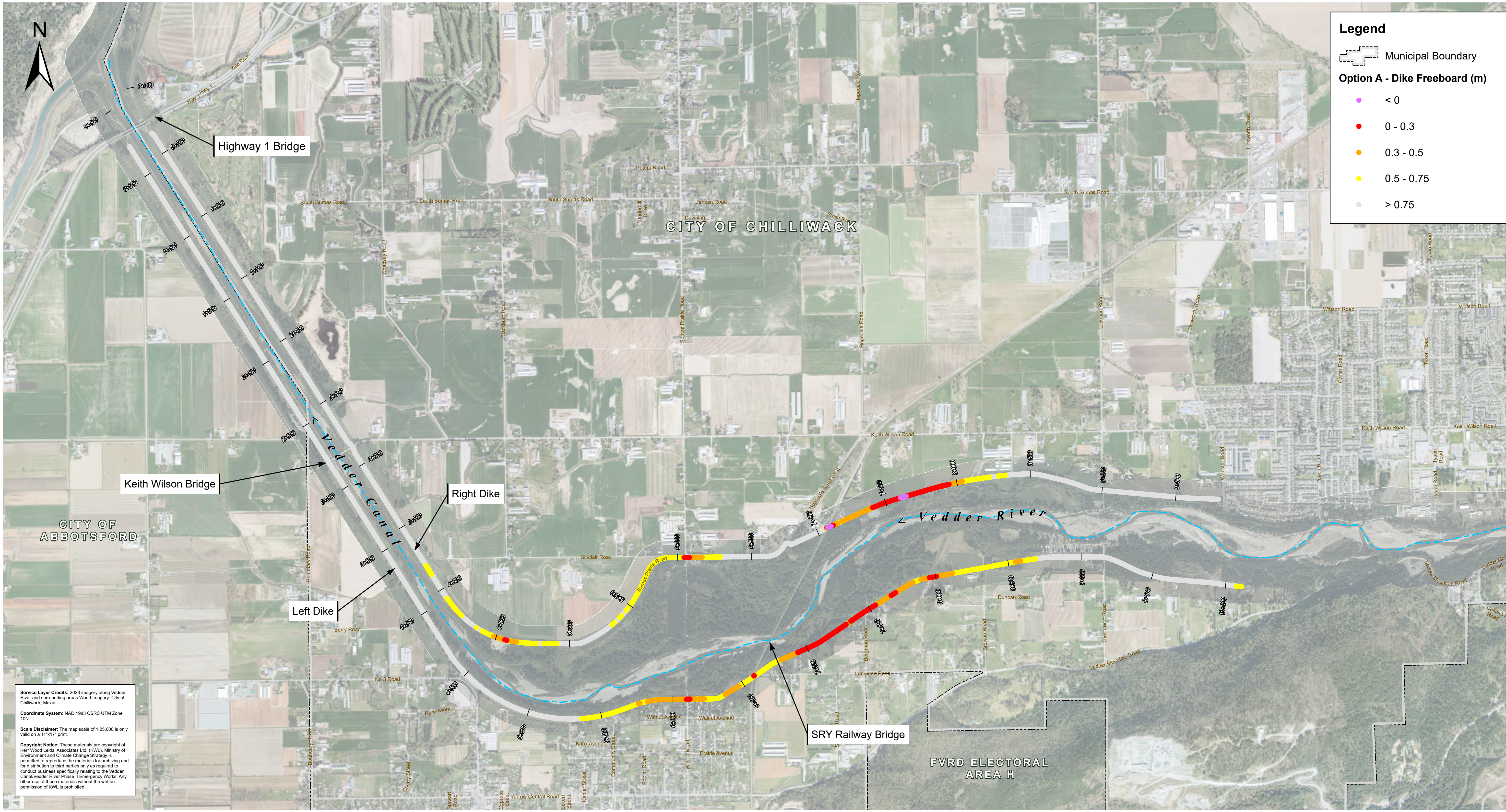

Service Layer Credits: 2023 imagery along Vedder River and surrounding areas.World Imagery: City of Chilliwack, Maxar

Coordinate System: NAD 1983 CSRS UTM Zone 10N

Scale Disclaimer: The map scale of 1:25,000 is only valid on a 11"x17" print.

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Baseline Condition (Option A) - Dike Freeboard Deficient Areas

Figure 7-3

8. Options Analysis

8.1 Screening of Options

The project team considered a wide range of options for the purpose of improving flood protections on the Vedder River and Vedder Canal in response to the November 2021 ARE. This list is not extensive and is intended to represent mitigation options that rely on dikes to contain the design flood within the current Vedder Floodway. A list of options considered is presented in Table 8-1 below.

Table 8-1: List of Options Considered Prior to Screening.

Option	Short Description	Comments
A	Do Nothing (Baseline)	• This option represents no sediment removal or dike raising and no reduction in flood risk – no change from the baseline condition.
B	Updated 2023 Proposed Option – Lower Volume Yield	• This option is intended to use sediment removal sites identified in the 2023 proposed with minor adjustments to suit current river conditions. • This option is targeting a lower sediment removal volume relative to other sediment removal options.
C	New 2024 Proposed Option – Higher Volume Yield	• This option targets a higher sediment removal volume by including many sediment removal sites from the 2023 proposal (Option B) and the addition of new 2024 sites.
D	New 2024 Proposed Option – Moderate Volume Yield	• This option considers a moderate sediment removal volume by including many sediment removal sites from the 2023 proposal (Option B) and the addition of new 2024 sites.
E	Remove Full Nov 2021 ARE Sediment Volume	• This option is intended to target the remaining sediment input volume (estimated at 405,570 m^3) from the November 2021 ARE.
F	Dike Upgrades and/or SRY Embankment Flow Capacity Increases	• This option considers raising existing dike crest and/or increasing the flow capacity through the SRY railway embankment to restore full freeboard, as opposed to sediment removal in the river.

Option A – Do Nothing is not recommended as it does not address flood risk that is evident in the flood profile analysis detailed in Section 7.

Option E – Remove Full Nov 2021 ARE Sediment Volume is not recommended as sediment removal of that magnitude is not considered feasible due to constructability limitations, potential impact to fish habitat, and geomorphological risk to the stability of the river.

Option F - Dike Upgrades has limitations with seismic design criteria, land acquisition timelines, and Disaster Financial Assistance Arrangements (DFAA) funding eligibility and was not evaluated further as part of this project.

As a result, only Options B, C, and D are evaluated further in the following sections of this report.

8.2 Screening of Sediment Removal Sites

Nova Pacific Environmental completed the initial screening of potential sediment removal sites by reviewing aerial imagery from fall 2023 and completing a field review of site conditions against program guidelines. Through this process, 17 sediment removal sites were identified. Each sediment removal site is intended to:

- reduce the flood profile in freeboard-limited areas, or
- trap sediment upstream of the freeboard limited areas, or
- increase capacity in the canal reach to reduce the backwater impacts to the flood profile in the lower river reach freeboard limited area.

All sediment removal sites are intended to:

- provide neutral or positive habitat outcomes while facilitating the removal of sediments in support of the floodway objective, and
- provide additional habitat in the immediate vicinity of sediment excavations (where suitable).

All proposed sediment excavation sites were selected using the guidelines outlined in the Vedder River Management Area Plan and reiterated in the NPE Environmental Permitting Report. Excavation footprint, slopes, and access were all designed by NPE. For individual excavation site details – please refer to the NPE Environmental Assessment Report.

Excavated volumes were estimated using the proposed excavation extents and side slopes, as provided by NPE, and LiDAR terrain surface of the sediment bars. An approximately 3 m depth of excavation below the adjacent water surface was adopted for all pit excavations, while habitat and bar top excavations were based on depth inputs from NPE. The water surface was estimated using data collected during the LiDAR flight with a Vedder River flow of approximately 13 m^3/s. The sediment volumes represent the highest possible yield based on optimal conditions in the field during construction. Significant variation in excavated volumes could likely be encountered in the field depending on conditions at the time of the works. Actual excavation yield is likely to be less than the estimated volumes.

All estimates of proposed excavated extent, volume, and specific locations are based on the best available information at the time of planning sediment removals. However, freshet flows in spring 2024 are likely to alter sediment bar geometry and significant variations to the volumes excavated at any given site are possible due to site conditions including water levels during the fish construction window. Actual excavation details will be determined in the field by the Environmental Monitor at the time of the construction works.

An overview of the selected sites is provided in Figure 8-1. Details at each sediment removal site are provided in Figure 8-2A through Q. Table 8-2 summarizes the site names and the estimated sediment removal volumes.

Table 8-2: 2024 Potential Sediment Removal Sites and Estimated Excavation Volumes – Ordered from Upstream to Downstream.

Reach	Site Name	Proposed Excavation Volume (m^3)
Upper	S45 Bar	27,400
	Giesbrecht Bar	24,200
	Peach Bar (including Habitat Enhancement Excavation)	34,500
Middle	Campground Upstream Bar	13,600
	Lickman Bar (including Bar Top Excavation)	19,300
	Campground DS Bar (including Habitat Enhancement Excavation)	46,400
	Brown (A+B) Bar	31,200
	Bergman Bar (including Habitat Enhancement Excavation)	10,900
	Railway Bar	7,000
Lower	Greendale Bar (including Habitat Enhancement Excavation)	33,200
Canal	Salad Bar (including Habitat Enhancement Excavation)	14,000
	Powerline Bar	19,000
	Keith Wilson Bar	13,300
	Boundary Bar (including Habitat Enhancement Excavation)	18,800
	Chadsey Bar	22,800
	C16 Bar	28,000
	C12 Bar	22,700

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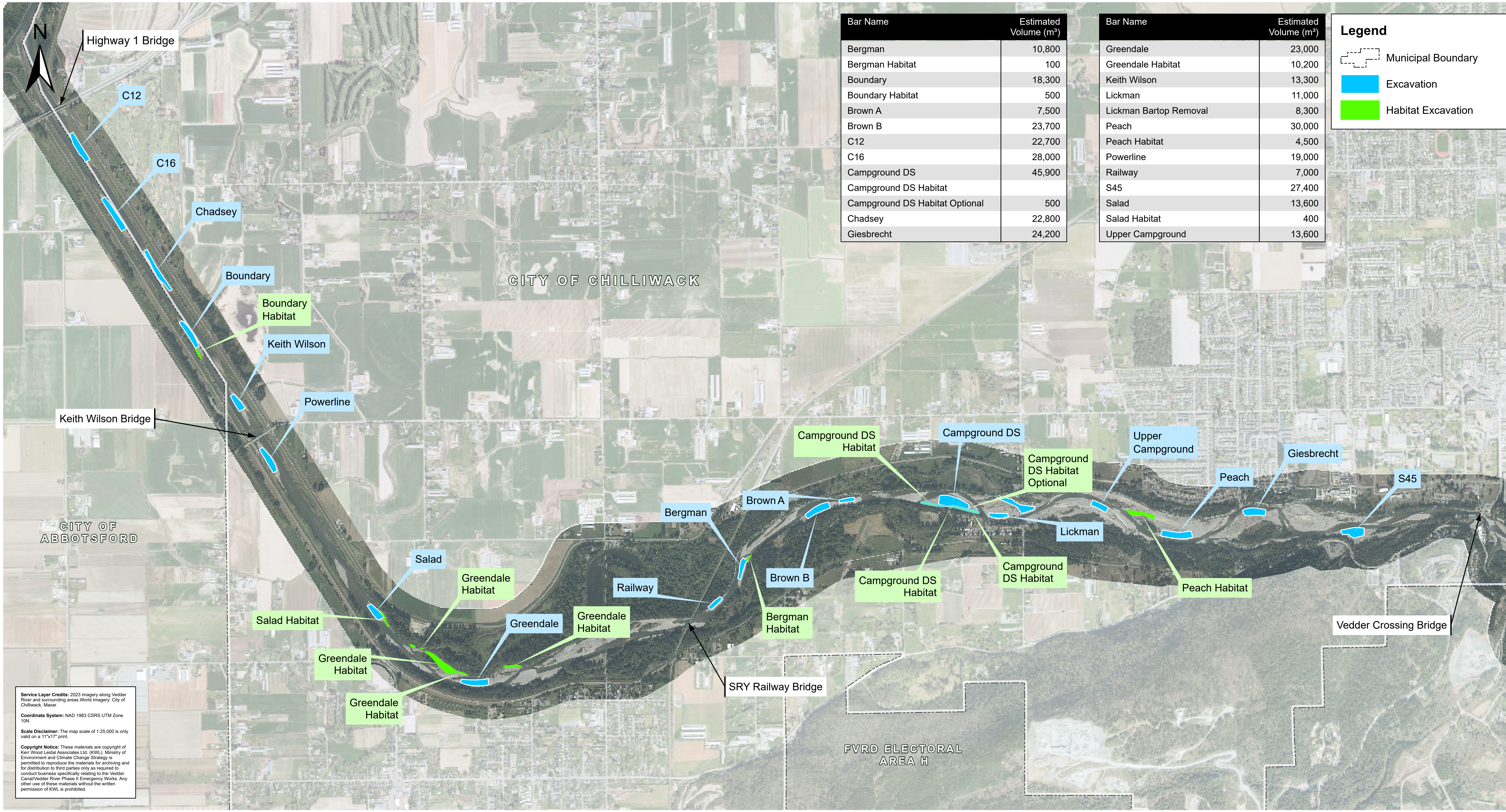

Bar Name	Estimated Volume (m^3)
Bergman	10,800
Bergman Habitat	100
Boundary	18,300
Boundary Habitat	500
Brown A	7,500
Brown B	23,700
C12	22,700
C16	28,000
Campground DS	45,900
Campground DS Habitat	
Campground DS Habitat Optional	500
Chadsey	22,800
Giesbrecht	24,200

Bar Name	Estimated Volume (m^3)
Greendale	23,000
Greendale Habitat	10,200
Keith Wilson	13,300
Lickman	11,000
Lickman Bartop Removal	8,300
Peach	30,000
Peach Habitat	4,500
Powerline	19,000
Railway	7,000
S45	27,400
Salad	13,600
Salad Habitat	400
Upper Campground	13,600

Service Layer Credits: 2023 imagery along Vedder River and surrounding areas.World Imagery: City of Chilliwack, Maxar

Coordinate System: NAD 1983 CSRS UTM Zone 10N

Scale Disclaimer: The map scale of 1:25,000 is only valid on a 11"x17" print.

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2024 Vedder Canal / Vedder River Sediment Removal Plan - Potential Sediment Removal Locations

Figure 8-1

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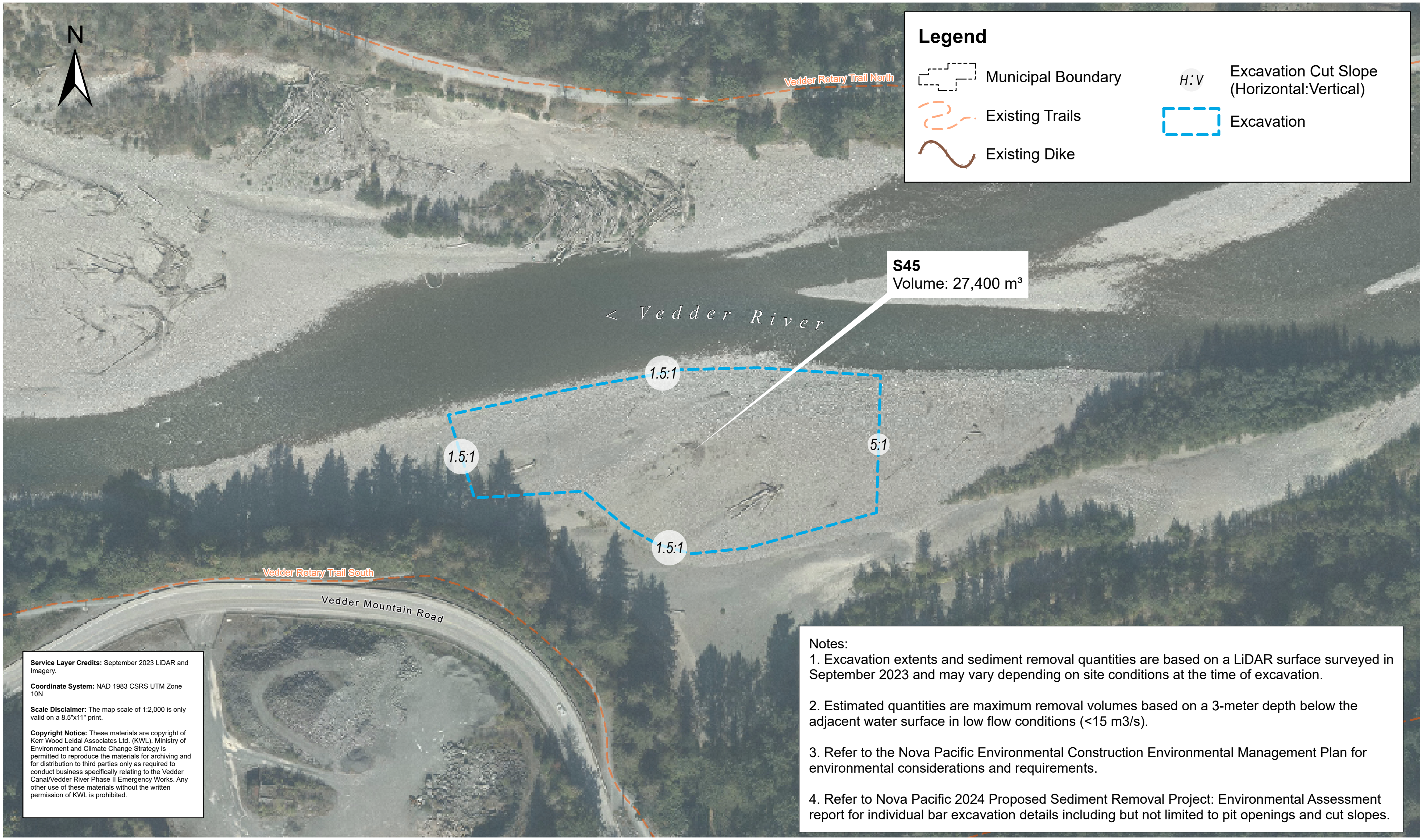

Legend

- Municipal Boundary
- Existing Trails
- Existing Dike
- H:V Excavation Cut Slope (Horizontal:Vertical)
- Excavation

Notes:
1. Excavation extents and sediment removal quantities are based on a LiDAR surface surveyed in September 2023 and may vary depending on site conditions at the time of excavation.

2. Estimated quantities are maximum removal volumes based on a 3-meter depth below the adjacent water surface in low flow conditions (<15 m3/s).

3. Refer to the Nova Pacific Environmental Construction Environmental Management Plan for environmental considerations and requirements.

4. Refer to Nova Pacific 2024 Proposed Sediment Removal Project: Environmental Assessment report for individual bar excavation details including but not limited to pit openings and cut slopes.

Service Layer Credits: September 2023 LiDAR and Imagery.

Coordinate System: NAD 1983 CSRS UTM Zone 10N

Scale Disclaimer: The map scale of 1:2,000 is only valid on a 8.5"x11" print.

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Date	February 2024
Scale	1:2,000

0 12.5 25 50 m

2024 Vedder Canal / Vedder River Sediment Removal Plan - S45 Sediment Removal Location Details

Figure 8-2A

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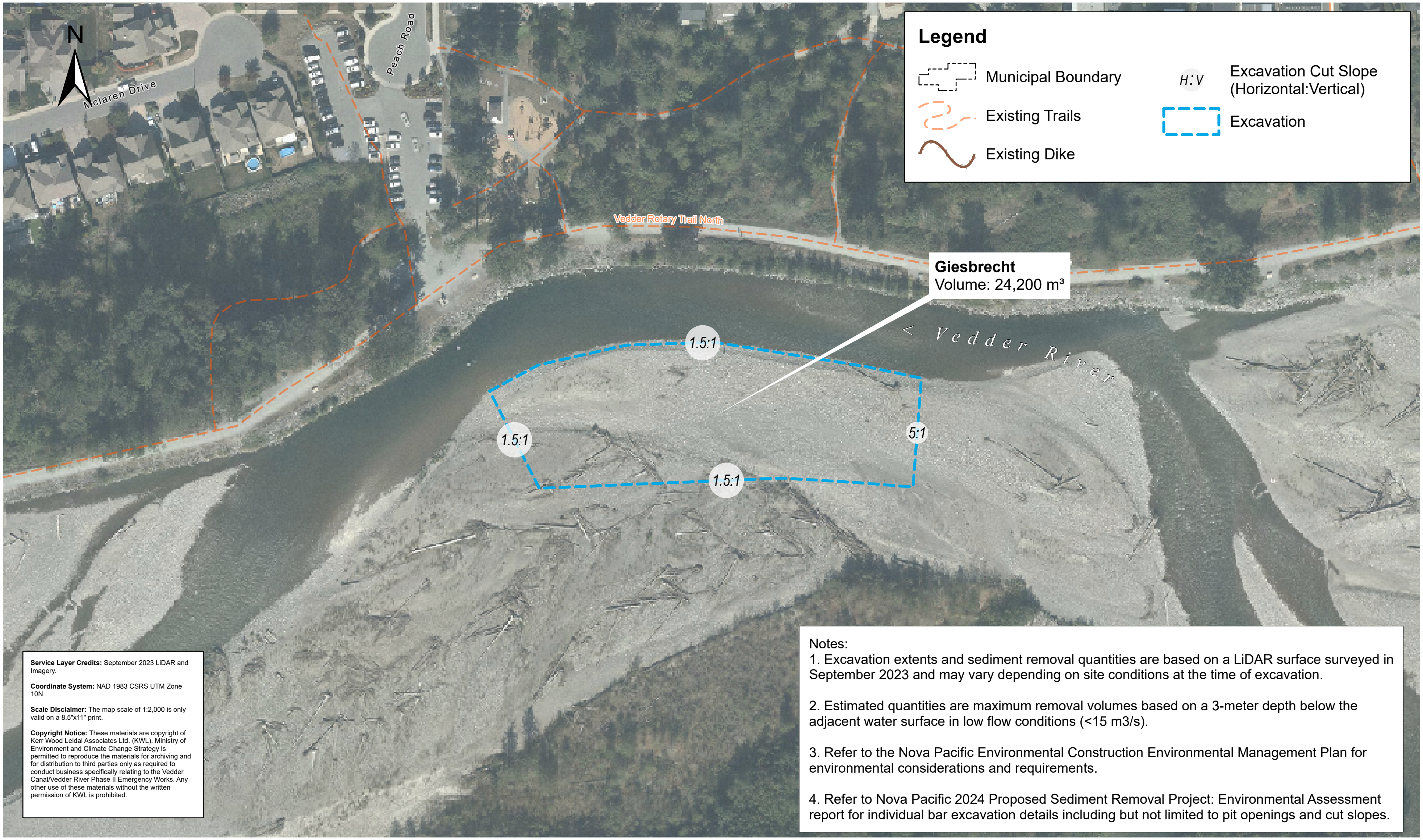

Service Layer Credits: September 2023 LiDAR and Imagery.

Coordinate System: NAD 1983 CSRS UTM Zone 10N

Scale Disclaimer: The map scale of 1:2,000 is only valid on a 8.5"x11" print.

Notes:

1. Excavation extents and sediment removal quantities are based on a LiDAR surface surveyed in September 2023 and may vary depending on site conditions at the time of excavation.

2. Estimated quantities are maximum removal volumes based on a 3-meter depth below the adjacent water surface in low flow conditions (<15 m3/s).

3. Refer to the Nova Pacific Environmental Construction Environmental Management Plan for environmental considerations and requirements.

4. Refer to Nova Pacific 2024 Proposed Sediment Removal Project: Environmental Assessment report for individual bar excavation details including but not limited to pit openings and cut slopes.

Project No.	3427.018
Date	February 2024
Scale	1:2,000

0 12.5 25 50 m

2024 Vedder Canal / Vedder River Sediment Removal Plan - Geisbrecht Sediment Removal Location Details

Figure 8-2B

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Vedder Canal/Vedder River Phase II Emergency Works

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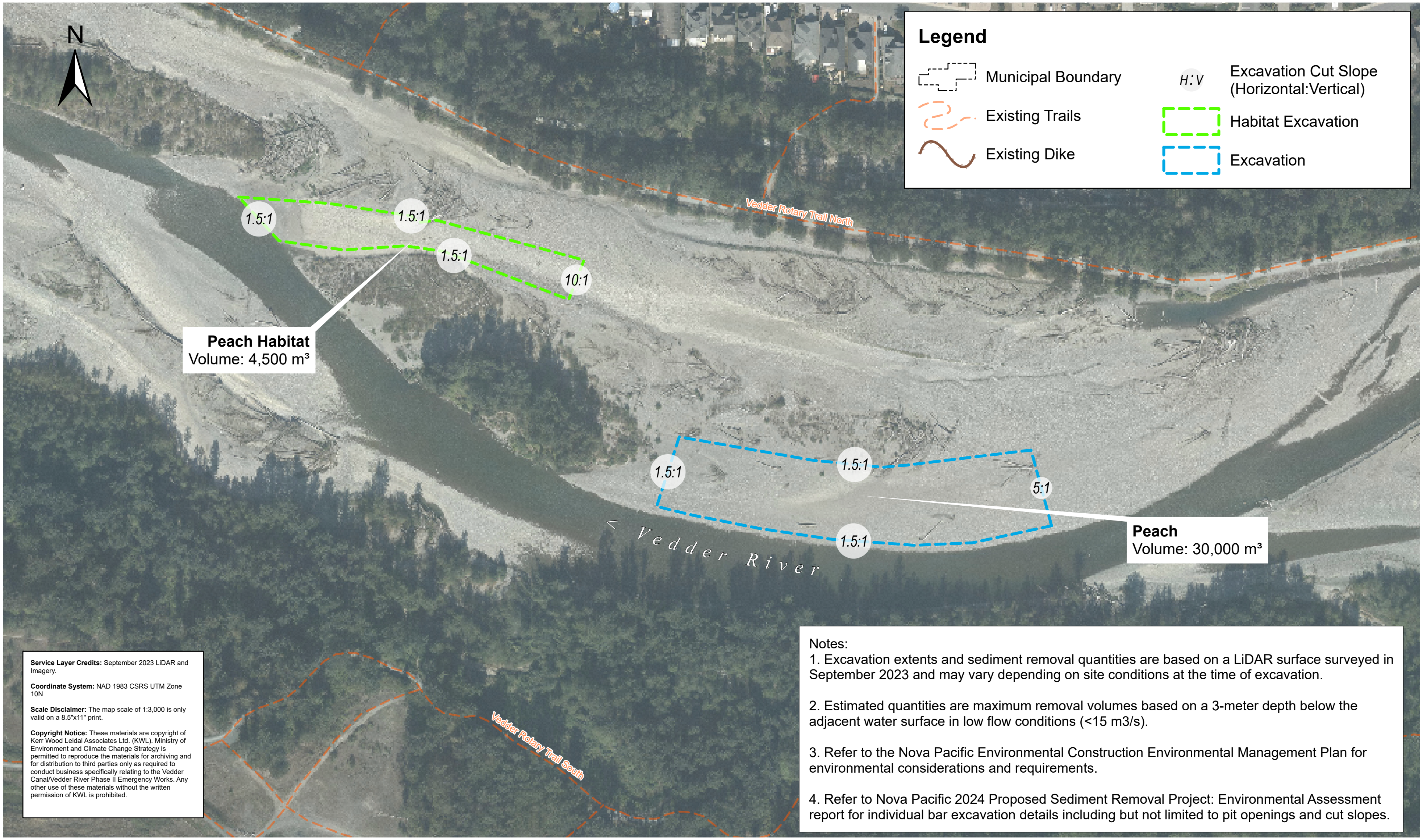

Notes:
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Coordinate System: NAD 1983 CSRS UTM Zone 10N

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Project No. 3427.018
Date February 2024
Scale 1:3,000
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2024 Vedder Canal / Vedder River Sediment Removal Plan - Peach Sediment Removal Location Details

Figure 8-2C

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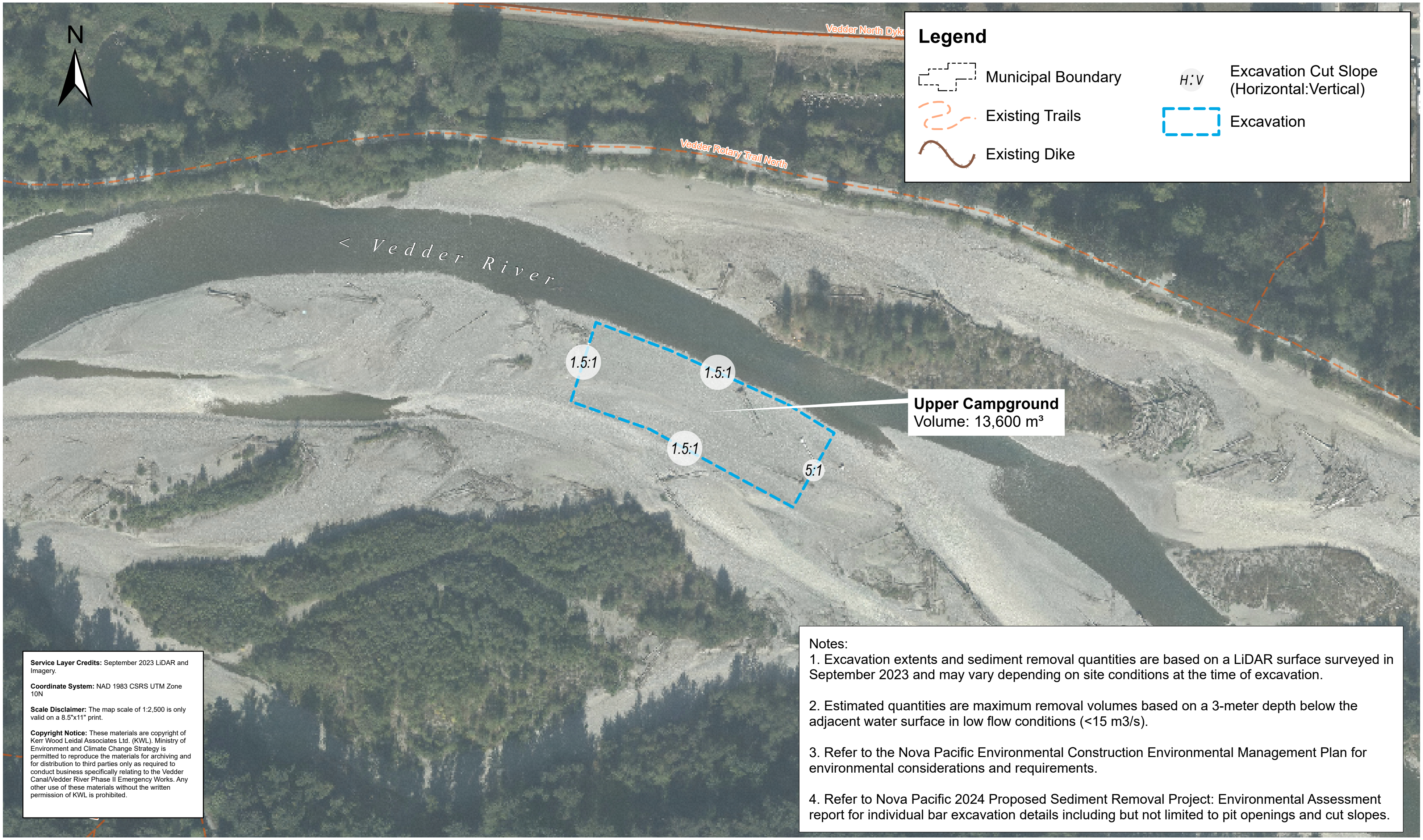

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Coordinate System: NAD 1983 CSRS UTM Zone 10N

Scale Disclaimer: The map scale of 1:2,500 is only valid on a 8.5"x11" print.

Project No.	3427.018
Date	February 2024
Scale	1:2,500

0 12.5 25 50 m

2024 Vedder Canal / Vedder River Sediment Removal Plan - Upper Campground Sediment Removal Location Details

Figure 8-2D

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Vedder Canal/Vedder River Phase II Emergency Works

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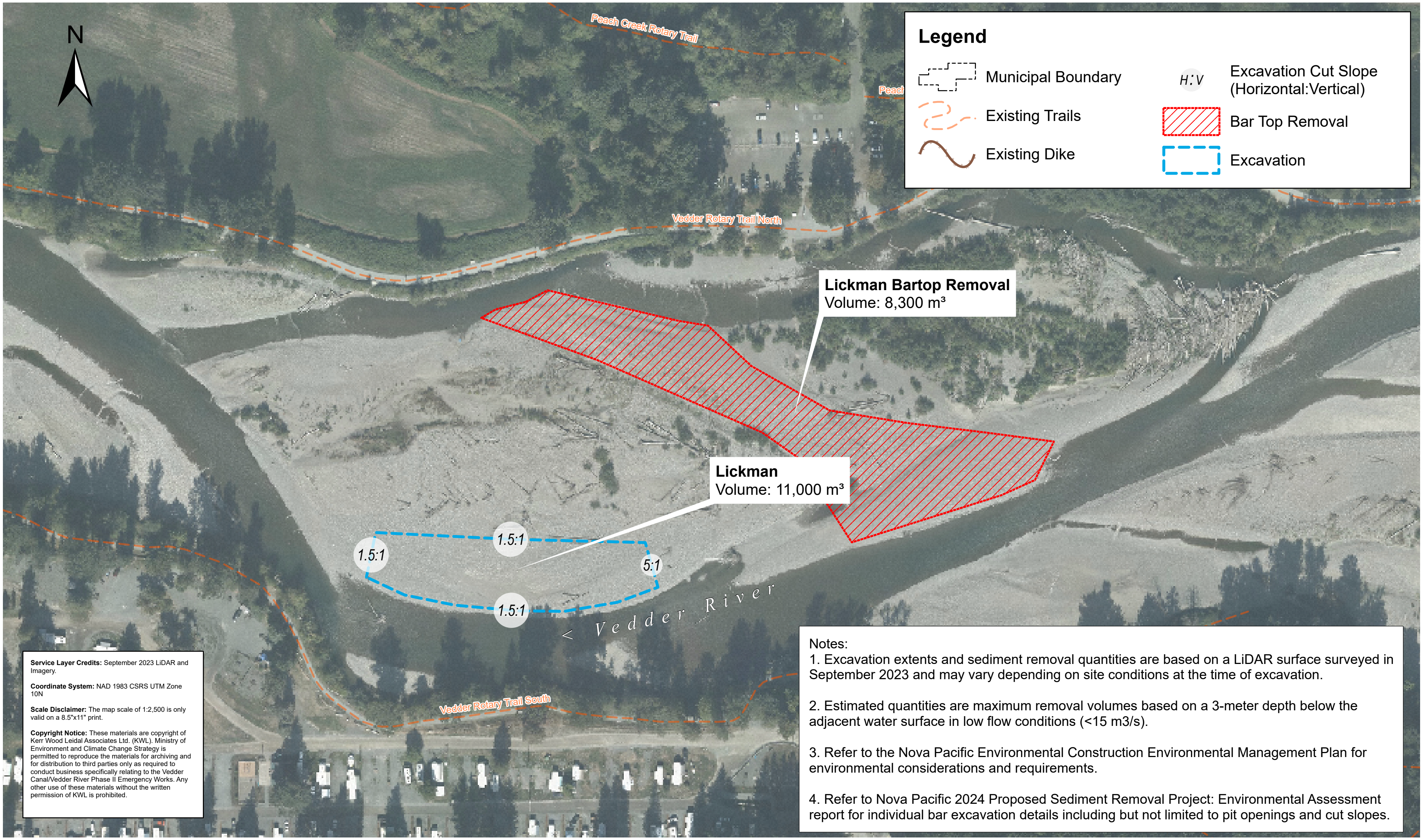

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Project No. 3427.018
Date February 2024
Scale 1:2,500
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2024 Vedder Canal / Vedder River Sediment Removal Plan - Lickman Sediment Removal Location Details

Figure 8-2E

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Vedder Canal/Vedder River Phase II Emergency Works

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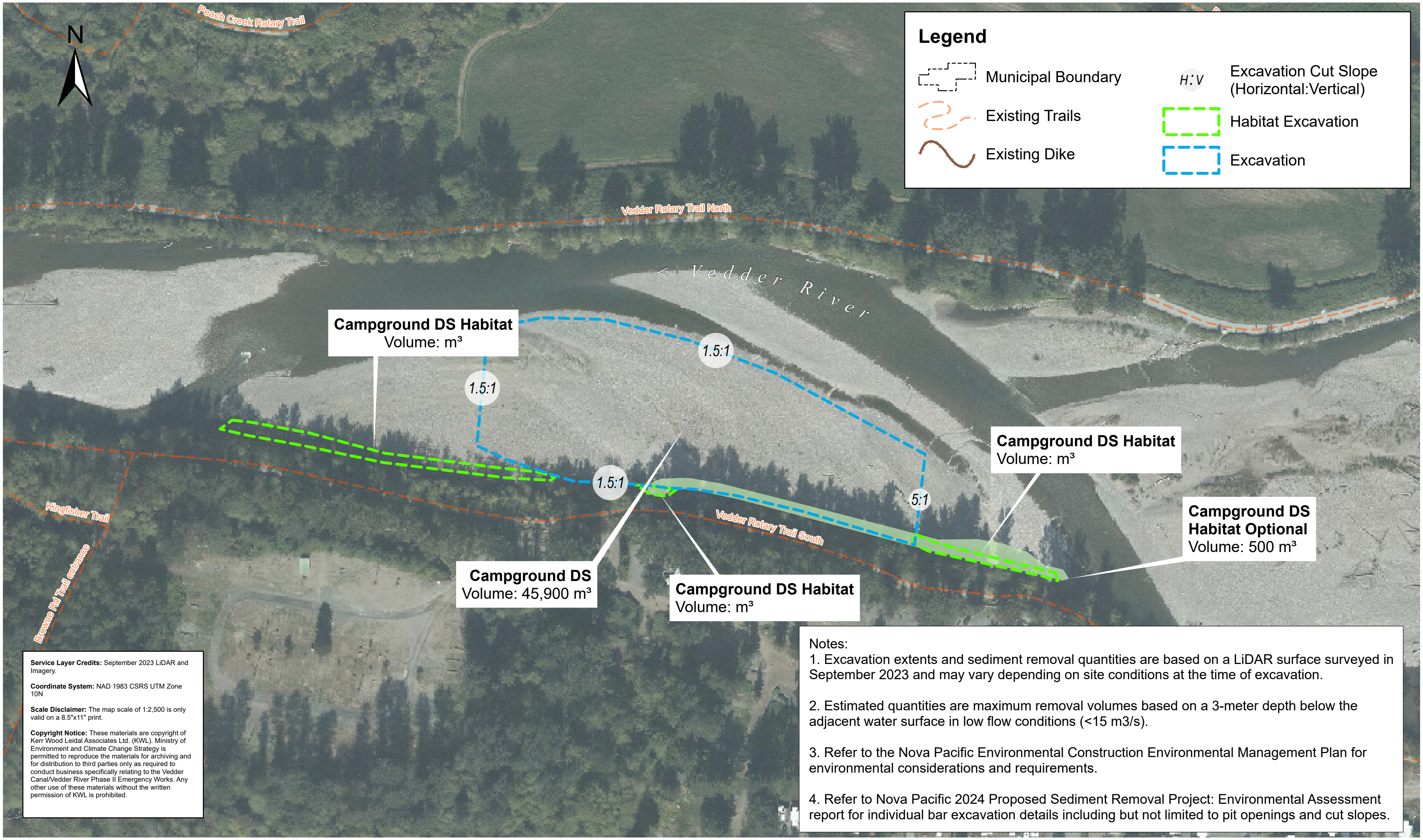

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Date February 2024
Scale 1:2,500
0 12.5 25 50 m

2024 Vedder Canal / Vedder River Sediment Removal Plan - Campground DS Sediment Removal Location Details

Figure 8-2F

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Vedder Canal/Vedder River Phase II Emergency Works

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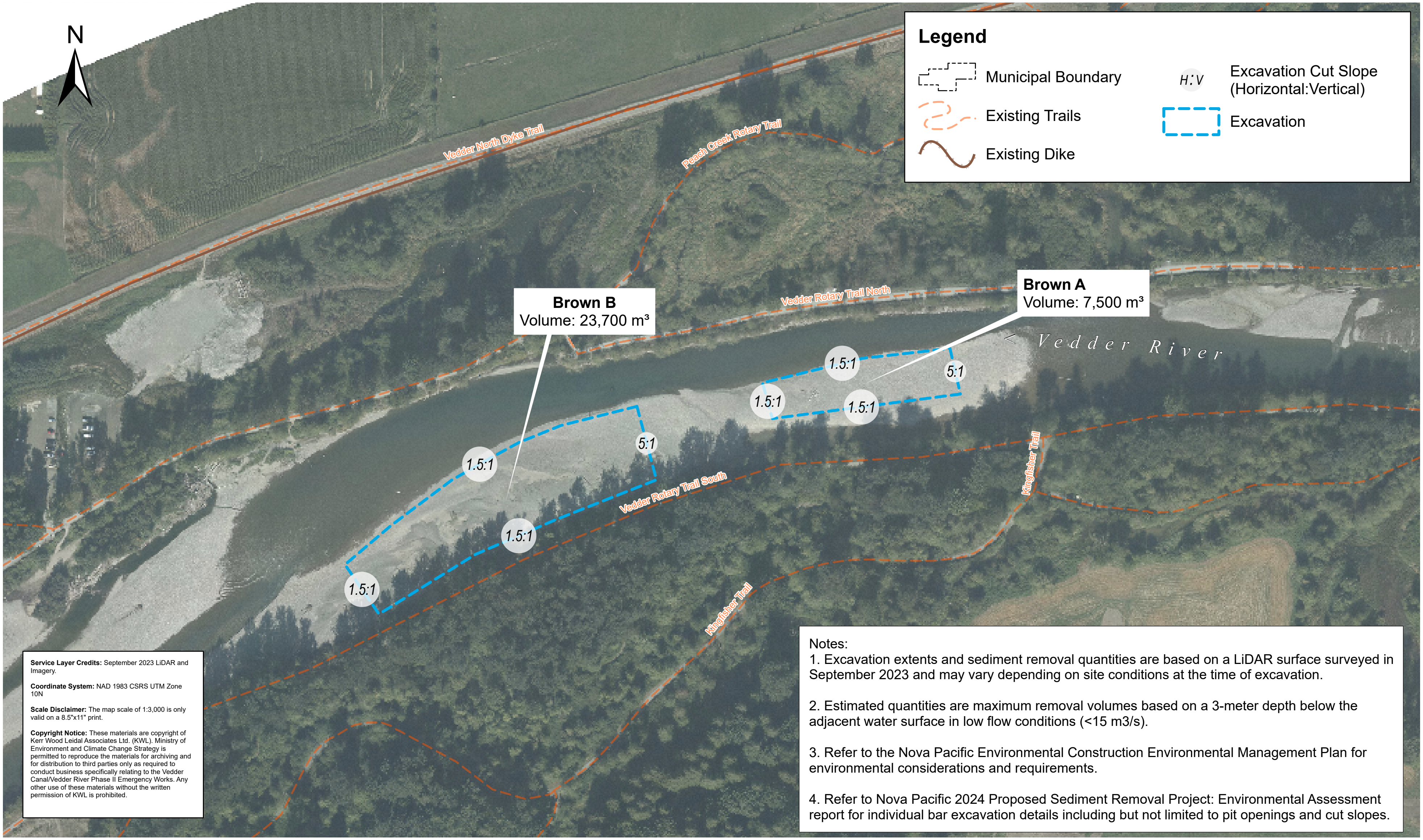

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Coordinate System: NAD 1983 CSRS UTM Zone 10N

Scale Disclaimer: The map scale of 1:3,000 is only valid on a 8.5"x11" print.

Notes:

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Project No. 3427.018

Date February 2024

Scale 1:3,000

0 12.5 25 50 m

2024 Vedder Canal / Vedder River Sediment Removal Plan - Brown A and Brown B Sediment Removal Location Details

Figure 8-2G

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Vedder Canal/Vedder River Phase II Emergency Works

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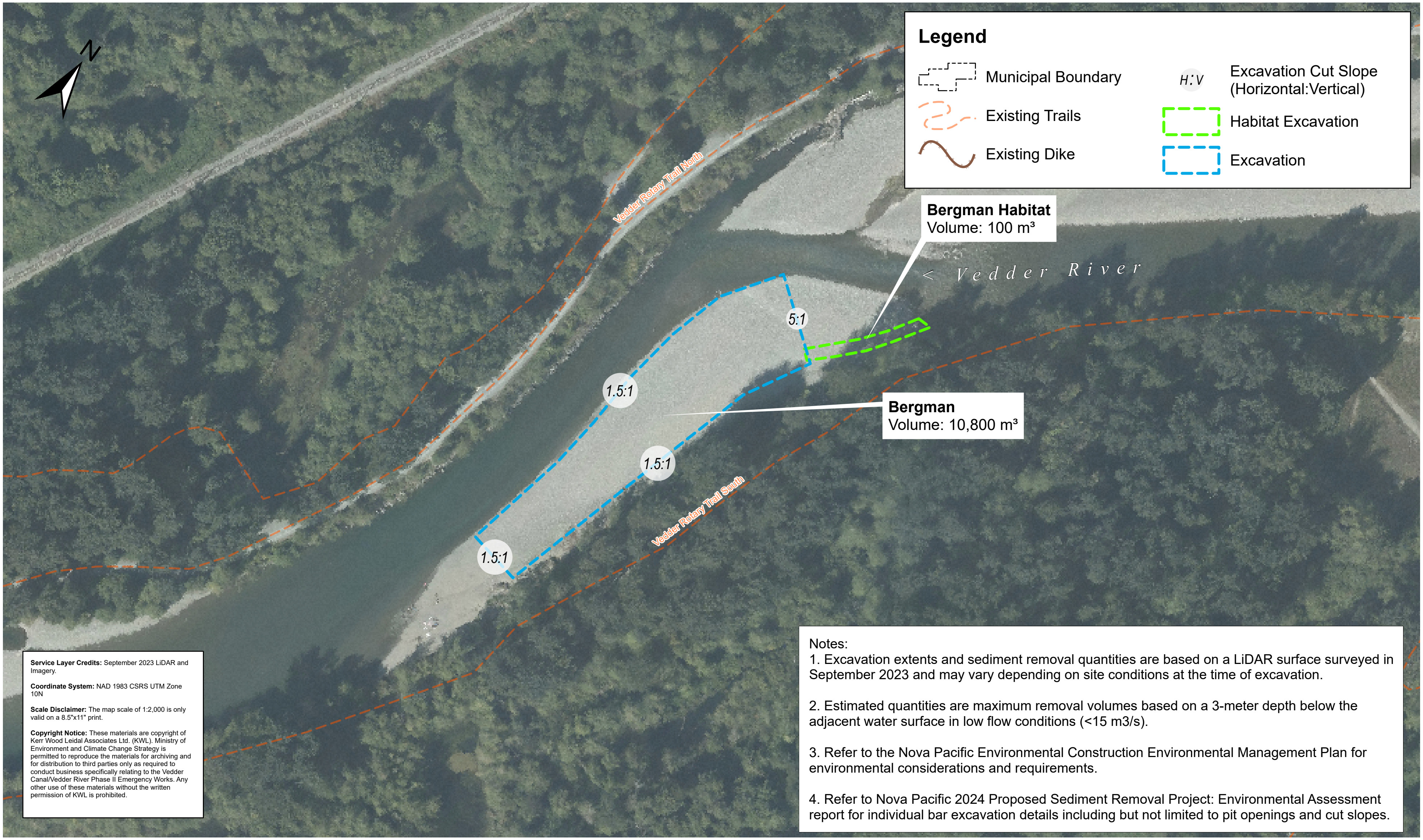

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Coordinate System: NAD 1983 CSRS UTM Zone 10N

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Project No.	3427.018
Date	February 2024
Scale	1:2,000

0 12.5 25 50 m

2024 Vedder Canal / Vedder River Sediment Removal Plan - Bergman Sediment Removal Location Details

Figure 8-2H

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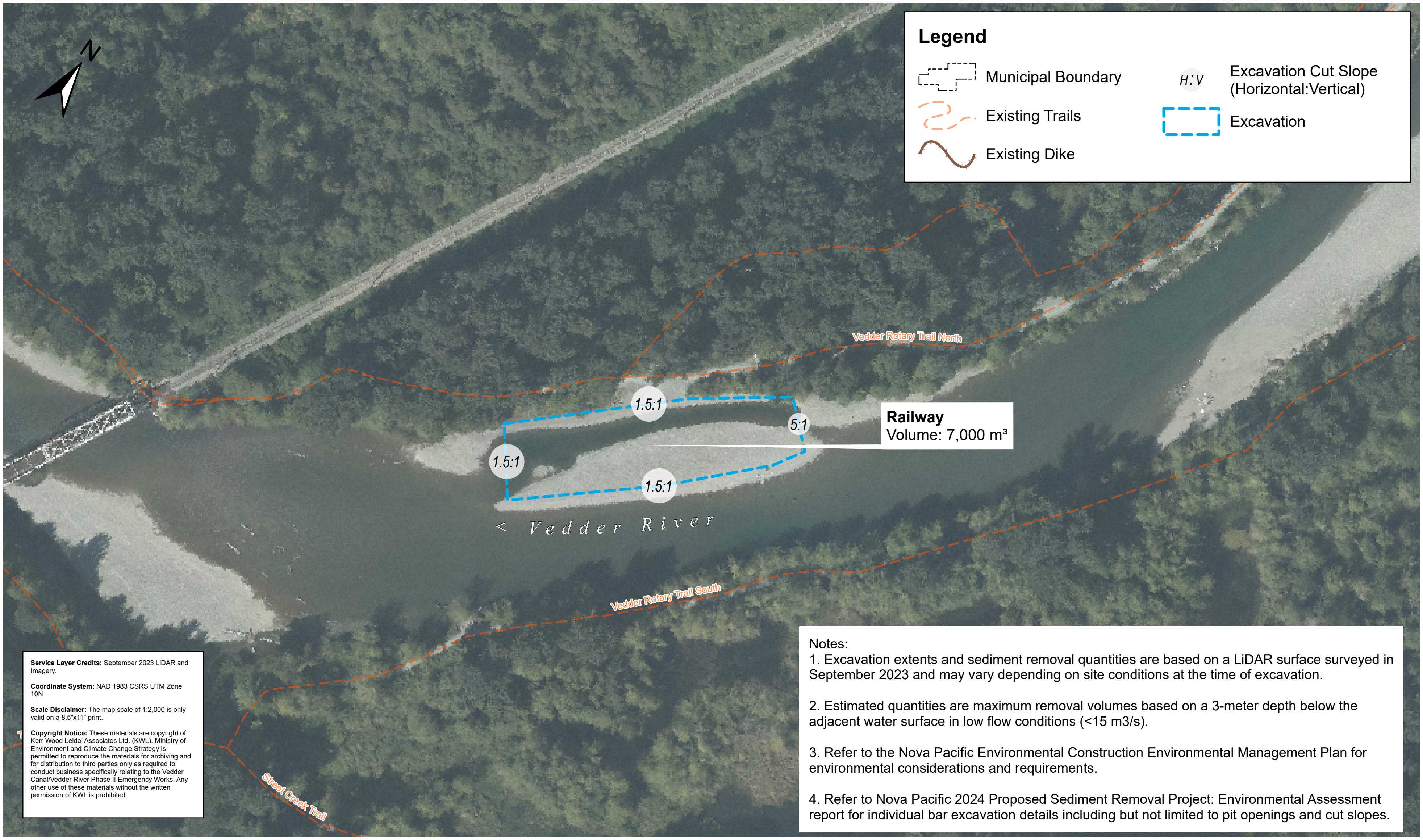

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Service Layer Credits: September 2023 LiDAR and Imagery.

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Project No. 3427.018
Date February 2024
Scale 1:2,000
0 12.5 25 50 m

2024 Vedder Canal / Vedder River Sediment Removal Plan - Railway Bar Sediment Removal Location Details

Figure 8-2I

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Vedder Canal/Vedder River Phase II Emergency Works

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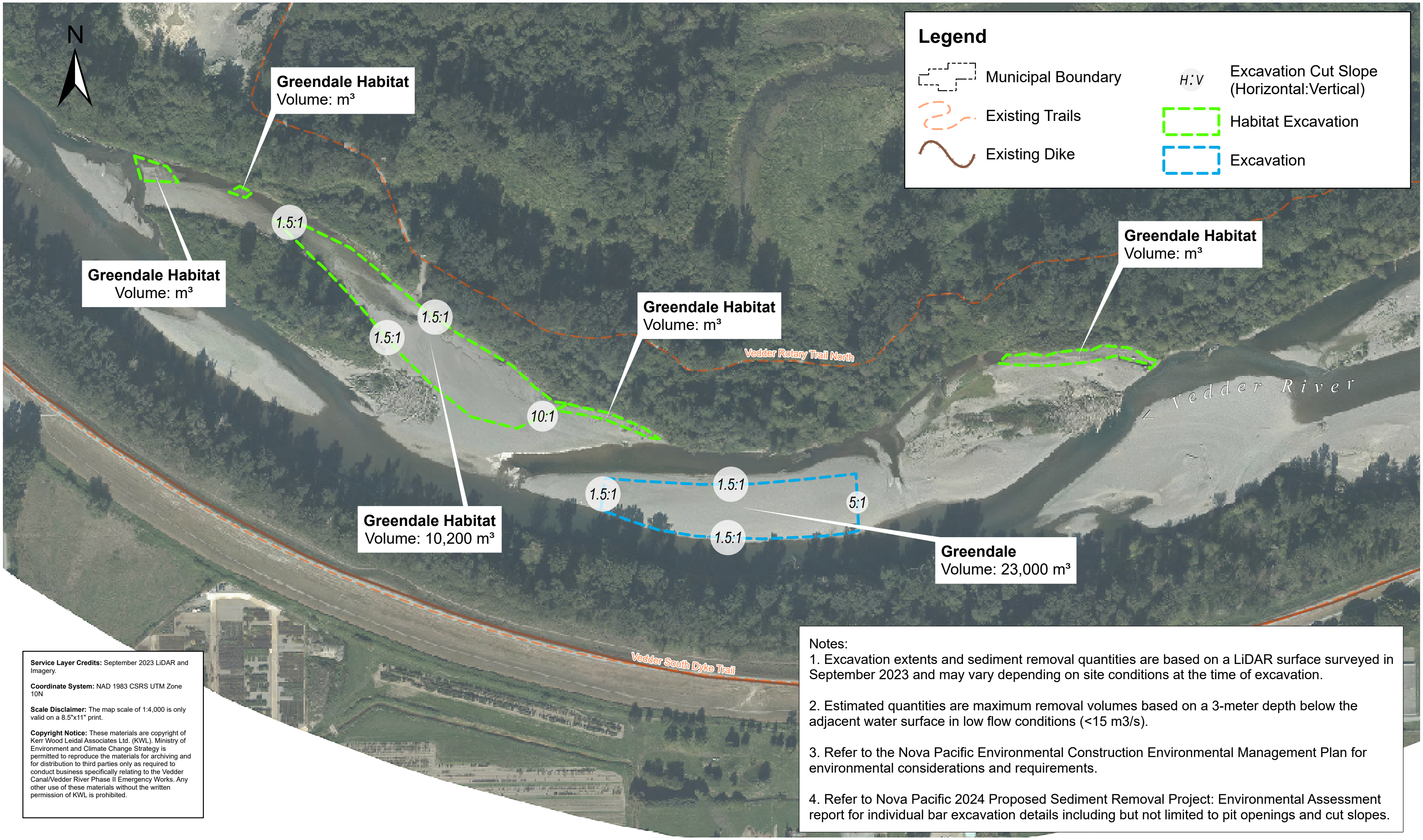

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Project No. 3427.018
Date February 2024
Scale 1:4,000
0 12.525 50 m

2024 Vedder Canal / Vedder River Sediment Removal Plan - Greendale Sediment Removal Location Details

Figure 8-2J

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Vedder Canal/Vedder River Phase II Emergency Works

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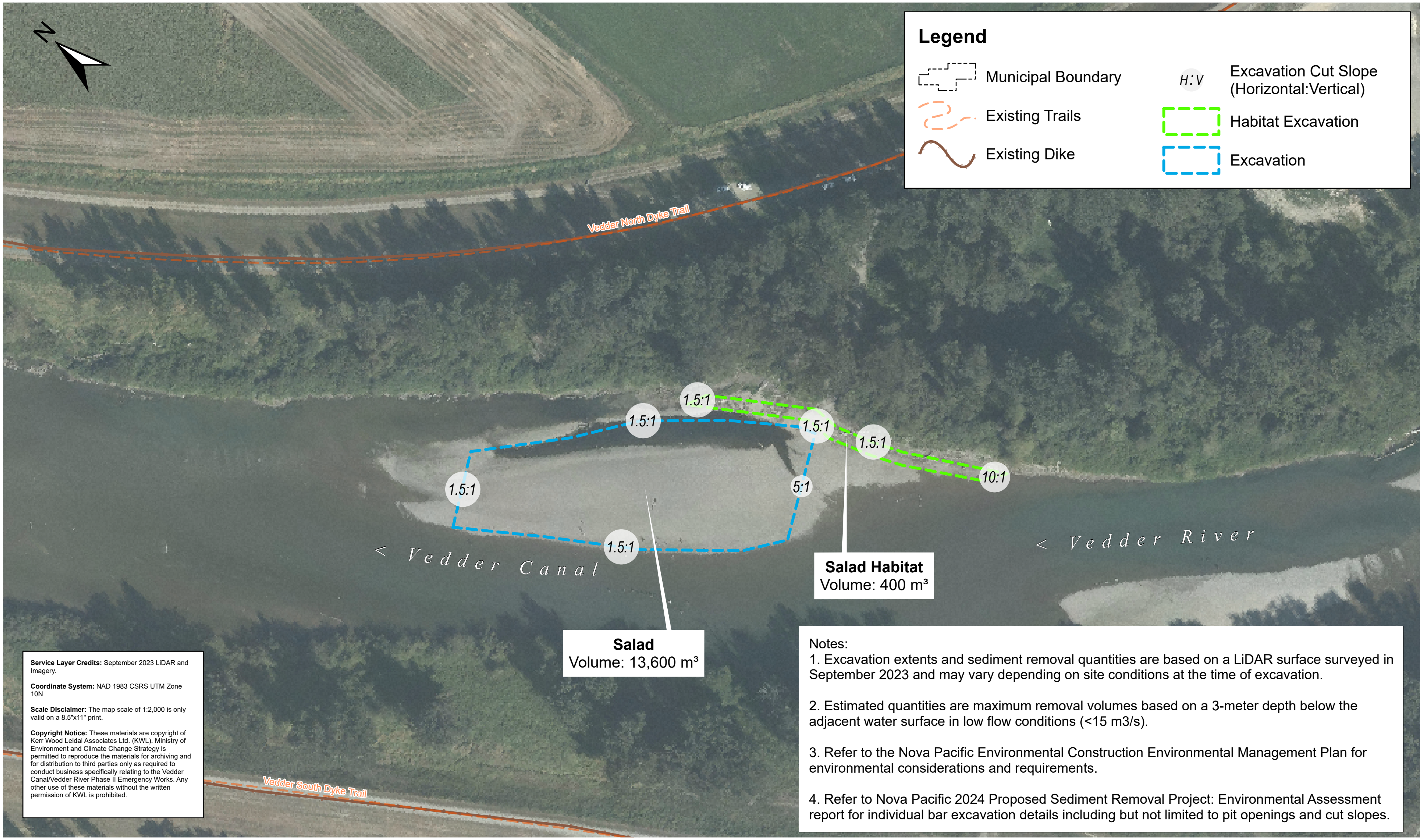

Service Layer Credits: September 2023 LiDAR and Imagery.

Coordinate System: NAD 1983 CSRS UTM Zone 10N

Scale Disclaimer: The map scale of 1:2,000 is only valid on a 8.5"x11" print.

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Project No.	3427.018
Date	February 2024
Scale	1:2,000

0 12.5 25 50 m

2024 Vedder Canal / Vedder River Sediment Removal Plan - Salad Bar Sediment Removal Location Details

Figure 8-2K

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Vedder Canal/Vedder River Phase II Emergency Works

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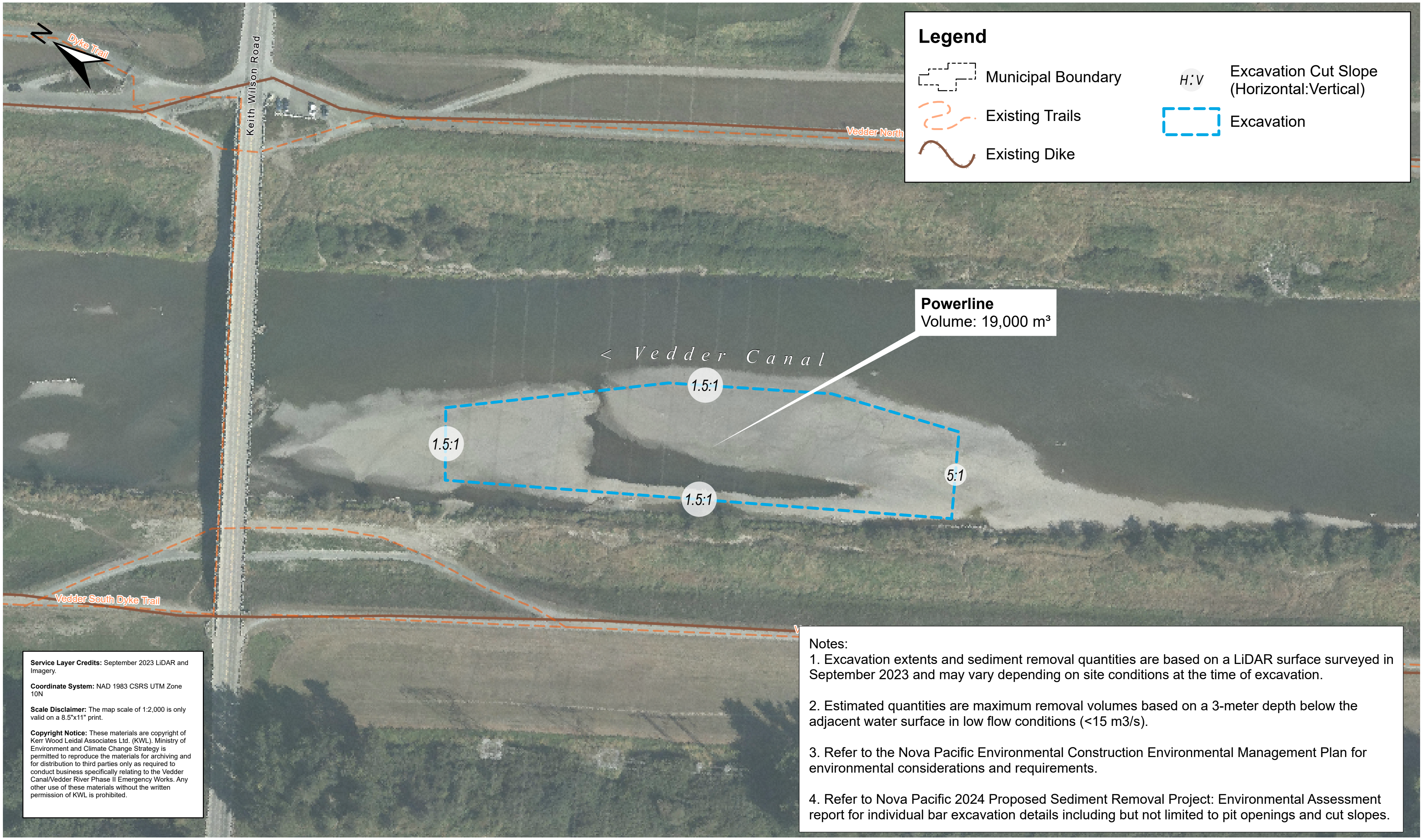

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Coordinate System: NAD 1983 CSRS UTM Zone 10N

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Project No.	3427.018
Date	February 2024
Scale	1:2,000

0 12.5 25 50 m

2024 Vedder Canal / Vedder River Sediment Removal Plan - Powerline Sediment Removal Location Details

Figure 8-2L

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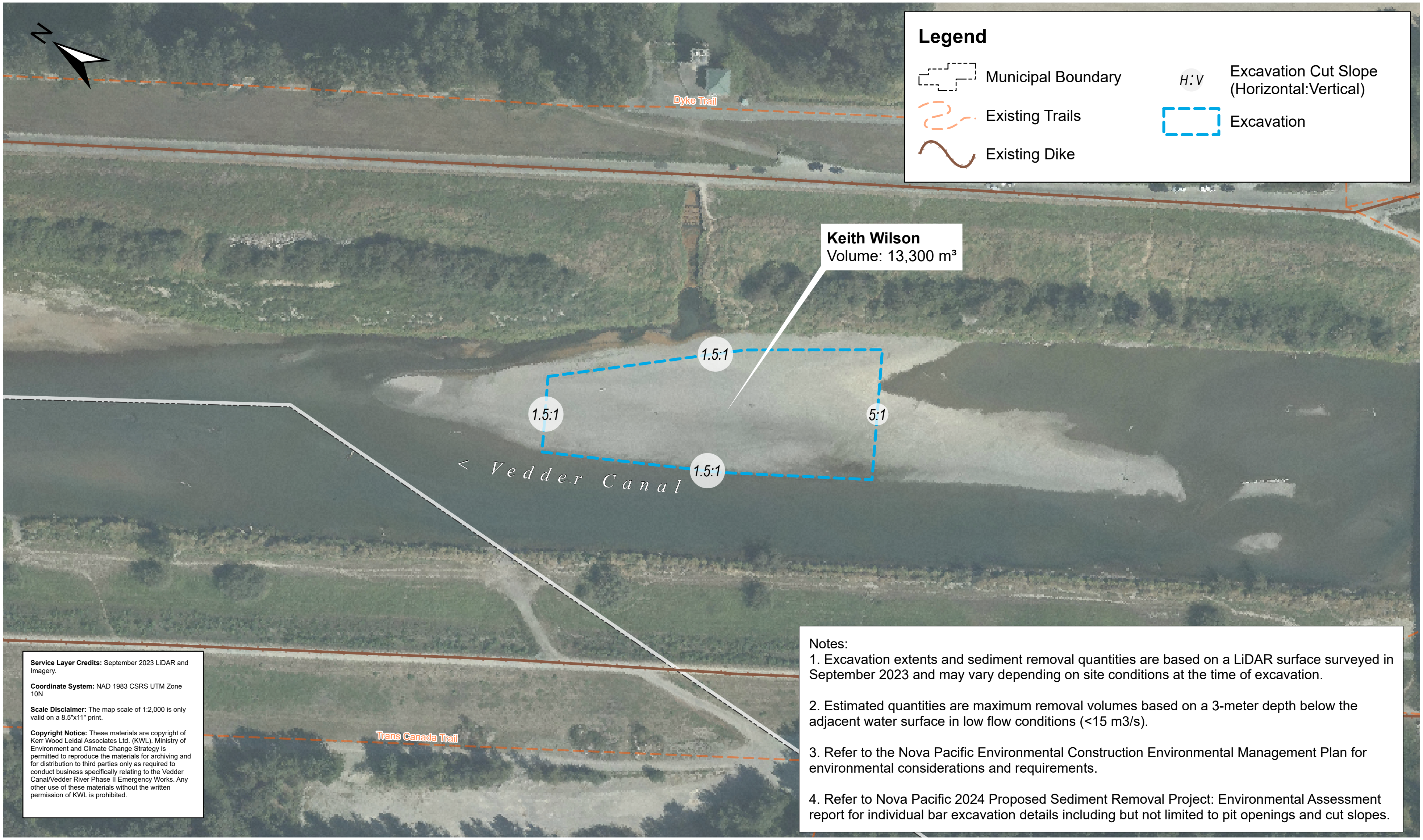

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Project No. 3427.018

Date February 2024

Scale 1:2,000

0 12.5 25 50 m

2024 Vedder Canal / Vedder River Sediment Removal Plan - Keith Wilson Sediment Removal Location Details

Figure 8-2M

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Vedder Canal/Vedder River Phase II Emergency Works

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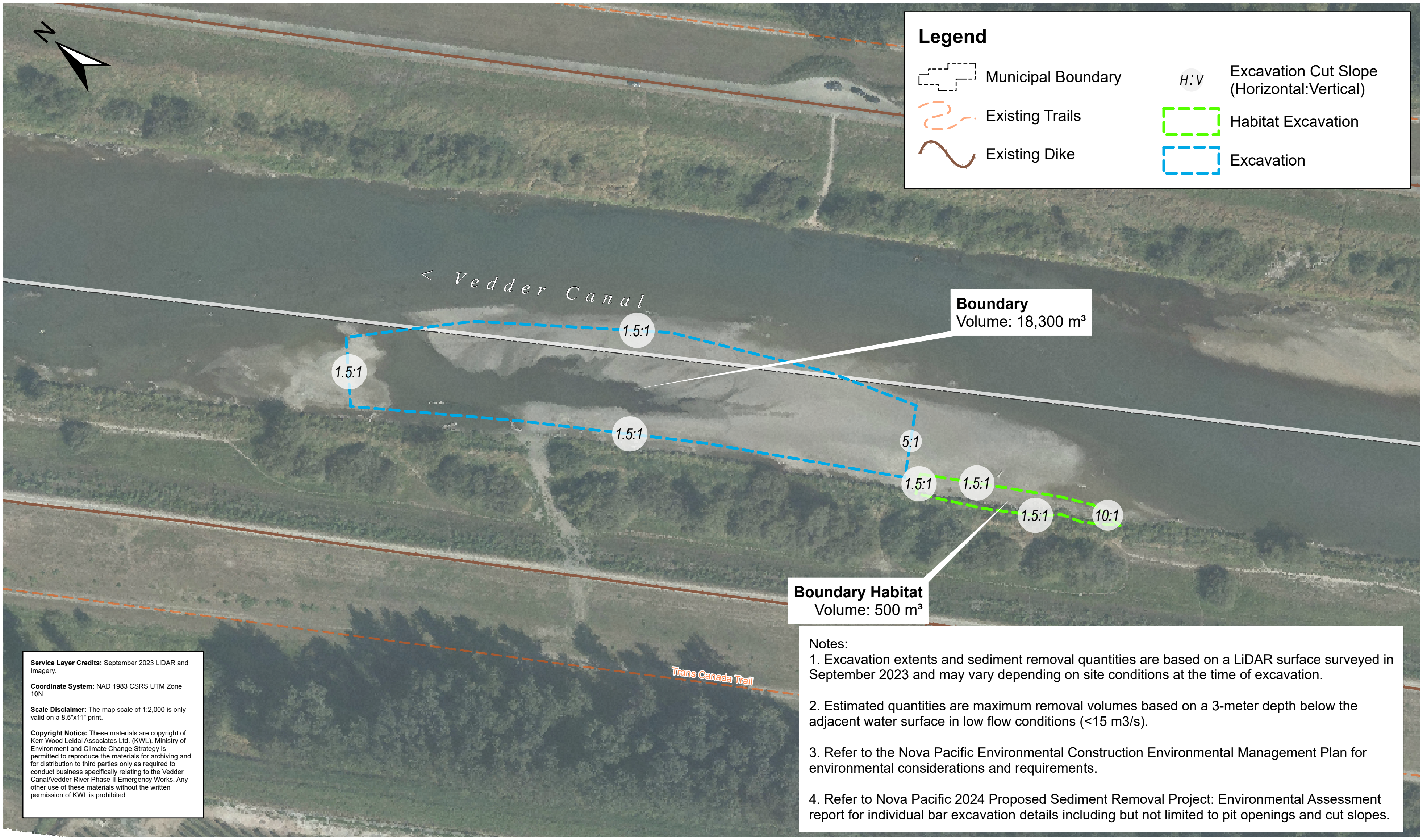

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Date February 2024
Scale 1:2,000
0 12.5 25 50 m

2024 Vedder Canal / Vedder River Sediment Removal Plan - Boundary Bar Sediment Removal Location Details

Figure 8-2N

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Vedder Canal/Vedder River Phase II Emergency Works

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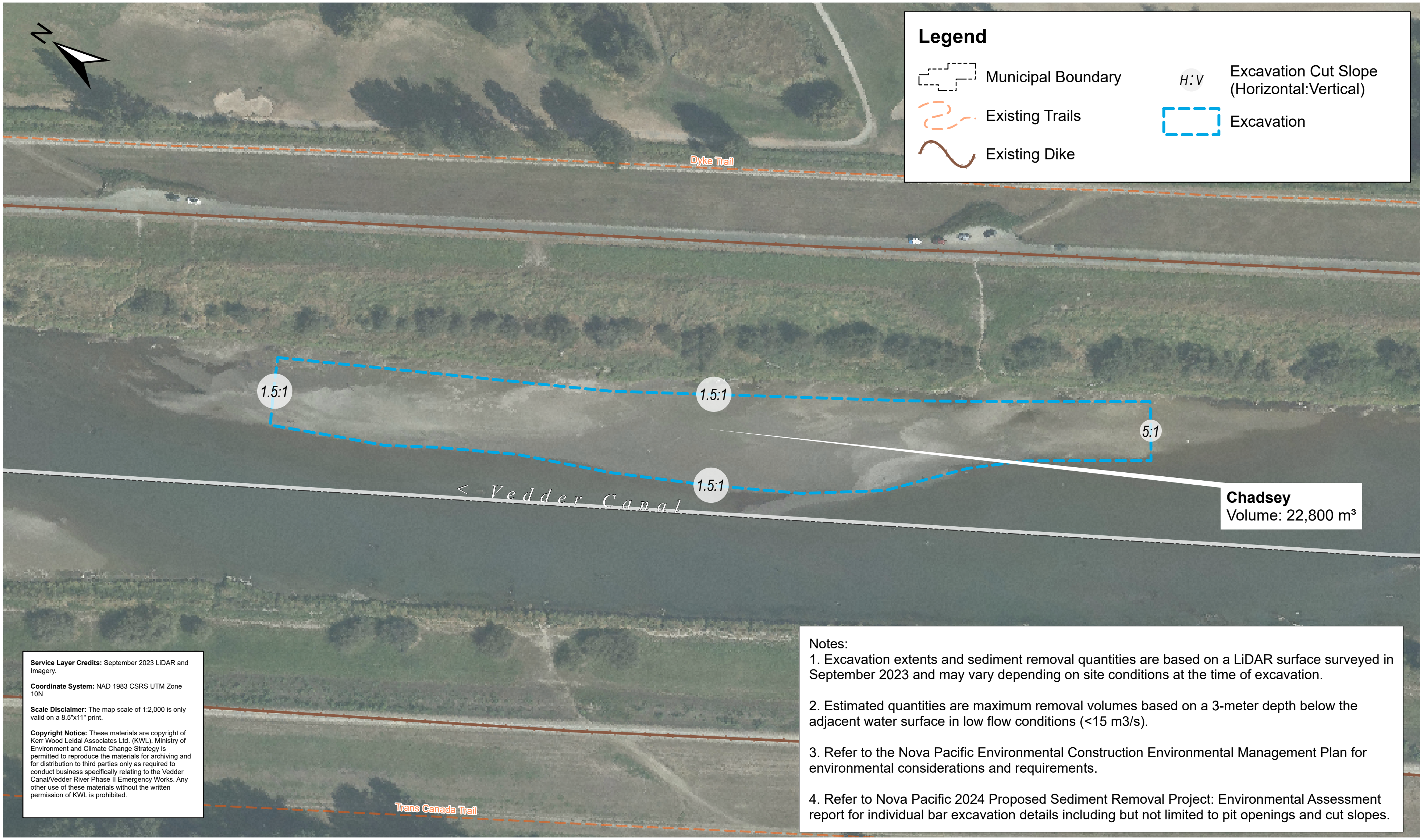

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Project No. 3427.018
Date February 2024
Scale 1:2,000
0 12.5 25 50 m

2024 Vedder Canal / Vedder River Sediment Removal Plan - Chadsey Sediment Removal Location Details

Figure 8-2O

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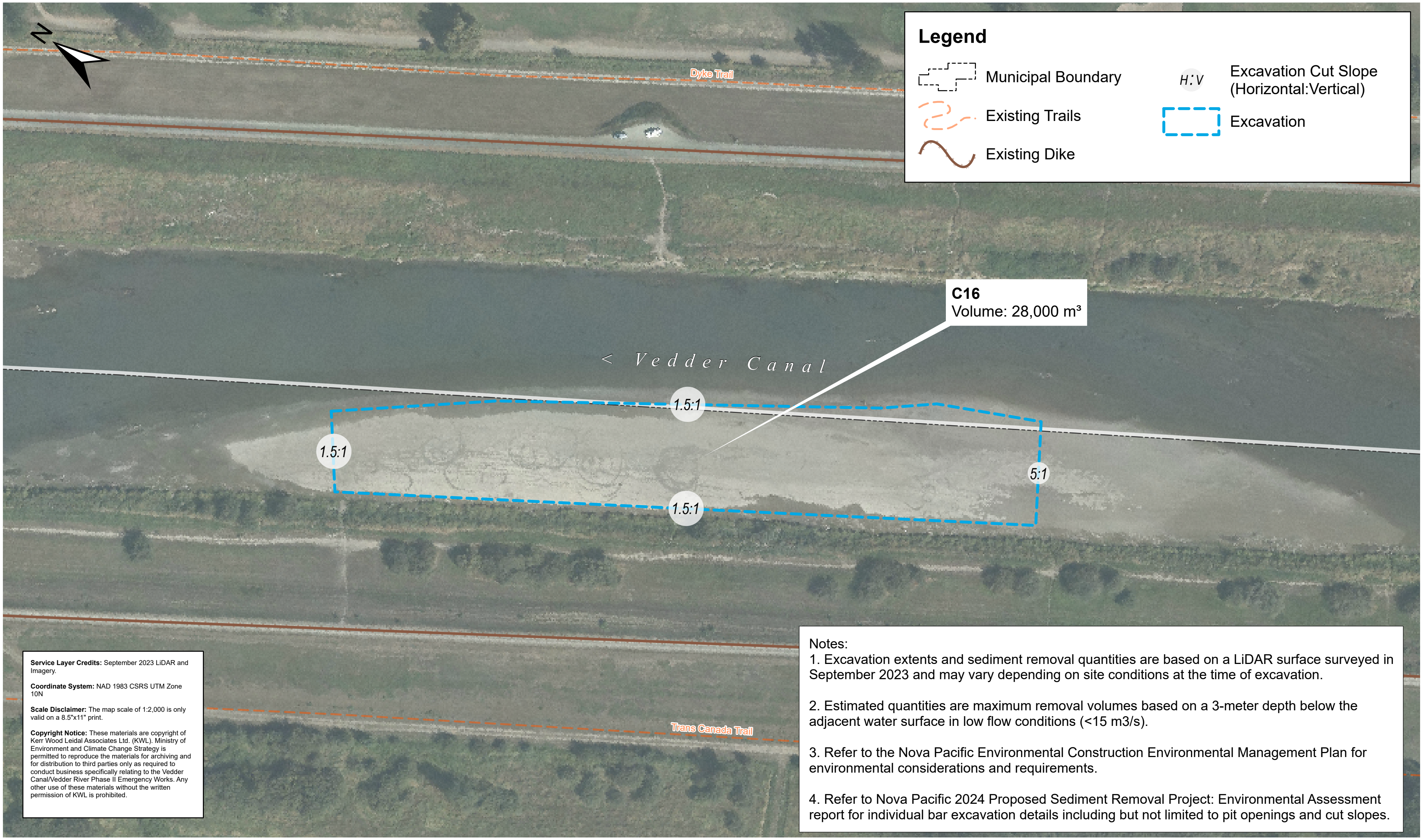

Service Layer Credits: September 2023 LiDAR and Imagery.

Coordinate System: NAD 1983 CSRS UTM Zone 10N

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Project No.	3427.018
Date	February 2024
Scale	1:2,000

0 12.5 25 50 m

2024 Vedder Canal / Vedder River Sediment Removal Plan - C16 Sediment Removal Location Details

Figure 8-2P

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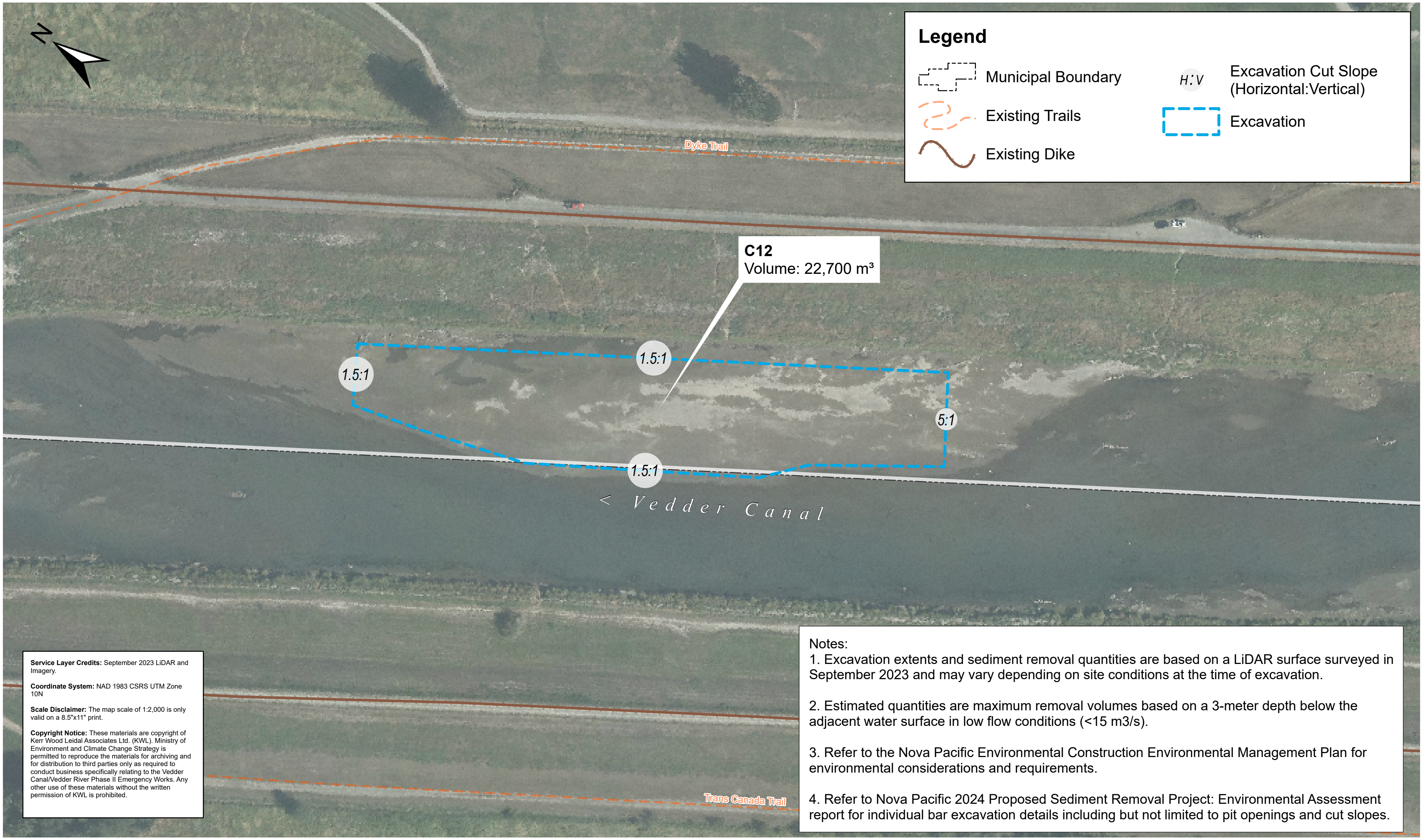

Service Layer Credits: September 2023 LiDAR and Imagery.

Coordinate System: NAD 1983 CSRS UTM Zone 10N

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Project No.	3427.018
Date	February 2024
Scale	1:2,000

0 12.5 25 50 m

2024 Vedder Canal / Vedder River Sediment Removal Plan - C12 Sediment Removal Location Details

Figure 8-2Q

8.3 Sediment Removal Effectiveness

Introduced in the 2015 Vedder River Management Area Plan Update, the effectiveness coefficient is used to assess how effective individual sediment removal sites or combinations of sediment removal options are at reducing the flood profile. This effectiveness coefficient factors in the volume of sediment removal and the length of improved (lowered) water level profile (the influenced reach length). This analysis is intended to provide a quantitative comparison of sediment removal sites.

The effectiveness coefficient (C) is computed using the following equation:

$$C = \frac{Mean\ Water\ Level\ Reduction\ per\ XS\ (cm) \times Influencing\ Reach\ Length\ (km)}{10{,}000 \times Excavation\ Volume\ (m^3)}$$

A summary of effectiveness coefficients for individual sediment removal sites are presented in Table 8-3. S45 Bar has the highest effectiveness coefficient due to the large reduction in WSE relative to other sites. Bergman Bar and Brown Bars also have high effectiveness coefficients. However, Bergman Bar's high effectiveness coefficient is due to a smaller excavation volume resulting in a lesser WSE reduction that impacted a greater influenced reach. Whereas the Brown Bar excavations show a much greater WSE reduction but required a much larger excavation and did not influence as long of a reach. Based on this analysis, the Keith Wilson Bar is not an effective sediment removal site. Due to low effectiveness and other environmental and constructability considerations, it was removed from consideration for sediment removal options.

Table 8-3: Summary of Effectiveness Coefficients for Individual Sediment Removal Sites – Ordered by Effectiveness.

Site	Total Excavation Volume	Mean WSE Reduction	Reach Length	Effectiveness
	(m^3)	(cm)	(km)	(cm*km/10^4 m^3)
S45 Bar	27,400	21.5	0.8	6.7
Bergman Bar (+Habitat)	10,900	3.1	2.1	6.1
Brown (A+B) Bar	31,200	11.8	1.4	5.4
Giesbrecht Bar	24,200	12.0	0.6	3.2
C12 Bar	22,700	1.5	4.6	3.0
Peach Bar (+Habitat)	34,500	9.0	1.1	3.0
Chadsey Bar	22,800	1.5	4.4	2.9
C16 Bar	28,000	1.5	4.4	2.4
Powerline Bar	19,000	1.1	3.7	2.2
Boundary Bar (+Habitat)	18,800	1.0	4.1	2.1
Campground DS Bar (+Habitat)	46,400	13.5	0.7	2.1
Greendale Bar (+Habitat)	33,200	3.4	1.8	1.8
Railway Bar	7,000	1.4	0.9	1.7
Campground US Bar	13,600	4.0	0.5	1.6
Lickman Bar (+Bar Top)	19,300	4.0	0.6	1.3
Salad Bar (+Habitat)	14,000	0.4	2.6	0.7
Keith Wilson Bar	13,300	0.0	2.5	0.0

8.4 Sediment Removal Options

To develop sediment removal options, the project team reviews screened sediment removal sites and assembled combinations of sites using the design criteria outlined below:

- Habitat Impacts
- Environmental Design
- Hydraulic Effectiveness and Flood Risk Mitigation
- Geomorphological Review

Three (3) sediment removal options were assembled based on inputs from the environmental screening, design, and hydraulic assessment stages of work. Option A is the 'Do Nothing' option and is included to represent the baseline conditions.

Options B, C, and D use different combinations of sediment removal sites to achieve different excavation volume targets and outcomes. A summary of the sediment removal sites included in each option with total excavation volumes is presented in Table 8-4. Sediment removal sites included in Option B, Option C, and Option D are represented in Figure 8-3, Figure 8-4, and Figure 8-5, respectively.

Table 8-4: Summary of Sediment Removal Sites by Option – Ordered from Upstream to Downstream.

Sediment Removal Sites	Excavation Volume (m^3)	Option A	Option B	Option C	Option D
S45 Bar	27,400			X	X
Giesbrecht Bar	24,200		X	X	X
Peach Bar (+Habitat)	34,500		X	X	X
Campground US Bar	13,600			X	
Lickman Bar (+Bar Top)	19,300		X		X
Campground DS Bar (+Habitat)	46,400			X	
Brown (A+B) Bar	31,200		X	X	X
Bergman Bar (+Habitat)	10,800			X	X
Railway Bar	7,000		X	X	X
Greendale Bar (+Habitat)	33,200		X	X	X
Salad Bar (+Habitat)	14,000		X	X	X
Powerline Bar	19,000			X	X
Keith Wilson Bar	13,300				
Boundary Bar (+Habitat)	18,800		X		
Chadsey Bar	22,800		X	X	X
C16 Bar	28,000				
C12 Bar	22,700				
Total Excavation Volume (m^3)	**386,300**	**0**	**205,000**	**284,200**	**243,500**

Notes:
- 'X' indicates a site included in the Sediment Removal Option.
- Option D total excavation volume does not include the optional Campground DS Habitat Enhancement Excavation

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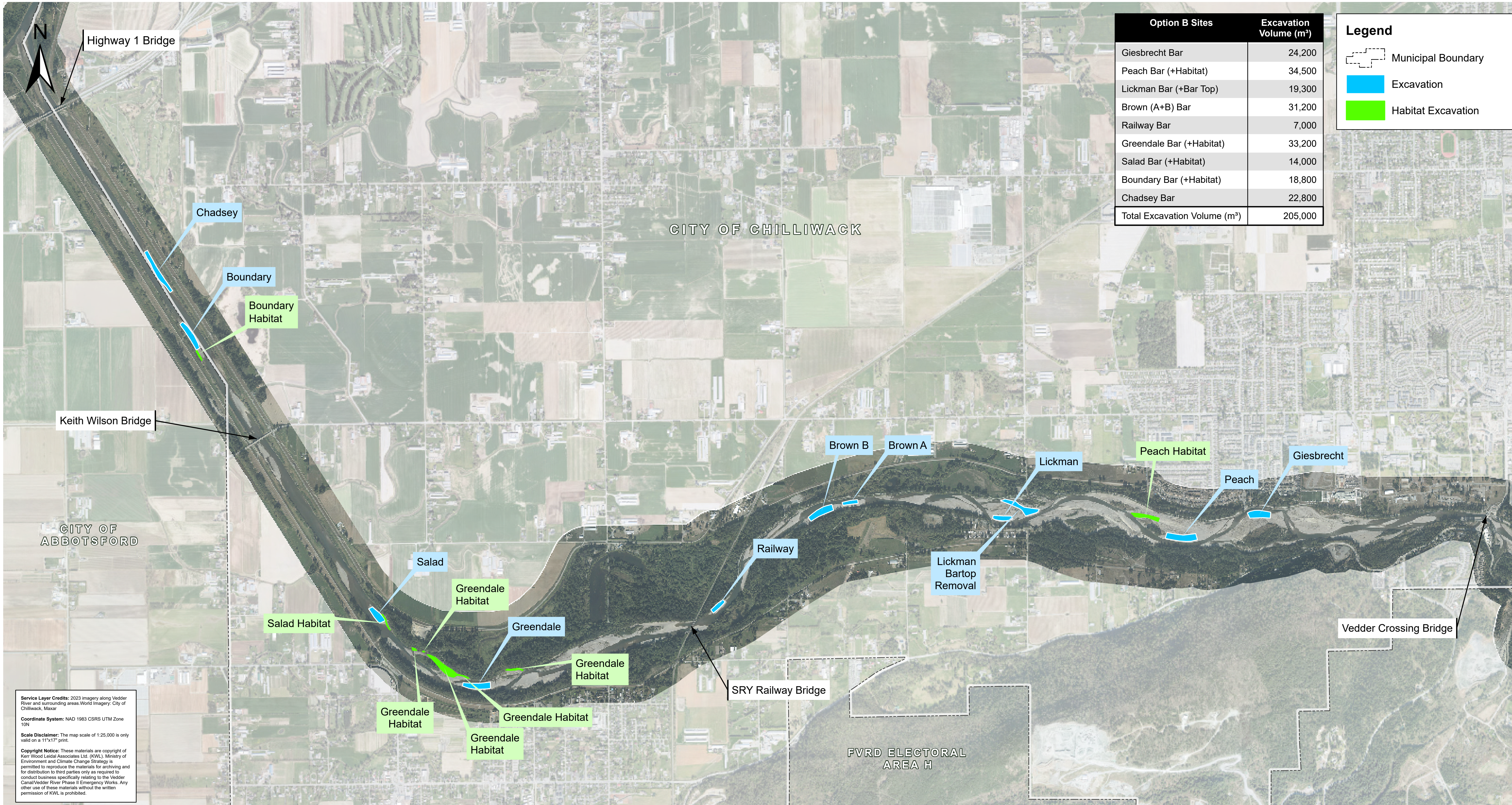

Option B Sites	Excavation Volume (m³)
Giesbrecht Bar	24,200
Peach Bar (+Habitat)	34,500
Lickman Bar (+Bar Top)	19,300
Brown (A+B) Bar	31,200
Railway Bar	7,000
Greendale Bar (+Habitat)	33,200
Salad Bar (+Habitat)	14,000
Boundary Bar (+Habitat)	18,800
Chadsey Bar	22,800
Total Excavation Volume (m³)	205,000

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2024 Vedder Canal / Vedder River Sediment Removal Plan - Option B

Figure 8-3

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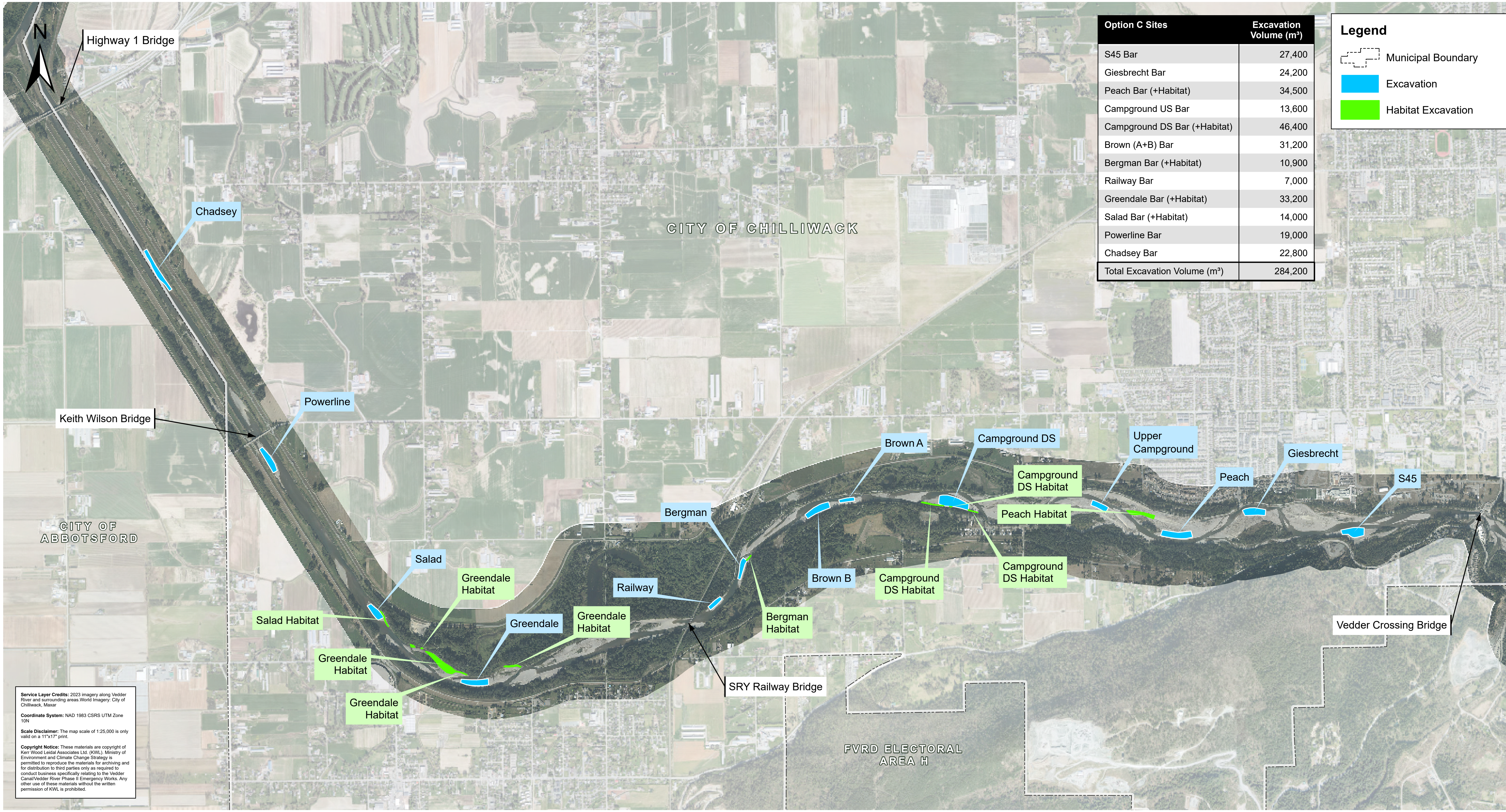

Option C Sites	Excavation Volume (m³)
S45 Bar	27,400
Giesbrecht Bar	24,200
Peach Bar (+Habitat)	34,500
Campground US Bar	13,600
Campground DS Bar (+Habitat)	46,400
Brown (A+B) Bar	31,200
Bergman Bar (+Habitat)	10,900
Railway Bar	7,000
Greendale Bar (+Habitat)	33,200
Salad Bar (+Habitat)	14,000
Powerline Bar	19,000
Chadsey Bar	22,800
Total Excavation Volume (m³)	284,200

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2024 Vedder Canal / Vedder River Sediment Removal Plan - Option C

Figure 8-4

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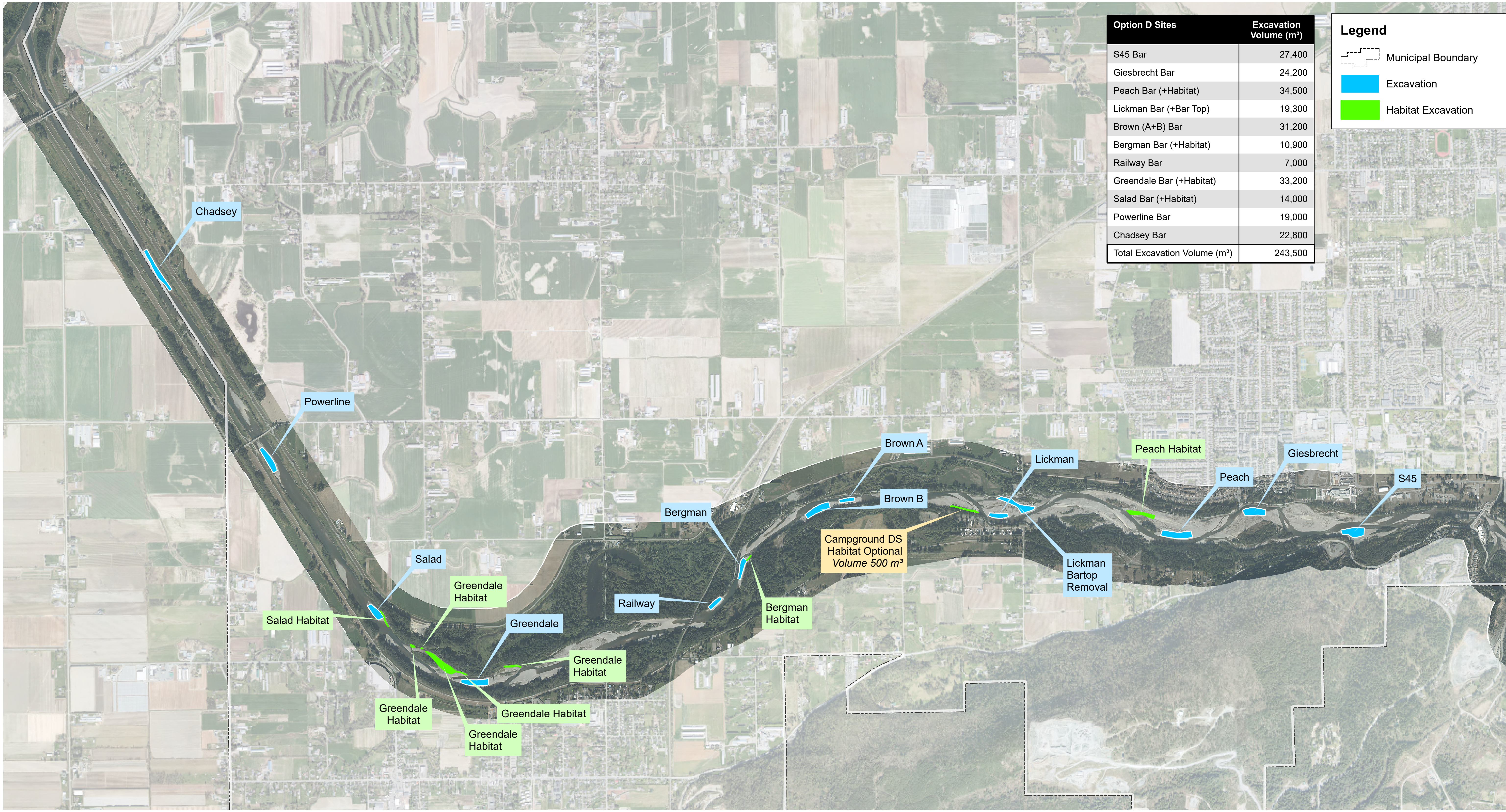

Option D Sites	Excavation Volume (m³)
S45 Bar	27,400
Giesbrecht Bar	24,200
Peach Bar (+Habitat)	34,500
Lickman Bar (+Bar Top)	19,300
Brown (A+B) Bar	31,200
Bergman Bar (+Habitat)	10,900
Railway Bar	7,000
Greendale Bar (+Habitat)	33,200
Salad Bar (+Habitat)	14,000
Powerline Bar	19,000
Chadsey Bar	22,800
Total Excavation Volume (m³)	243,500

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2024 Vedder Canal / Vedder River Sediment Removal Plan - Option D

Figure 8-5

8.5 Hydraulic Evaluation of Options

For each sediment removal option, a 2D terrain was created using proposed excavation extents, side slopes, and depths from the sediment removal plans described above. The 1D channel geometries for each option were updated to include detail at each excavation site. As proposed excavation extents typically do not extend through one or more of the 85 established cross-section locations, additional sections were inserted to better represent hydraulic conditions along the proposed excavation sites.

The flood profile was computed for each option and the resulting flood profiles were compared against the baseline (Option A) flood profile to assess the estimated improvements to freeboard deficient areas and effectiveness of proposed sediment removals. For sediment removal options, the excavated volume component of the calculation only considers excavations within the diked reach of the river as these excavations will have the potential to improve freeboard. Any difference between the total excavation volume and excavation in the diked reach represents sites upstream of the diked reach that can act as gravel traps to prevent sediment transport to the diked reach of the river.

Representation of the computed flood profiles and improvements to the Left and Right Dike freeboard are provided in Figure 8-6 and Figure 8-7, respectively. Model results, including the flood profile, dike (left and right) elevations and freeboard values, are provided in Appendix B. These flood profiles should not be used for dike upgrade design until other conveyance mitigation options are explored (e.g., increasing conveyance through the SRY railway embankment).

Table 8-5: Summary of Effectiveness Coefficients for Sediment Removal Options.

Option	Total Excavation Volume (m^3)	Excavation within Diked Reach (m^3)	Mean WSE Reduction (cm)	Reach Length (km)	Effectiveness ($cm*km/10^4\ m^3$)
Option A	0	0	0.0	0.0	0.0
Option B	205,000	180,840	4.5	11.6	2.9
Option C	284,200	232,600	6.2	11.6	3.1
Option D	243,500	191,940	5.8	11.6	3.5

Table 8-6: Freeboard Deficient Statistics for Left and Right Dikes by Sediment Removal Option.

Option	Dike	Length of Freeboard Deficient Dike (m)	% of Option A	Length x Freeboard Deficiency of Freeboard Deficient Dike (m^2)	% of Option A
Option A	Left	3,304	100%	910	100%
	Right	2,700	100%	741	100%
	Total	**6,004**	**100%**	**1,651**	**100%**
Option B	Left	2,871	87%	724	80%
	Right	2,331	86%	551	74%
	Total	**5,202**	**87%**	**1,276**	**77%**
Option C	Left	2,825	86%	671	74%
	Right	2,305	85%	512	69%
	Total	**5,130**	**85%**	**1,183**	**72%**
Option D	Left	2,839	86%	676	74%
	Right	2,305	85%	512	69%
	Total	**5,144**	**86%**	**1,189**	**72%**

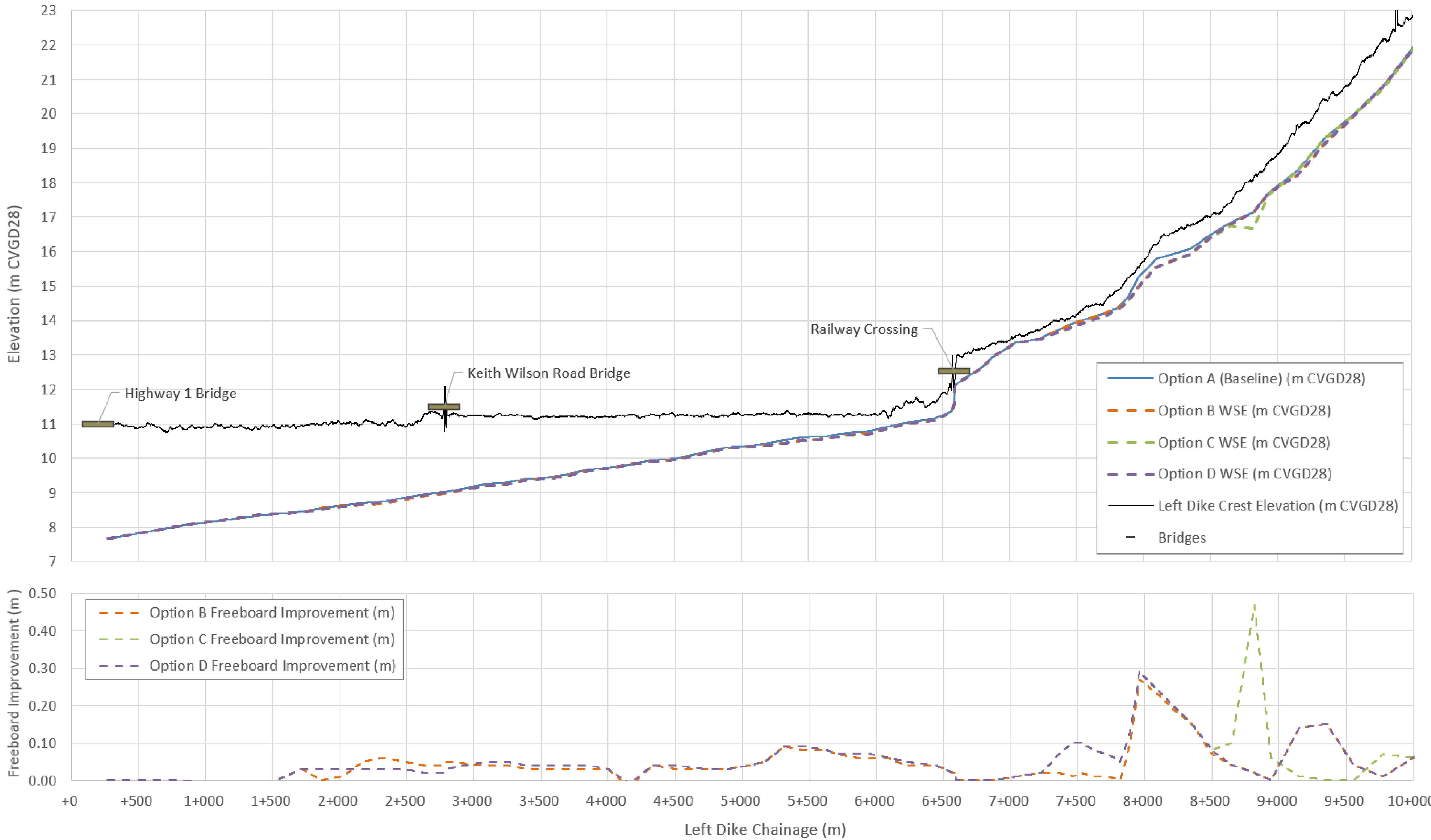

Figure 8-6: Flood Profiles and Improvement to Left Dike Freeboard Comparing Option A (Baseline) Versus Options B, C, and D.

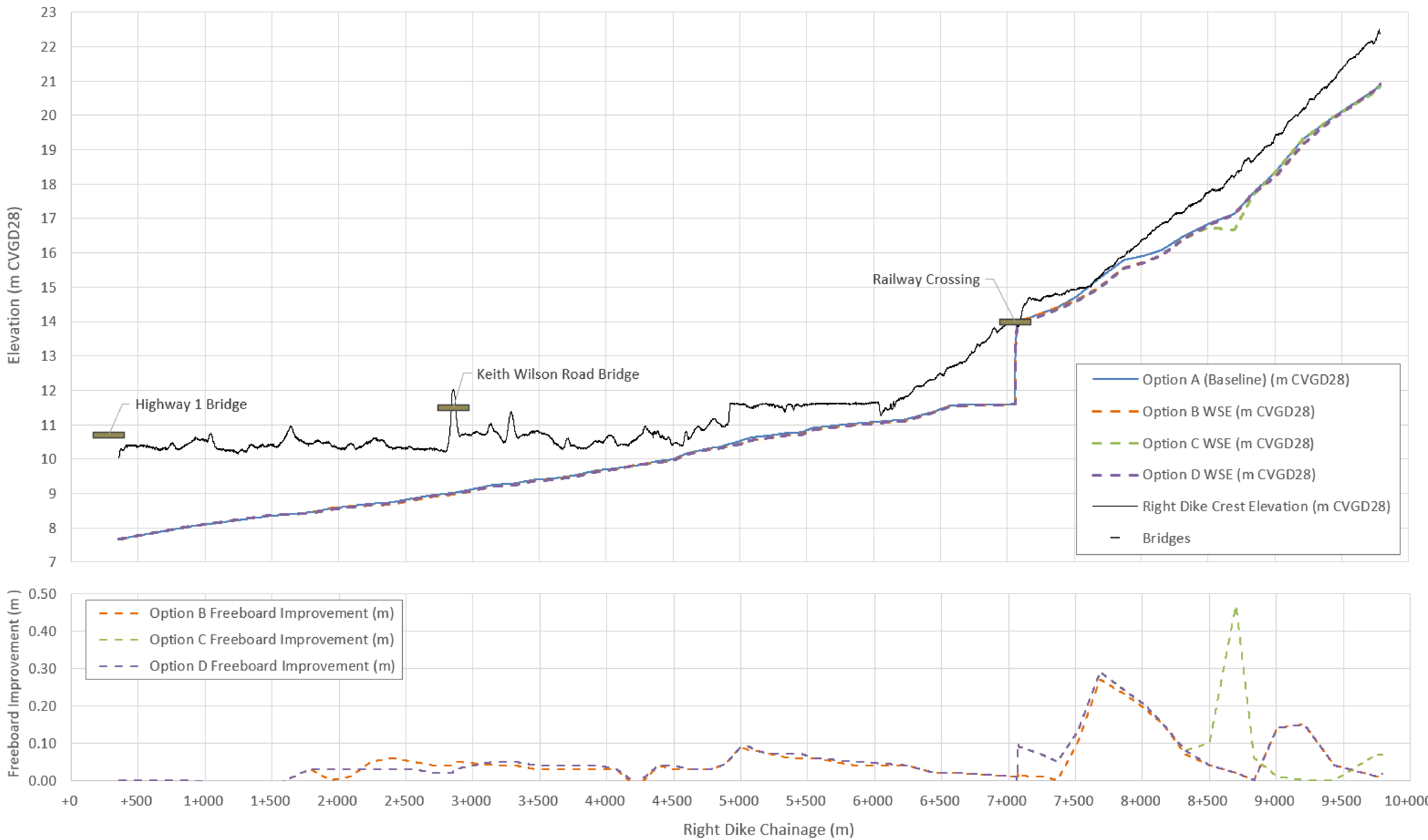

Figure 8-7: Flood Profiles and Improvement to Right Dike Freeboard Comparing Option A (Baseline) Versus Options B, C, and D.

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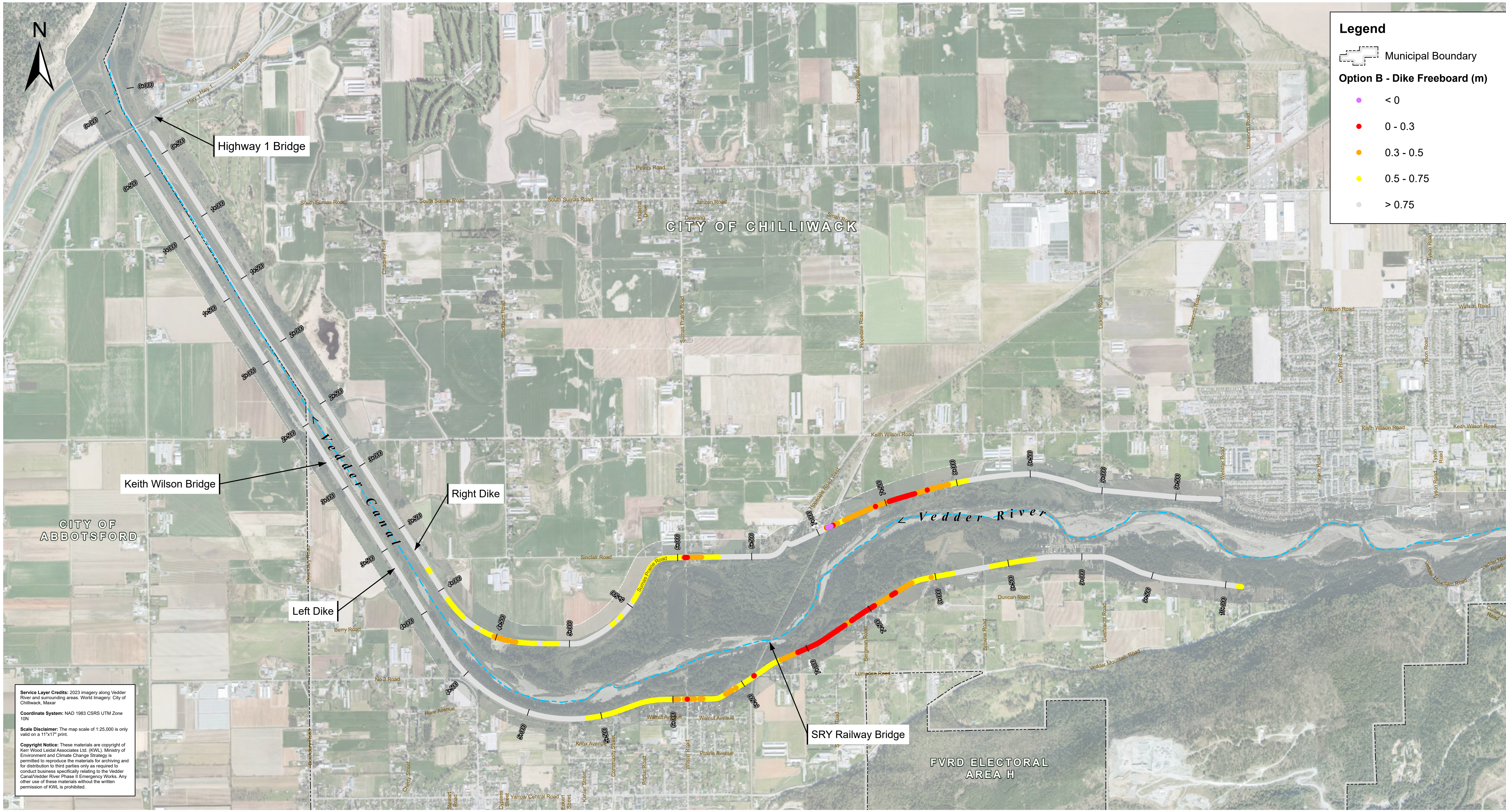

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Option B - Dike Freeboard Deficient Areas

Figure 8-8

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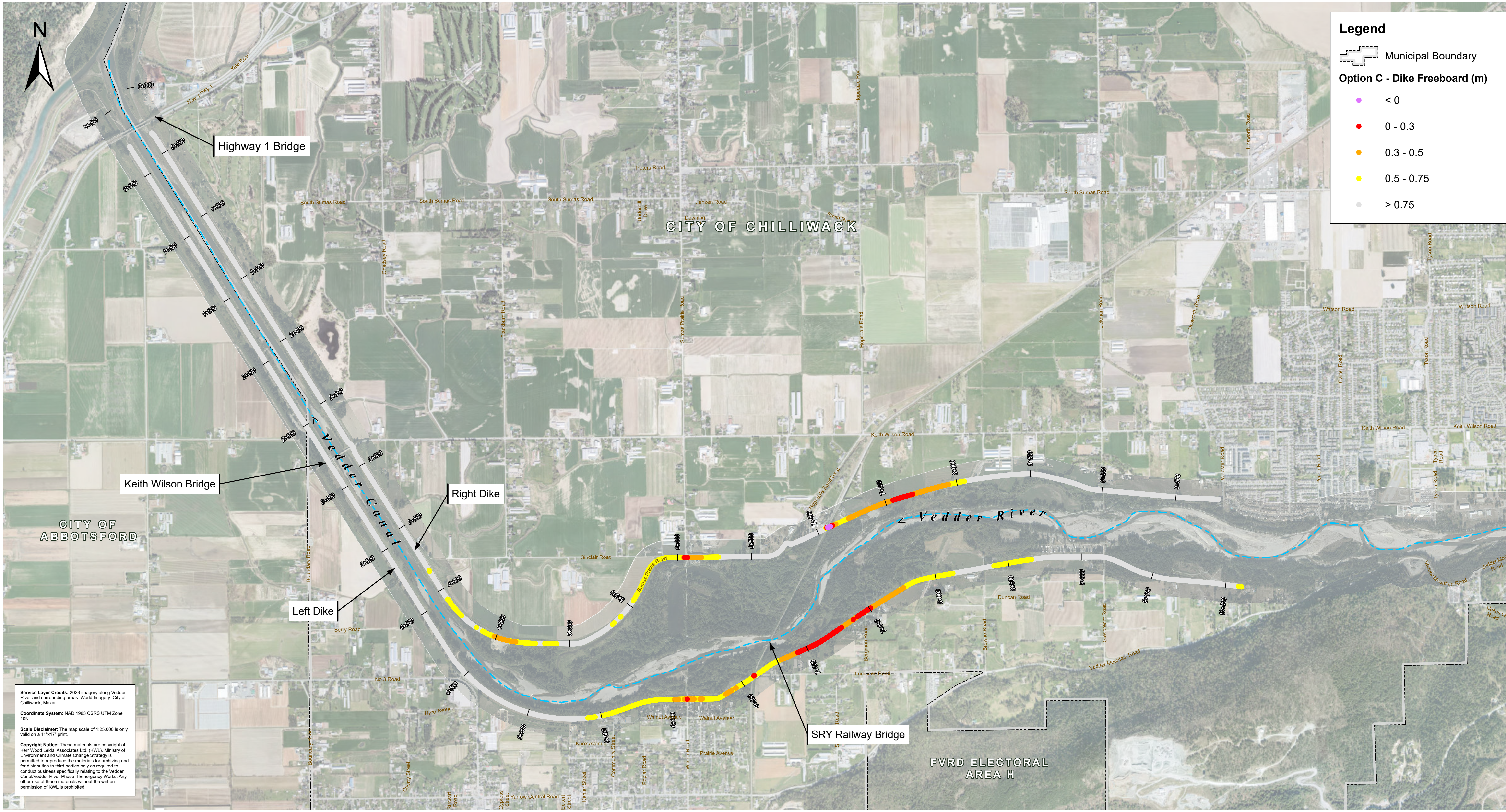

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Option C - Dike Freeboard Deficient Areas

Figure 8-9

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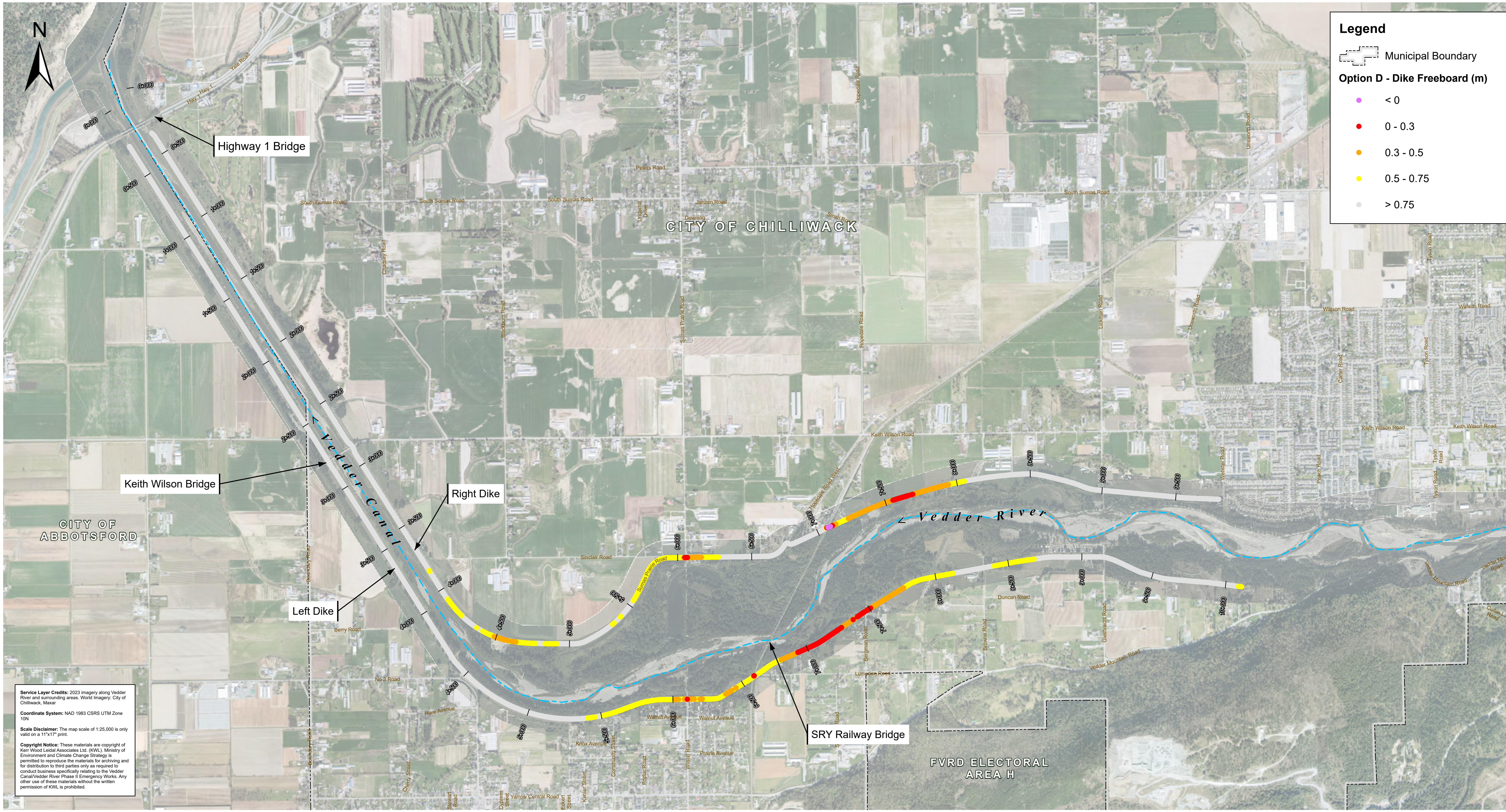

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Option D - Dike Freeboard Deficient Areas

Figure 8-10

9. Other Considerations

9.1 Stockpiling of Sediments

Due to the large volume of sediment proposed for removal within a short instream window, the capacity of nearby temporary stockpiling sites was reviewed to reduce potential risk to the program. Haul routes and stockpiling locations specific to each sediment removal site will be provided to contractors bidding on this work. The stockpiling criteria and information provided in this section do not impact the design of the proposed sediment plan but address the viability of the construction.

An overview of existing and potential stockpile sites in relation to the program's study area is presented in Figure 9-1. A summary of stockpiles with potential (or estimated) capacity, area, and existing stockpiled material is contained in Table 9-1 below.

A conditional withdrawal (Section 17) application form has been submitted to request the use of the Lickman Hayfield for stockpiling of sediments and is pending approval.

An approval was received on June 23, 2023 for the Notice of Intent to place fill on Land in the Agricultural Land Reserve for the Keith Wilson Field Stockpile site (see Appendix C).

Table 9-1: Summary of Existing and Potential Stockpiles.

Stockpile Name	Status	Stockpile Area (m^2)	Existing Material[1] (m^3)	Potential Maximum Capacity[2] (m^3)
Municipal Quarry	Existing	5,300	-	53,400
Giesbrecht Stockpile A	Existing	8,100	-	34,100
Giesbrecht Stockpile B	Existing	11,150	-	67,100
Lickman Hayfield	*Potential*	*42,351*	*-*	*348,800*
Hooge Stockpile	Existing	3,467	1,000[3]	12,400
Bergman Stockpile	Existing	5,242	-	23,800
Wilson Road Stockpile	Existing	5,870	-	19,300
Greendale Stockpile	Existing	9,094	0[4]	44,100
No. 2 Road Stockpile	Existing	7,282	-	36,000
Keith Wilson Field Stockpile	Approved	2,818	-	23,000

[1] Based on stockpile material present in the LiDAR dataset collection on October 4, 2022.
[2] Volume estimated using total stockpile area; 2H:1V side slopes, and an estimated stockpile height.
[3] Approximately 1,000 m^3 of gravel remains in the Hooge Stockpile that belongs to DFO.
[4] A small amount of stockpiled sediment remains in the Greendale Stockpile as of February 28, 2024; however, this material is assumed to be removed by the construction window.

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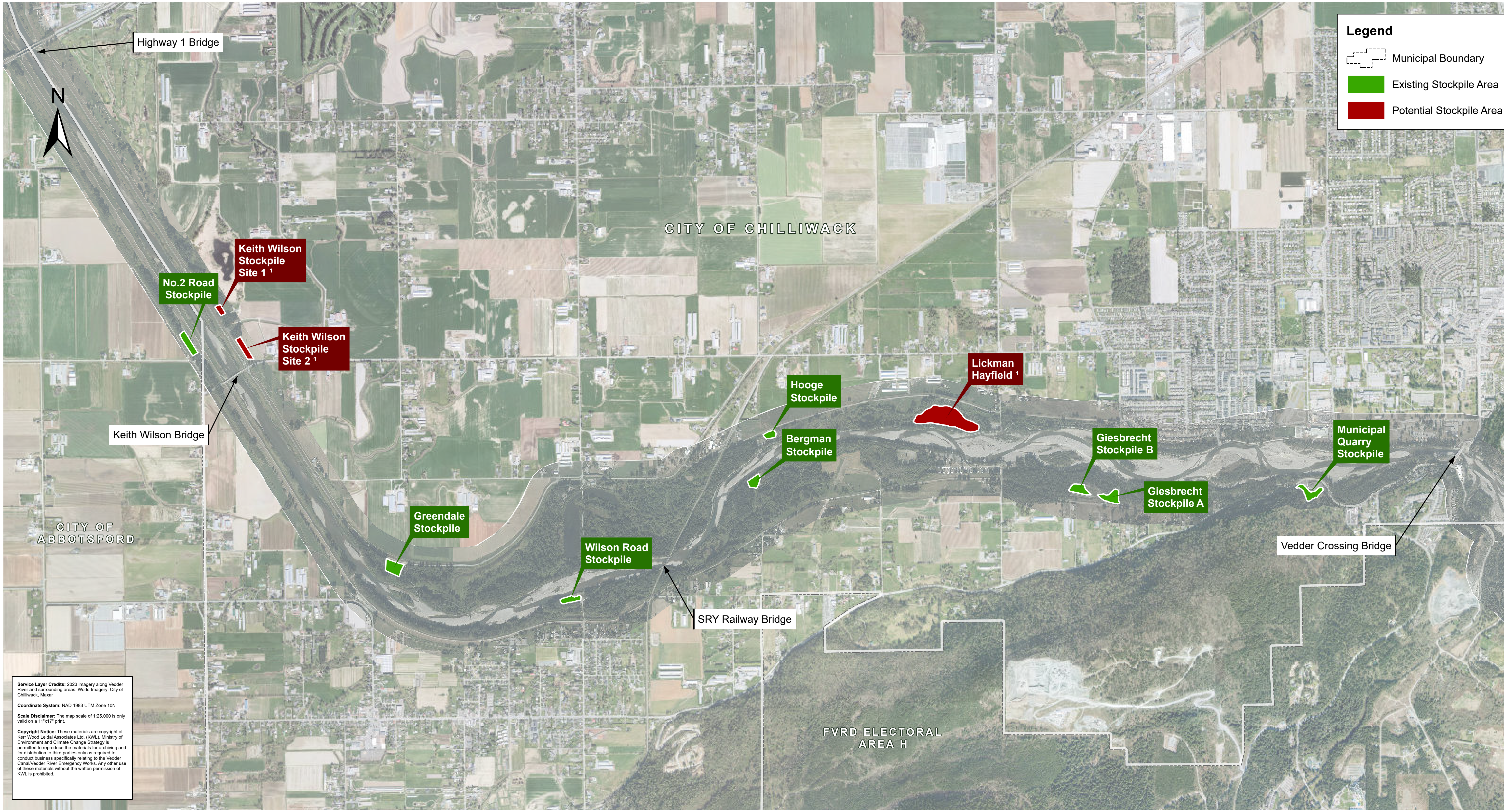

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2024 Hydraulic Assessment
Stockpile Locations

Figure 9-1

9.2 Archaeological Context

A previous archaeological overview assessment (AOA) had been completed in 2012 for the study area. Information is contained within the 2012 AOA for Vedder River Area Management Plan completed by Stó:lō Research and Resource Management Centre (SRRMC). To understand the archaeological context of the study area, KWL engaged WSP to complete a review of the 2012 AOA and review the proposed 2023 sediment removal plans to consider any potential new data or archaeological findings. WSP reviewed the 2012 AOA and provided a Technical Memorandum for the Evaluation of the 2023 Sediment Removal Plans (Appendix D). Based on the WSP review:

- Five (5) areas of archaeological potential (AOPs) were identified near the study area.
- No protected archaeological sites or areas of potential conflict with the proposed project activities.
- No further archaeological work is recommended unless ground-disturbing activities are anticipated within the identified AOPs.

KWL has reviewed the proposed changes to 2024 program, primarily the additional sediment removal sites, and confirmed they do not conflict with the five (5) AOPs mentioned above.

WSP recommended an Archaeological Chance Find Policy to be implemented during the proposed works (Appendix E). This provides a framework of archaeological materials found during construction and provides a reporting structure to engage an archaeologist. Should any archaeological materials be found during the works, SRRMC should be contacted immediately.

9.3 Geomorphological Context

Prior to channelization and dike works, the Chilliwack River downstream of the Vedder gap would naturally migrate across its vast alluvial fan in response to deposition of sediment and wood debris. The Vedder/Chilliwack River system also has a history of channel relocations, or avulsions, as a result of large flood events[7]. Currently, the canal and dike works have confined the Vedder River system to a narrow corridor where channel migration and sediment deposition can occur. Recurring sediment removal is required to maintain the utility of the dikes (i.e., provide flood protection) and to limit channel morphology changes over time (e.g., channel migration, bank erosion).

An analysis of how the morphology of the Vedder River is expected to change in response to each of the 3 sediment removal options (Option B, C, or D) was not conducted. While each option varies in the total volume of sediment to be removed (Table 8-1), the relative difference in sediment removal volumes is unlikely to generate a detectable difference in how the channel may respond. A notable response in channel morphology is not expected since the design and the location of the sediment removal sites follow established sediment removal guidelines for limiting channel morphology changes post removal. Details of the guideline include, but are not limited to: replication of natural streambed shape, protecting the stability of natural features (e.g., sediment bar, and riffle/pool locations), and avoiding consecutive removal sites to limit interaction between them[8].

[7] McLean, D,G, 1975. Flood Control and Sediment Transport Study of the Vedder River. University of British Columbia. Thesis submission for partial fulfillment of degree of Master of Applied Science.
[8] Tetra Tech EBA Inc., 2015. Vedder River Management Area Update. Presented to City of Chilliwack. File 704-WTR.WTRM-OH.

Since the volume of sediment deposition in the Vedder River can vary year to year, a threshold that establishes when sediment removal is needed, and how much sediment should be removed in any given year may be useful. This threshold for sediment removal could be related to the flood profile and flood risk. In addition, a sediment budget for the Vedder River should be developed and establishment of a lower limit for sediment removal volume. The value for the lower limit would be balanced by providing enough capacity to absorb a large volume of sediment from a high flow event (e.g., 2021 ARE event) and minimizes impacts to fish habitat.

10. Discussion

The current flood risk on the Vedder River is elevated due to sediment aggradation following the Nov 2021 ARE and recent observations of the flood profile on December 1, 2021 and the associated model calibrations for that flood event. Freeboard deficient areas in a design flood event are anticipated in the Upper Canal, Lower River, and the Middle River reaches. The magnitude of freeboard deficiencies have also increased, specifically upstream of the railway crossing with two sections of the right dike potentially overtopping, near the railway crossing and just upstream of the Hooge Stockpile, in the design flood.

Assessed sediment removal options could reduce the flood hazard by improving available freeboard and providing sediment traps in the upper reach to mitigate the risk of sediment transport to the freeboard-limited lower and middle reaches. None of the sediment removal options evaluated fully eliminate freeboard deficiencies and the associated flood risk, but all options incrementally improve the freeboard deficit.

Based on the hydraulic assessment results, Option C provides the greatest reduction in freeboard deficient area and freeboard deficient length of dike. Option D provides a very similar reduction in freeboard deficient area (72% for both Option C and D) and length of dike (85% for Option C versus 86% for Option D). Option B provides a lesser reduction in freeboard deficient area (77%) and slightly less reduction in freeboard deficient dike length (87%).

When considering excavation volume of proposed sediment removal options, Option D is the most effective option with an effectiveness coefficient of 3.5. Option C was the second most effective option with an effectiveness coefficient of 3.1. Option B was the least effective option with an effectiveness coefficient of 2.9.

Based on input from the Task Force, there was interest to consider an additional habitat enhancement excavation at the Campground DS site to improve conditions at the Brown Creek Wetland intake structure. This is included as an optional item in Option D but will need to be evaluated further prior to construction.

11. Recommendations

KWL recommends the following:

- Proceed with Option D for construction in 2024 as it is the most efficient sediment removal option and preferred from a flood protection perspective.
- Further development of the optional habitat enhancement excavation at the Campground DS site should be undertaken and engagement with DFO to understand whether to include it in the 2024 works.
- Evaluate other options such as dike raising, side channel development and others to reduce flood risk.
- Develop a 2D model to assess the flood extent and routing around the railway bridge, railway embankment, and relief structures. Current 1D models rely on a flow split stated in the 2008 report with a prescribed flow and location leaving the channel through the existing relief structures. To our knowledge this assumption has not been updated or revisited since 2008 and due to the current freeboard deficient dikes in this area it is recommended to revisit these assumptions.
- Undertake an options analysis to mitigate flood risk around and upstream of the railway bridge. This scope should include but is not limited to potential modifications to the railway bridge, addition or modification of railway embankment relief structures, and raising of setback dikes.
- Develop a threshold for when sediment removal is needed, and how much sediment should be removed in any given year. This threshold would be influenced by future conveyance and diking upgrades. This analysis would also include development of a sediment budget and establishing a lower limit for the sediment removal volume.

Report Submission

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Statement of Limitations

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Revision History

Revision #	Date	Status	Revision	Author
0	2024-02-29	FINAL	Issued for Regulatory Review	MSJS

Appendix A

Pre-Flood versus Post-Flood Hydraulic Model Results

Reach	Cross Section	River Stn	Option A (2024 Baseline)		
			2023 W.L. (7.4 m)	L Dike F.B. (m)	R Dike F.B. (m)
Upper River	XS 49	13075	36.17		
	XS 48	12988	35.22		
	XS 47	12800	32.72		
	XS 46	12501	30.62		
	XS 45	12237	29.16		
	XS 44	12089	28.31		
	XS 43	11866	26.91		
	XS 42	11559	25.70		
	XS 41	11217	24.44		
	XS 40	10909	23.29		
	XS 39	10638	21.87	0.91	
	XS 38	10393	20.75	1.36	1.43
	XS 37	10102	19.94	1.05	1.07
	XS 36	9875	19.30	1.11	0.86
	XS 35	9639	18.36	1.31	1.08
Middle River	XS 34	9424	17.72	0.91	0.94
	XS 33	9241	17.14	0.96	1.10
	XS 32	9067	16.84	**0.59**	0.91
	XS 31	8904	16.49	**0.51**	**0.69**
	XS 30	8755	16.08	**0.67**	0.76
	XS 29	8603	15.92	**0.63**	**0.51**
	XS 28	8468	15.79	**0.42**	**0.10**
	XS 27	8296	15.25	**0.27**	**0.03**
	XS 26	8141	14.72	**0.53**	**0.21**
	XS 25	7998	14.39	**0.51**	**0.43**
	XS 24	7883	14.22	**0.35**	**0.39**
	XS 23-1	7804	14.10	**0.33**	**0.57**
	XS 23	7694	13.99	**0.24**	
	XS 22	7617	13.90	**0.23**	
	XS 21	7461	13.72	**0.26**	
	XS 20	7302	13.48	**0.26**	
	XS 19	7161	13.35	**0.18**	
	XS 18	7032	12.97	**0.37**	
	XS 50	6956	12.62	**0.57**	
	XS 172	6932	12.12		
	SRBC				

Reach	Cross Section	River Stn	Option A (2024 Baseline)		
			2023 W.L. (7.4 m)	L Dike F.B. (m)	R Dike F.B. (m)
Lower River	XS 171	6924	11.60		
	XS 51	6902	11.57		1.11
	XS 16	6780	11.37	**0.71**	0.94
	XS 15	6590	11.15	**0.45**	**0.66**
	XS 14	6441	11.03	**0.57**	**0.58**
	XS 13	6304	10.91	**0.41**	**0.70**
	XS 12	6168	10.78	**0.48**	**0.74**
	XS 11	6049	10.76	**0.49**	0.78
	XS 10	5879	10.69	**0.57**	0.91
	XS 9	5768	10.64	**0.63**	0.89
	XS 8	5639	10.61	**0.68**	0.92
	XS 7	5510	10.52	0.77	1.05
	XS 6	5381	10.42	0.90	**0.60**
	XS 5	5296	10.36	0.92	**0.63**
	XS 4	5153	10.32	0.88	0.75
	XS 3	4977	10.17	1.04	**0.53**
	XS 2	4785	9.99	1.27	**0.43**
	XS 1	4648	9.94	1.35	0.88
Canal	XS C37	4468	9.81	1.46	0.77
	XS C36	4312	9.73	1.48	**0.74**
	XS C35	4167	9.67	1.50	0.82
	XS C34	4008	9.53	1.67	0.86
	XS C33	3855	9.44	1.78	1.04
	XS C32	3703	9.40	1.80	1.39
	XS C31	3550	9.29	1.95	1.72
	XS C29	3398	9.25	1.99	1.60
	XS C271	3107	9.02	2.65	2.89
	XS C27	3089	9.01	2.46	2.89
	XS C26	2941	8.95	2.32	1.34
	XS C25	2788	8.85	2.12	1.47
	XS C24	2636	8.74	2.26	1.59
	XS C23	2484	8.70	2.32	1.80
	XS C22	2330	8.63	2.38	1.82
	XS C21	2179	8.56	2.40	1.86
	XS C20	2027	8.45	2.51	2.00
	XS C18	1722	8.34	2.51	2.06
	XS C14	1112	8.03	2.91	2.40
	XS C10	583	7.66	3.28	1.29

KERR WOOD LEIDAL
consulting engineers

Appendix B

Baseline versus Sediment Removal Scenarios Model Results

Reach	Cross Section	River Stn	Option B			
			W.L. (m)	W.L. Change from Option A (m)	L Dike F.B. (m)	R Dike F.B. (m)
Upper River	XS 49	13075	36.17	0.00		
	XS 48	12988	35.22	0.00		
	XS 47	12800	32.72	0.00		
	XS 46	12501	30.62	0.00		
	XS 45	12237	29.16	0.00		
	XS 44	12089	28.31	0.00		
	XS 43	11866	26.90	-0.01		
	XS 42	11559	25.47	-0.23		
	XS 41	11217	24.44	0.00		
	XS 40	10909	23.17	-0.12		
	XS 39	10638	21.81	-0.06	0.97	
	XS 38	10393	20.74	-0.01	1.37	1.44
	XS 37	10102	19.90	-0.04	1.09	1.11
	XS 36	9875	19.15	-0.15	1.26	1.01
	XS 35	9639	18.22	-0.14	1.45	1.22
Middle River	XS 34	9424	17.72	0.00	0.91	0.94
	XS 33	9241	17.12	-0.02	0.98	1.12
	XS 32	9067	16.80	-0.04	**0.63**	0.95
	XS 31	8904	16.42	-0.07	**0.58**	0.76
	XS 30	8755	15.93	-0.15	0.82	0.91
	XS 29	8603	15.73	-0.19	0.82	**0.70**
	XS 28	8468	15.56	-0.23	**0.65**	**0.33**
	XS 27	8296	14.98	-0.27	**0.54**	**0.30**
	XS 26	8141	14.62	-0.10	**0.63**	**0.31**
	XS 25	7998	14.39	0.00	**0.51**	**0.43**
	XS 24	7883	14.21	-0.01	**0.36**	**0.40**
	XS 23-1	7804	14.09	-0.01	**0.34**	**0.58**
	XS 23	7694	13.97	-0.02	**0.26**	
	XS 22	7617	13.89	-0.01	**0.24**	
	XS 21	7461	13.70	-0.02	**0.28**	
	XS 20	7302	13.46	-0.02	**0.28**	
	XS 19	7161	13.34	-0.01	**0.19**	
	XS 18	7032	12.97	0.00	**0.37**	
	XS 50	6956	12.62	0.00	**0.57**	
	XS 172	6932	12.12	0.00		
	SRBC					

Reach	Cross Section	River Stn	Option B			
			W.L. (m)	W.L. Change from Option A (m)	L Dike F.B. (m)	R Dike F.B. (m)
Lower River	XS 171	6924	11.59	-0.01		
	XS 51	6902	11.55	-0.02		1.13
	XS 16	6780	11.35	-0.02	**0.73**	0.96
	XS 15	6590	11.11	-0.04	**0.49**	**0.70**
	XS 14	6441	10.99	-0.04	**0.61**	**0.62**
	XS 13	6304	10.85	-0.06	**0.47**	0.76
	XS 12	6168	10.72	-0.06	**0.54**	0.80
	XS 11	6049	10.70	-0.06	**0.55**	0.84
	XS 10	5879	10.62	-0.07	**0.64**	0.98
	XS 9	5768	10.56	-0.08	**0.71**	0.97
	XS 8	5639	10.53	-0.08	0.76	1.00
	XS 7	5510	10.43	-0.09	0.86	1.14
	XS 6	5381	10.37	-0.05	0.95	**0.65**
	XS 5	5296	10.32	-0.04	0.96	**0.67**
	XS 4	5153	10.29	-0.03	0.91	0.78
	XS 3	4977	10.14	-0.03	1.07	**0.56**
	XS 2	4785	9.96	-0.03	1.30	**0.46**
	XS 1	4648	9.90	-0.04	1.39	0.92
Canal	XS C37	4468	9.83	0.02	1.44	**0.75**
	XS C36	4312	9.70	-0.03	1.51	0.77
	XS C35	4167	9.64	-0.03	1.53	0.85
	XS C34	4008	9.50	-0.03	1.70	0.89
	XS C33	3855	9.41	-0.03	1.81	1.07
	XS C32	3703	9.37	-0.03	1.83	1.42
	XS C31	3550	9.25	-0.04	1.99	1.76
	XS C29	3398	9.21	-0.04	2.03	1.64
	XS C271	3107	8.97	-0.05	2.70	2.94
	XS C27	3089	8.97	-0.04	2.50	2.93
	XS C26	2941	8.91	-0.04	2.36	1.38
	XS C25	2788	8.80	-0.05	2.17	1.52
	XS C24	2636	8.68	-0.06	2.32	1.65
	XS C23	2484	8.65	-0.05	2.37	1.85
	XS C22	2330	8.62	-0.01	2.39	1.83
	XS C21	2179	8.56	0.00	2.40	1.86
	XS C20	2027	8.42	-0.03	2.54	2.03
	XS C18	1722	8.36	0.02	2.49	2.04
	XS C14	1112	8.03	0.00	2.91	2.40
	XS C10	583	7.66	0.00	3.28	1.29

Reach	Cross Section	River Stn	Option C			
			W.L. (m)	W.L. Change from Option A (m)	L Dike F.B. (m)	R Dike F.B. (m)
Upper River	XS 49	13075	36.17	0.00		
	XS 48	12988	35.22	0.00		
	XS 47	12800	32.72	0.00		
	XS 46	12501	30.61	-0.01		
	XS 45	12237	28.74	-0.42		
	XS 44	12089	28.31	0.00		
	XS 43	11866	26.90	-0.01		
	XS 42	11559	25.47	-0.23		
	XS 41	11217	24.44	0.00		
	XS 40	10909	23.17	-0.12		
	XS 39	10638	21.81	-0.06	0.97	
	XS 38	10393	20.68	-0.07	1.43	1.50
	XS 37	10102	19.94	0.00	1.05	1.07
	XS 36	9875	19.30	0.00	1.11	0.86
	XS 35	9639	18.35	-0.01	1.32	1.09
Middle River	XS 34	9424	17.66	-0.06	0.97	1.00
	XS 33	9241	16.67	-0.47	1.43	1.57
	XS 32	9067	16.74	-0.10	**0.69**	1.01
	XS 31	8904	16.41	-0.08	**0.59**	0.77
	XS 30	8755	15.93	-0.15	0.82	0.91
	XS 29	8603	15.72	-0.20	0.83	**0.71**
	XS 28	8468	15.55	-0.24	**0.66**	**0.34**
	XS 27	8296	14.96	-0.29	**0.56**	**0.32**
	XS 26	8141	14.59	-0.13	**0.66**	**0.34**
	XS 25	7998	14.34	-0.05	**0.56**	**0.48**
	XS 24	7883	14.15	-0.07	**0.42**	**0.46**
	XS 23-1	7804	14.02	-0.08	**0.41**	**0.65**
	XS 23	7694	13.89	-0.10	**0.34**	
	XS 22	7617	13.80	-0.10	**0.33**	
	XS 21	7461	13.65	-0.07	**0.33**	
	XS 20	7302	13.46	-0.02	**0.28**	
	XS 19	7161	13.34	-0.01	**0.19**	
	XS 18	7032	12.97	0.00	**0.37**	
	XS 50	6956	12.62	0.00	**0.57**	
	XS 172	6932	12.12	0.00		
	SRBC					

Reach	Cross Section	River Stn	Option C			
			W.L. (m)	W.L. Change from Option A (m)	L Dike F.B. (m)	R Dike F.B. (m)
Lower River	XS 171	6924	11.59	-0.01		
	XS 51	6902	11.55	-0.02		1.13
	XS 16	6780	11.35	-0.02	**0.73**	0.96
	XS 15	6590	11.11	-0.04	**0.49**	**0.70**
	XS 14	6441	10.98	-0.05	**0.62**	**0.63**
	XS 13	6304	10.85	-0.06	**0.47**	0.76
	XS 12	6168	10.71	-0.07	**0.55**	0.81
	XS 11	6049	10.69	-0.07	**0.56**	0.85
	XS 10	5879	10.62	-0.07	**0.64**	0.98
	XS 9	5768	10.56	-0.08	**0.71**	0.97
	XS 8	5639	10.52	-0.09	0.77	1.01
	XS 7	5510	10.43	-0.09	0.86	1.14
	XS 6	5381	10.37	-0.05	0.95	**0.65**
	XS 5	5296	10.32	-0.04	0.96	**0.67**
	XS 4	5153	10.29	-0.03	0.91	0.78
	XS 3	4977	10.14	-0.03	1.07	**0.56**
	XS 2	4785	9.95	-0.04	1.31	**0.47**
	XS 1	4648	9.90	-0.04	1.39	0.92
Canal	XS C37	4468	9.82	0.01	1.45	0.76
	XS C36	4312	9.70	-0.03	1.51	0.77
	XS C35	4167	9.63	-0.04	1.54	0.86
	XS C34	4008	9.49	-0.04	1.71	0.90
	XS C33	3855	9.40	-0.04	1.82	1.08
	XS C32	3703	9.36	-0.04	1.84	1.43
	XS C31	3550	9.24	-0.05	2.00	1.77
	XS C29	3398	9.20	-0.05	2.04	1.65
	XS C271	3107	8.99	-0.03	2.68	2.92
	XS C27	3089	8.99	-0.02	2.48	2.91
	XS C26	2941	8.93	-0.02	2.34	1.36
	XS C25	2788	8.82	-0.03	2.15	1.50
	XS C24	2636	8.71	-0.03	2.29	1.62
	XS C23	2484	8.67	-0.03	2.35	1.83
	XS C22	2330	8.60	-0.03	2.41	1.85
	XS C21	2179	8.53	-0.03	2.43	1.89
	XS C20	2027	8.42	-0.03	2.54	2.03
	XS C18	1722	8.36	0.02	2.49	2.04
	XS C14	1112	8.03	0.00	2.91	2.40
	XS C10	583	7.66	0.00	3.28	1.29

Reach	Cross Section	River Stn	Option D			
			W.L. (m)	W.L. Change from Option A (m)	L Dike F.B. (m)	R Dike F.B. (m)
Upper River	XS 49	13075	36.17	0.00		
	XS 48	12988	35.22	0.00		
	XS 47	12800	32.72	0.00		
	XS 46	12501	30.61	-0.01		
	XS 45	12237	28.74	-0.42		
	XS 44	12089	28.31	0.00		
	XS 43	11866	26.90	-0.01		
	XS 42	11559	25.47	-0.23		
	XS 41	11217	24.44	0.00		
	XS 40	10909	23.17	-0.12		
	XS 39	10638	21.81	-0.06	0.97	
	XS 38	10393	20.74	-0.01	1.37	1.44
	XS 37	10102	19.90	-0.04	1.09	1.11
	XS 36	9875	19.15	-0.15	1.26	1.01
	XS 35	9639	18.22	-0.14	1.45	1.22
Middle River	XS 34	9424	17.72	0.00	0.91	0.94
	XS 33	9241	17.12	-0.02	0.98	1.12
	XS 32	9067	16.80	-0.04	**0.63**	0.95
	XS 31	8904	16.41	-0.08	**0.59**	0.77
	XS 30	8755	15.93	-0.15	0.82	0.91
	XS 29	8603	15.72	-0.20	0.83	**0.71**
	XS 28	8468	15.55	-0.24	**0.66**	**0.34**
	XS 27	8296	14.96	-0.29	**0.56**	**0.32**
	XS 26	8141	14.59	-0.13	**0.66**	**0.34**
	XS 25	7998	14.34	-0.05	**0.56**	**0.48**
	XS 24	7883	14.15	-0.07	**0.42**	**0.46**
	XS 23-1	7804	14.02	-0.08	**0.41**	**0.65**
	XS 23	7694	13.89	-0.10	**0.34**	
	XS 22	7617	13.80	-0.10	**0.33**	
	XS 21	7461	13.65	-0.07	**0.33**	
	XS 20	7302	13.46	-0.02	**0.28**	
	XS 19	7161	13.34	-0.01	**0.19**	
	XS 18	7032	12.97	0.00	**0.37**	
	XS 50	6956	12.62	0.00	**0.57**	
	XS 172	6932	12.12	0.00		
	SRBC					

Reach	Cross Section	River Stn	Option D			
			W.L. (m)	W.L. Change from Option A (m)	L Dike F.B. (m)	R Dike F.B. (m)
Lower River	XS 171	6924	11.59	-0.01		
	XS 51	6902	11.55	-0.02		1.13
	XS 16	6780	11.35	-0.02	**0.73**	0.96
	XS 15	6590	11.11	-0.04	**0.49**	**0.70**
	XS 14	6441	10.98	-0.05	**0.62**	**0.63**
	XS 13	6304	10.85	-0.06	**0.47**	0.76
	XS 12	6168	10.71	-0.07	**0.55**	0.81
	XS 11	6049	10.69	-0.07	**0.56**	0.85
	XS 10	5879	10.62	-0.07	**0.64**	0.98
	XS 9	5768	10.56	-0.08	**0.71**	0.97
	XS 8	5639	10.52	-0.09	0.77	1.01
	XS 7	5510	10.43	-0.09	0.86	1.14
	XS 6	5381	10.37	-0.05	0.95	**0.65**
	XS 5	5296	10.32	-0.04	0.96	**0.67**
	XS 4	5153	10.29	-0.03	0.91	0.78
	XS 3	4977	10.14	-0.03	1.07	**0.56**
	XS 2	4785	9.95	-0.04	1.31	**0.47**
	XS 1	4648	9.90	-0.04	1.39	0.92
Canal	XS C37	4468	9.82	0.01	1.45	0.76
	XS C36	4312	9.70	-0.03	1.51	0.77
	XS C35	4167	9.63	-0.04	1.54	0.86
	XS C34	4008	9.49	-0.04	1.71	0.90
	XS C33	3855	9.40	-0.04	1.82	1.08
	XS C32	3703	9.36	-0.04	1.84	1.43
	XS C31	3550	9.24	-0.05	2.00	1.77
	XS C29	3398	9.20	-0.05	2.04	1.65
	XS C271	3107	8.99	-0.03	2.68	2.92
	XS C27	3089	8.99	-0.02	2.48	2.91
	XS C26	2941	8.93	-0.02	2.34	1.36
	XS C25	2788	8.82	-0.03	2.15	1.50
	XS C24	2636	8.71	-0.03	2.29	1.62
	XS C23	2484	8.67	-0.03	2.35	1.83
	XS C22	2330	8.60	-0.03	2.41	1.85
	XS C21	2179	8.53	-0.03	2.43	1.89
	XS C20	2027	8.42	-0.03	2.54	2.03
	XS C18	1722	8.36	0.02	2.49	2.04
	XS C14	1112	8.03	0.00	2.91	2.40
	XS C10	583	7.66	0.00	3.28	1.29

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consulting engineers

Appendix C

Keith Wilson Field ALR Approval Letter

PROVINCIAL AGRICULTURAL LAND COMMISSION

T: 604-660-7000
E: ALCBurnaby@Victoria1.gov.bc.ca
201 – 4940 Canada Way, Burnaby
B.C., Canada V5G 4K6

June 23, 2023

ALC File: 68456

SENT BY E-MAIL

Attention: Gulraiz Cheema, Agent

Dear Gulraiz Cheema:

Approval Subject to Limits and Conditions Under Section 20.3(2)(b)(ii) of the *Agricultural Land Commission Act*

Re: Notice of Intent to place fill on Land in the Agricultural Land Reserve
PID: 013-571-664
Legal Description: Parcel "G" (Explanatory Plan 42091) South East Quarter and of the South West Quarter Section 7 Township 23 New Westminster District
Civic Address: 41495 Vedder Canal, Chilliwack, BC
(the "Property")

On May 19, 2023 the Chief Executive Officer (CEO) of the Agricultural Land Commission received a Notice of Intent (NOI) pursuant to section 20.3(1)(c) of the *Agricultural Land Commission Act* (ALCA) for the proposed placement of fill on the Property (the Proposed Fill Placement Activities). The CEO also received a fee of $150 with respect to the NOI pursuant to subsection 20.3(1)(c)(ii).

As delegate CEO pursuant to subsection 20.3(6) of the ALCA, I understand the following about the Proposed Fill Placement Activities from the NOI and accompanying documents:

- The landowner of the Property is the City of Chilliwack;
- Gulraiz Cheema, P, Eng, Senior Project Manager with the Ministry of Environment and Climate Change was appointed as Agent by Jacqueline Morgan, Corporate Officer with the City of Chilliwack;
- The total area of the Proposed Fill Placement Activities is 0.9 ha (9,000 m^2).
- The mapped agricultural capability of the proposed fill placement areas on the Property is Class 4, 5, and 6, limited by undesirable soil structure and/or low permeability and excess water;

- The purpose of the Proposed Fill Placement Activities is to temporarily stockpile fill excavated from the Vedder River and Canal on two areas within the Property;
  - Site 1, which would be a 0.3 ha area located in the northern area of the Property;
  - Site 2, which would a 0.6 ha area located in the southern area of the Property;
- The temporarily stockpiled fill would be removed from the Property after approx. five (5) years;
- The sediment removal in the Vedder River and Vedder Canal is proposed to increase capacity of the Vedder Floodway and reduce the risk of flooding in adjacent lands;
- The type of material proposed to be temporarily placed on the Property is fluvial sediments (i.e., silt, sand, gravel, cobbles), which would be removed from the Property after approx. five (5) years;
- The proposed volume of materials to be temporarily placed on the Property is 33,000 m^3, which would be removed from the Property after approx. five (5) years;
- The proposed maximum depth of material to be temporarily placed on the Property is 6 m; and,
- The proposed duration of the Proposed Fill Placement is five (5) years.

Upon review of the Notice of Intent and accompanying documents, I hereby approve the Proposed Fill Placement Activities subject to the attached Schedule A: Limits and Conditions under section 20.3(2)(b)(ii) of the Act.

This approval is only for the Proposed Fill Placement Activities. This approval does not constitute approval for any other activity on the Property for which CEO or Commission approval would otherwise be required. This approval does not relieve you of your obligation to comply with all applicable Acts, regulations, bylaws of local government, and decisions and orders of any person or body having jurisdiction over the land under an enactment.

Should you not agree to restrictions on the intended specified use, as set out in the above 'terms and conditions', the option of submitting a formal application to the Commission is available. Information on application process can be found on the ALC website under Applications.

As agent, it is your responsibility to advise your client of this, and any future, correspondence. Further correspondence with respect to this letter should be directed to Nida Asad at ALC.soil@gov.bc.ca.

Sincerely,

Jenny Huynh
Delegate of the Chief Executive Officer

Enclosure: Schedule A: Limits and Conditions
Schedule B: Approval Map
Schedule C: Cross Sections
Schedule D: Criteria for Technical Reports Submitted by Consultants

cc: Tara Friesen, P.Eng. Manager of Environmental Services – City of Chilliwack (tfriesen@chilliwack.com)

City of Chilliwack (ALCapplication@chilliwack.com)

Alexander Salvaille, Senior Floor Hazard Officer, Regional Operations Division - Coast Area, Ministry of Forests (Alexandre.Salvaille@gov.bc.ca)

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Schedule A:

Limits and Conditions on the Proposed Fill Placement Activities

GENERAL

1. The Proposed Fill Placement Activities must be conducted in compliance with the limits and conditions set out in this NOI approval;
2. The Proposed Fill Placement Activities are restricted to the 0.3 ha and 0.6 ha areas shown in the Schedule B: Approval Map attached to this NOI approval;
3. The total allowed volume of material to be temporarily placed is limited to 33,000 m^3;
4. The type of material to be temporarily placed is fluvial sediments (i.e., silt, sand, gravel, cobbles) excavated from the Vedder River and Canal;
5. The total fill placement must be limited in depth to achieve the finished grade elevations as identified in the Schedule C: Cross-Section attached to this NOI approval;
6. Approval for placement of fill on the Property is granted for the sole benefit of the Applicant and is non-transferable without the written approval of the ALC;

CONDUCTING PROPOSED FILL PLACEMENT ACTIVITIES

Topsoil Salvage

7. All existing topsoil should be salvaged for use elsewhere on the Property where appropriate;
    a. Stockpiled soils should be windrowed and located in an area where they will not be disturbed and will not impede site drainage.
    b. Stockpiled soil must not be removed from the Property without written permission from the ALC;

Vehicular Traffic

8. Access and egress of all vehicle traffic associated with the Proposed Fill Placement Activities and other related activities, must be restricted to a single access road onto the Property;
9. Dust suppression practices and/or restrictions on Proposed Fill Placement Activities related vehicle traffic must be applied when necessary to minimize air-borne dust from traffic on the access road;

Fill Material

10. As per Section 36 of the *Agricultural Land Reserve Use Regulation,* prohibited fill must not be placed on the Property. Prohibited fill includes:
    a. construction or demolition waste, including masonry rubble, concrete, cement, rebar, drywall and wood waste;
    b. asphalt;
    c. glass;
    d. synthetic polymers;
    e. treated wood;
    f. unchipped lumber;

Weed Control

15. Appropriate weed control must be practiced on all disturbed areas;

COMPLETION OF THE PROPOSED FILL PLACEMENT ACTIVITIES

Closure Report

16. A closure report, prepared by the qualified registered professional, prepared as per ALC Policy P-10 and Schedule D: Criteria for Technical Reports Submitted by Consultants, for the ALC's review and approval, must be submitted to the ALC upon

completion of the Proposed Fill Placement Activities. The closure report must include, but is not limited to, the following:

   a. A written description of the completed Proposed Fill Placement Activities;
   b. Evidence that the Proposed Fill Placement Activities has been completed as described in the limits and conditions of this NOI;
   c. Confirmation of the final agricultural capability and evidence that Proposed Fill Placement Activities have not negatively impacted the agricultural capability/suitability of the Proposed Fill Placement Area. This should be supported by detailed soil test pits, site information, and photographs;
   d. Outstanding issues and recommended remedial actions.

17. The closure report must be completed by a qualified professional. Activities must be conducted in compliance with the information submitted with the NOI and conditions set out in this approval;
18. The qualified registered professional is responsible for notifying the ALC the closure report is not provided to the ALC as per the conditions and timelines in this approval; and
19. The closure report must be submitted to the ALC no more than six (6) months after the completion of the Proposed Fill Placement Activities and no later than **December 23, 2028.**

DECISION/APPROVAL TERM

The Proposed Fill Placement Activities must be completed and reclaimed within five (5) years from the release of this NOI approval **(June 23, 2028).**

NOTE: Unless the ALC first approves an NOI made under section 20.3(5) of the *Agricultural Land Commission Act* (ALCA) as described in the cover letter, proceeding with the Proposed Fill Placement Activities other than in accordance with the above limits and conditions contravenes the ALCA and is subject to compliance and enforcement measures under sections 49-54 of the ALCA.

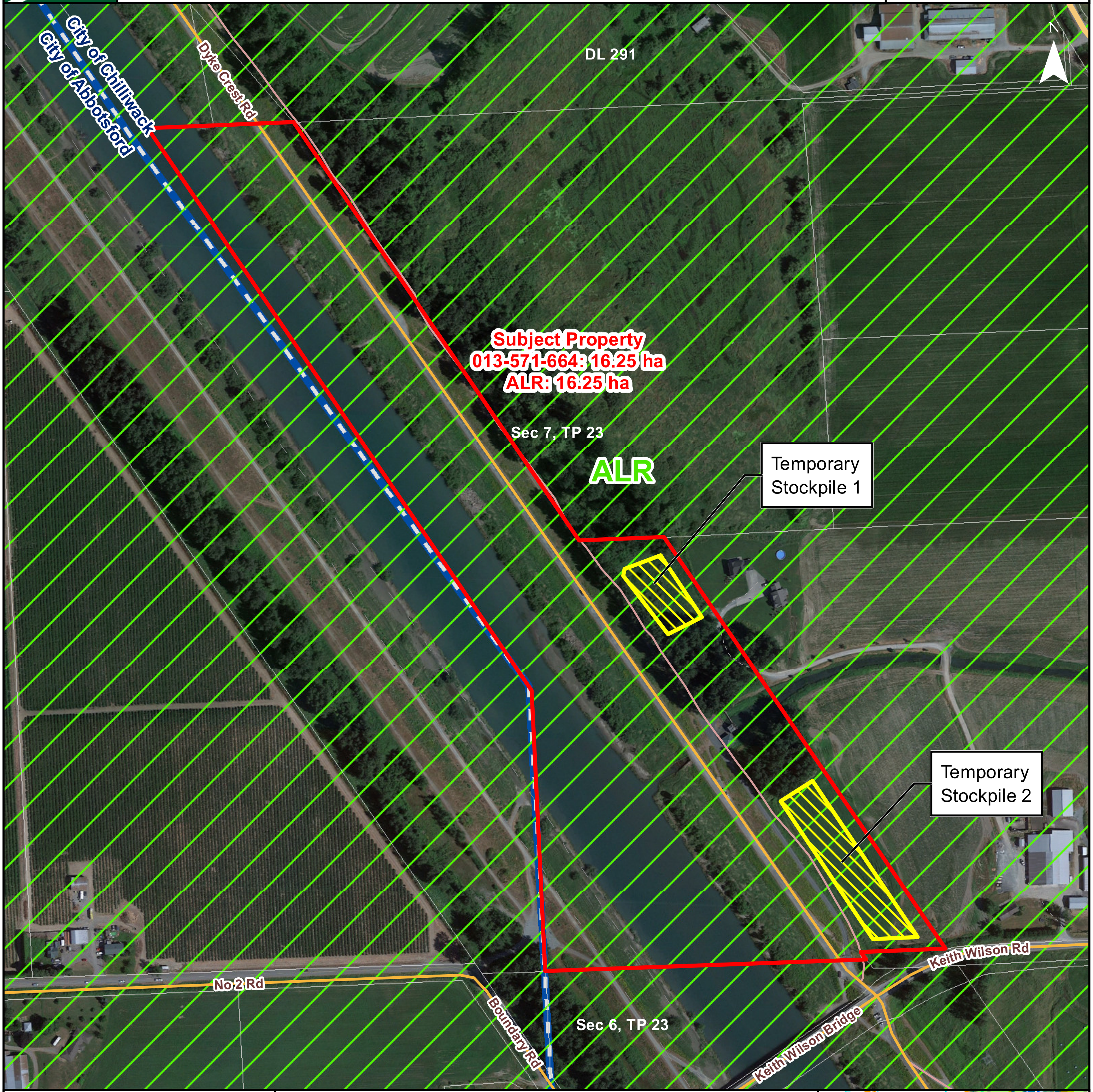
This approval does not relieve you of your obligation to comply with all applicable Acts, regulations, bylaws of local government, and decisions and orders of any person or body having jurisdiction over the land under an enactment.

Schedule B: Approval Map

2022 Google Earth Orthophoto

MAPSHEET NO:
92G.020

LOCAL GOVERNMENT:
Chilliwack



ALC FILE NO:
68456

MAP PRODUCED:
June 9, 2023

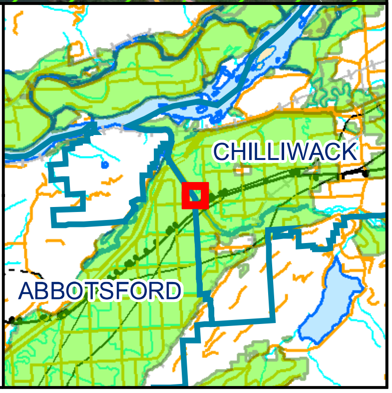
MAP SCALE:
1:5,000

DATA SOURCES & NOTES:
ALC, BCGW & Google Earth. Contains information licensed under Open Government License - British Columbia.

Map for reference only. Accuracy not guaranteed.

- Subject Property (41495 Vedder Canal, Chilliwack, BC)
- Approved Fill Placement Area Valid for 5 Years (~0.9 ha)
- Agricultural Land Reserve
- PMBC Parcel Cadastre

0 50 100 150 200 250
Metres



P:\3400-3499\3427-018\501-Drawings\b_Figures\PotentialStockpile\3427018_PotentialStockpileAreas.dwg

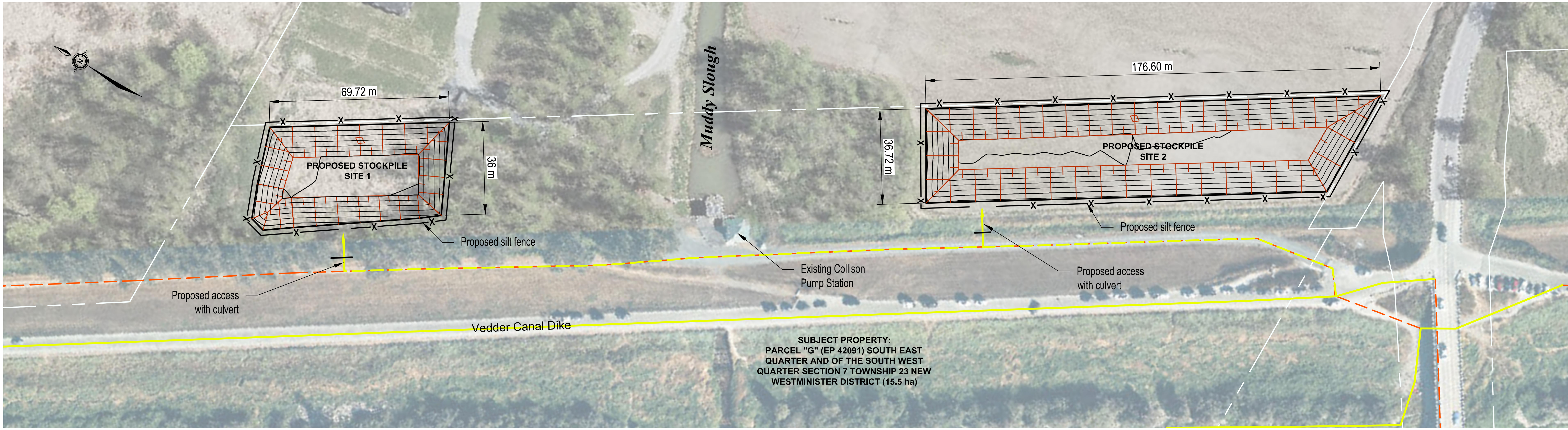
SAVED 2023/05/15, 3:58 PM

Paper Size = ANSI B
At Full Size, this border measures 260 mm x 400 mm

Ministry of Environment and Climate Change Strategy

Vedder River Sediment Removal Project

KERR WOOD LEIDAL
consulting engineers



Plan - Keith Wilson Field Stockpile

Scale 1:1500

Legend

Existing Trails

Existing Access

Key Information - Site 1

Stockpile Status: Potential

Stockpile Land Ownership: Municipal (013-571-664)

River Bank: Right

Stockpile Area: 2,818 m^2

Estimated Max Volume[1]: ± 10,000 m^3

Existing Material[2]: n/a

Key Information - Site 2

Stockpile Status: Potential

Stockpile Land Ownership: Municipal (013-571-664)

River Bank: Right

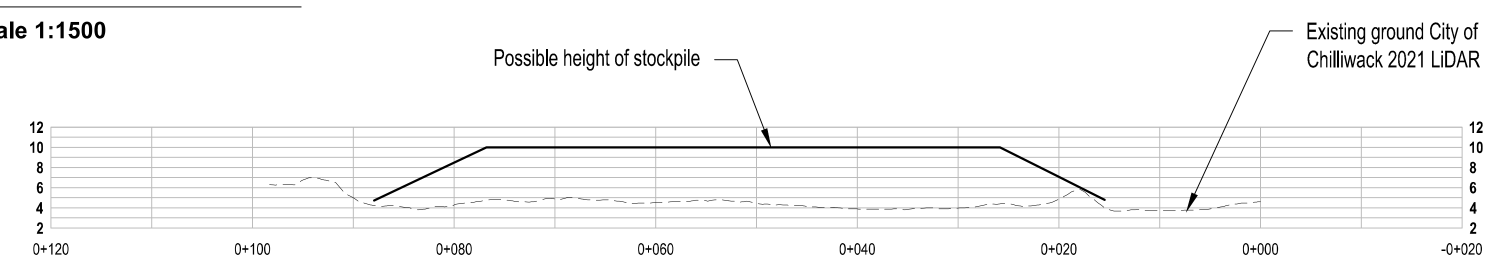
Stockpile Area: 6,100 m^2

Estimated Max Volume[1]: ± 23,000 m^3

Existing Material[2]: n/a

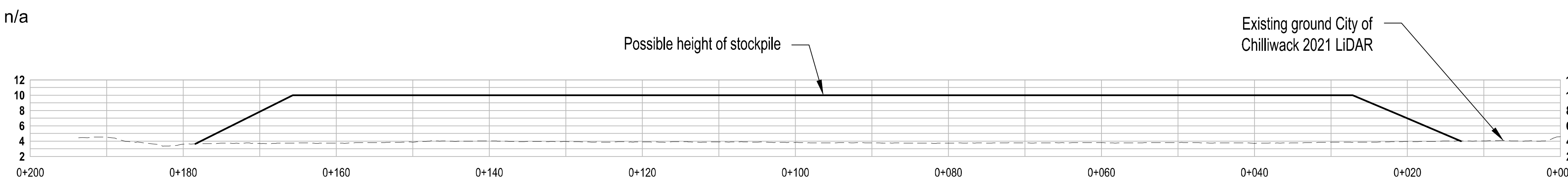
[1] Volume estimated using total stockpile area; 2H : 1V side slopes, and an estimated stockpile height.

[2] Based on stockpile material present in the LiDAR dataset collected April/May, 2021



Profile - Keith Wilson Field Stockpile - Site 1

Scale 1:750



Profile - Keith Wilson Field Stockpile - Site 2

Scale 1:750

Project No.	3427.018
Date	May 2023
Scale	As shown

Proposed Keith Wilson Field Stockpile

Figure 3

PROVINCIAL AGRICULTURAL LAND COMMISSION

REMOVAL AND/OR FILL PLACEMENT PROPOSALS
CRITERIA FOR TECHNICAL REPORTS SUBMITTED BY CONSULTANTS

The Agricultural Land Commission (ALC) requires consistency in the quality and format of technical reports submitted to the Commission by applicants (owners) and their agent(s). The ALC requires a technical report containing the following information for all resource extraction and/or fill placement proposals.

All reports must follow the criteria for field work and reporting as established in Policy P-10 Criteria for Agricultural Capability Assessments (attached).

LAND REHABILITATION REPORTS FOR SOIL REMOVAL OR FILL PLACEMENT

All technical reports submitted in support of applications and/or notices of intent involving land rehabilitation must meet the general requirements listed above and contain the following:

- A detailed soil survey and agricultural capability analysis of the land(s) under application, including potential soil bound crop options, and any affected or potentially affected neighbouring properties at an appropriate scale (see Policy P-10).
- All existing resource information such as government soil survey and agricultural capability mapping must be included and discussed in the context of the detailed survey.
- An inventory and description of existing land use on the subject land(s) and surrounding lands must be included.
- An assessment of existing surface and subsurface drainage conditions on the subject land(s) and surrounding lands should be included. In particular, possible drainage improvements apart from the proposed works must be assessed.
- A detailed operating and reclamation plan must be prepared and include, but not be limited to, the following elements:

    a) plans and cross-sections showing existing conditions, interim and final grades, and slope gradient (%) drawn at an appropriate scale and prepared by a Professional Engineer or Registered BC Land Surveyor;
    b) a topsoil management plan addressing stripping, storage and replacement issues;
    c) an operating, phasing and rehabilitation plan for the interim non-farm use activity;
    d) fill certification procedures and site control measures to ensure that only clean soil material is accepted at any site proposed for import of soil from off site;
    e) erosion control measures;
    f) weed management plan;
    g) plan for crop/vegetation establishment;
    h) detailed drainage plans for the rehabilitated site to ensure optimum surface and subsurface drainage conditions;
    i) schedule of monitoring procedures and reporting;

j) final proposed agricultural capability; and
k) closure procedures and certification of the work.

1.2 A discussion of any agricultural improvement to the land, or any loss of opportunity, which might be attributable to the proposed works described in the report.

Agricultural Land Commission Act	**Policy P-10** **October 2017** CRITERIA FOR AGRICULTURAL CAPABILITY ASSESSMENTS

This policy is intended to provide information for professional agrologists submitting agricultural capability assessment reports (a "Report") as part of an exclusion, subdivision, non-farm use application, or as required through a compliance and enforcement action to ensure that they: 1) are providing sufficient information and evidence to support their assessment; 2) are qualified to complete this work; and 3) perform their work on the Reports in accordance with the Code of Ethics of the British Columbia Institute of Agrologists (the "Code of Ethics").The submission of a Report as part of an application is optional; however, one is recommended if low agricultural capability is the primary reason for the application.

CRITERIA FOR FIELD WORK AND REPORTING:

A detailed soil survey must be completed in order to support the agricultural capability assessment and to confirm or revise existing published capability mapping. The soil survey must be conducted at a Survey Intensity Level 1 (in accordance with the Soil Inventory Methods of BC) at a density of one detailed test pit for every one to five hectares. The surveyor must use their discretion in the field to determine how many test pits are required to accurately assess the site. Detailed test pits must include the following information:

- Horizon designations
- Horizon depths
- Colour (Munsell Colour Chart)
- Texture
- Structure
- Consistence
- Coarse fragment content by percent volume for gravel, cobbles and stones
- Presence and depth of mottles (size, abundance, colour)
- Drainage class
- Rooting depth/root restricting layer

Other information that must be collected as necessary includes:

- laboratory data to revise fertility ratings and salinity;
- clinometer readings for slope gradients; and,
- revisions to soil moisture deficits that are supported by local climate data and evapotranspiration rates corrected for site specific texture and coarse fragment content

Test pits must be excavated into the C horizon or to auger refusal. The surveyor must include a soil profile photograph with each test pit (including a tape measure for scale) as well as a landscape photo of the test pit area.

The Report must include a map indicating the location of the test pits and any new capability delineations not previously mapped (polygons). If the site has multiple agricultural capability ratings, the Report must also include a table of the unimproved and improved agricultural capability ratings and area in hectares of each polygon. The Report must provide a discussion of crop suitability as well as non-soil bound agricultural suitability (e.g., greenhouses, poultry barns). Soil survey information and photos for each detailed test pit must be appended to the Report.

If any agricultural limitations are not considered improvable due to site specific considerations, the Report must provide evidence to support this claim. For example, if access to irrigation water is an issue that may limit agricultural capability of a property, the agrologist must calculate the agricultural water demand for a suitable crop compared to available water from various water sources. The Commission considers surface water licences, groundwater, dugouts, and purchasing water from water licence holders as viable options. If these are not considered viable, the agrologist must provide sufficient evidence as to why it is not.

Other information provided in the Report beyond these requirements is considered supplemental to the agricultural capability assessment. Examples of additional information include economic feasibility studies, planning considerations, access to markets, etc.

QUALIFICATIONS:

Agrologists who are submitting Reports to the Commission must provide a bio of their qualifications. The minimum requirements include:

- a bachelor's degree in Agriculture (preferred soils), physical geography, geology, civil or geological engineering, or equivalent;
- completion of upper level courses in agriculture and soil survey/soil genesis;
- completion of at least two full field seasons working under the supervision of a soil surveyor/pedologist;
- demonstrated knowledge of soil survey, soil mapping and agricultural capability classification according to the established methodology (see Methods below);
- registration with the British Columbia Institute of Agrologists in at least one of the following areas of practice:
  - soil and land conservation, reclamation planning and management;
  - soil and terrain classification, mapping and land evaluation; or,
  - arable land evaluation, conservation planning and management.

If the agrologist is unsure if they meet these minimum requirements or believe they have other training/education than those listed above, they should contact Commission Staff.

Reports will be reviewed by the Commission Staff for consistency with these requirements. Any Reports that are deficient in information may be sent back to the author for revision or may not be given the same weight as compliant Reports. The application will be put on hold while the Report is being revised.

CODE OF ETHICS:

It is extremely important that Reports not only comply with the requirements set out above but also that Reports must comply with the Code of Ethics. In particular, the following sections of the Code of Ethics are relevant and important:

1) Section 1
   “In discharging their responsibilities to the public, members must:

   (f) ensure that they distinguish between facts, assumptions and opinions in the preparation of reports or other materials; and

(g) ensure that they clearly state that a report or other materials constitutes an opinion and identifies the limitations within which the opinion is provided.

2) Section 2
"In discharging their responsibilities to the public, members must:

(f) decline any retainers, employment or assignments that would give rise to a conflict of interest.

3) Section 3
"In discharging their responsibilities as expert witnesses before courts and tribunals, members must:

(e) ensure that they provide an objective expert opinion and not an opinion that advocates for their client or employer or a particular partisan position."

The Commission is a "tribunal" under the *Administrative Tribunals Act*.

Members should be aware that, all else being equal, Reports that, in the opinion of the Commission, are not compliant with the Code of Ethics will not be given the same weight as Reports that are compliant with the Code of Ethics. This may adversely affect the application for which the Report has been prepared.

TERMS:

Agricultural capability assessment – means an assessment conducted as per the Land Capability Classification for Agriculture in BC (Kenk, 1983) to determine, confirm, or reassess the agricultural capability classification rating of agricultural land.

METHODS:

Agricultural Capability

Kenk, E. 1983. Land Capability Classification for Agriculture in BC. MOE Manual 1. Ministry of Environment. Victoria.

RAB. 1972. Climatic Capability for Agriculture in BC. Resource Analysis Branch Technical Paper 1. Province of BC. Victoria.

Soil Classification and Survey

Agriculture Canada Expert Committee on Soil Survey. 1987b. Soil Survey Handbook-Volume 1. Land Resource Research Centre, Contribution No. 85-30. Technical Bulletin 1987-9E. Agriculture Canada, Ottawa.

Agriculture and Agri-Food Canada, Soil Classification Working Group. 1998. The Canadian System of Soil Classification. Agriculture Canada. Research Branch. Ottawa.

Luttmerding, H.A., D.A. Demarchi, E.C. Lea, D.V. Meidinger and T.Vold (eds.). 1990. Describing Ecosystems in the Field - 2nd. Edition. MOE Manual 11, Ministry of Environment and Ministry of Forests. Victoria, B.C. 213pp.

Mapping Systems Working Group. 1981. A Soil Mapping System for Canada: Revised. Land Resource Research Institute, Contribution No. 142. Agriculture Canada, Ottawa. 94 pp.

Resources Inventory Committee. 1995 Soil Inventory Methods for British Columbia.

Appendix D

Archaeological Overview Assessment Review

Technical Memorandum

To:	Lawrence Francois (KWL)	**WSP File No.:**	VE22419
From:	Christopher Verral (WSP)		
CC:	Matt Stevenson (KWL) George Dill-Jones (WSP)		
Date:	24 March 2023		

1.0 Introduction

In anticipation of upcoming sediment removal activities along the Vedder River in Chilliwack, BC, WSP E&I Canada Limited (WSP) conducted a review of an archaeological overview assessment (AOA) completed in 2012 by Stó:lō Research and Resource Management Center (SRRMC) of the Vedder River Management area (the project area): *Archaeological Overview Assessment of the Vedder River Management Area* (SRRMC 2012). WSP's review serves to update the SRRMC AOA with details of archaeological sites and relevant archaeological studies carried out in the project area since 2012, and to provide updated archaeological management recommendations for the project.

SRRMC's 2012 AOA included both a desktop review of background and traditional use information, as well as a preliminary field reconnaissance (PFR) survey of the project area. Five areas of archaeological potential (AOPs) were identified (Figure 1-2) and it was recommended that an archaeological impact assessment (AIA) be undertaken prior to any ground disturbing work within those AOPs. Additionally, a traditional gathering area was identified at the east end of the project area, south of the river, largely outside the project area. No recommendations were provided for archaeological management of ground disturbing work within the traditional resources use area. WSP review does not address potential impacts to cultural or traditional use areas; any recommendations or management protocols for work within traditional use areas should be undertake with affected Indigenous communities as per the Stó:lō Heritage Policy (2003).

2.0 Methods

For the purposes of this review, WSP defined the project area based on design plans provided by Kerr Wood Leidal (KWL) dated March 10, 2023. Plans include proposed gravel excavation areas, potential stockpile locations, and access routes along the Vedder River between Chilliwack River Bridge and Vedder Bridge. Site access is anticipated to utilize existing road infrastructure and the Vedder River Rotary River Trail.

Tasks undertaken by WSP during review of the SRRMC AOA include:

- a review of archaeological sites recorded in the Provincial Heritage Register (PHR) via the Remote Access to Archaeological Data (RAAD) online database to identify archaeological resources, study areas, areas of potential, and unreviewed site records added within the project area since 2012;
- a review of the Provincial Archaeological Report Library (PARL) to identify relevant archaeological studies conducted in the project area since 2012; and,
- a review of the results of the SRRMC AOA against current project design plans as provided by KWL in March 2023.

3.0 Background Information

The project area is situated generally in the Lower Fraser Basin Watershed, which is part of the traditional territory of a number of First Nations, including the Stó:lō, Semá:th, Squiala, Leq'á:mel, Ch'iyaqtel, Áthelets, Pópkw'em, Skwah, Peters First Nation, Shxwh:y, Ts'elxweyeqw, Yeqwyeqwí:ws, Skowkale, and Qweqwe'ópelhp First Nations. Archaeological, linguistic, and historic evidence indicates that continuous human occupation in this region extends back at least 10,000 years. For more detailed information on the cultural and historic background of the area, refer to Section 2 in SRRMC's AOA (2012:4-9).

The Vedder River is a tributary that flows west from Vedder Crossing trough a natural channel before turning northwest at Yarrow through an artificially straightened channel (the Vedder Canal) into the Sumas River (Government of British Columbia 2023). Prior to the 1870s, Vedder Creek was only a shallow stream, but logging jams in 1875 and 1894 (resulting respectively in the establishment and eventual abandonment of the northern flowing Luckakuck River) caused the Vedder River to become the dominant distributary channel of the Chilliwack River. Extensive work has taken place since the 1960's to stabilize the channel as it is today, including construction of extensive dikes along the river (SRRMC 2012:5-6).

Current project activities include excavation of gravel and sediments from 12 locations within the Vedder River channel, stockpiling of excavated sediments in 10 proposed locations, and habitat restoration works (Figure 1-3).

4.0 Results

4.1 Previously Recorded Archaeological Sites Near the Project Area

Based on a search of the PHR via the RAAD online database, there are no archaeological sites present within the project area. There are, however, five sites located within 1 km of the project area, three of which have been recorded since 2012 (Figure 3, Table 1).

Table 1. Archaeological Sites within 1 km of the Project Area.

Borden #	Site Type	Proximity to Project	In conflict with project components
DgRl-39	Subsurface -Lithics	0.08 km SE	No
DgRl-52	Surface and subsurface – Lithics	0.2 km SE	No
DgRl-11	Surface – Lithics	0.5 km E	No
DgRl-49	Subsurface -Lithics	0.55 km E	No
DgRl-59	Subsurface -Lithics	0.6 km SW	No

Two of these sites, DgRl-39 and DgRl-52, are located within 0.2 km of the eastern most segment of the project area (Figure 3). These sites are surface and subsurface lithic scatters with abundant cultural materials. Over 5000 lithic artifacts (predominantly debitage, but also including 86 formal tools) were recovered from DgRl-39 at the location of a proposed pedestrian trail development over multiple site visits. The site is highly disturbed and lithics were observed from 0 to 60 cm below surface.

Recorded in 2018, DgRl-52 is a surface and subsurface lithic site consisting of thirty-one artifacts and is considered to be a potential extension of DhRl-39. Twenty-one of these lithics were cobble choppers, predominantly recovered as surface finds. As with DgRl-39, this site was determined to be highly disturbed.

Two additional sites, DgRl-11 and DgRl-49, are located 0.2 km west of the Vedder Crossing Bridge and approximately 0.5 km of the easternmost sediment removal location (Figure 3). DgRl-11 is a raised landform with abundant lithics (hand mauls, adze blades, ground slate knives), thought to have been traditionally used as a lookout spot over the river. DgRl-49 was recorded in 2016 as a possible extension of DgRl-11, from which lithic debitage was recovered during testing of hillslope slump deposits below the original site.

Finally, DgRl-59 was recorded in 2020 and is a small subsurface lithic scatter site identified during the assessment of a parking lot for a recreational trail (Figure 3).

None of these sites are in conflict with proposed project work areas included in the March 10, 2023, design provided to WSP.

4.2 Previous Archeological Studies Near the Project Area

In addition to the sites noted above, studies within 1 km of the project area since 2012 include Stantec Consulting Ltd.'s ongoing AIA of the TransMountain Expansion Pipeline. The pipeline route and study area pass across the Vedder River 0.3 km northeast of the northern end of Browne Road but does not intersect with any of the proposed project work areas. No other archaeological studies within 1 km of the project area were noted in RAAD or PARL.

4.3 Areas of Potential in SRRMC's AOA of the Vedder River Management Area

SRRMC's AOA concluded that the overall archaeological potential of the study area is low. However, five AOPs were identified during the PFR in March 2012 (SRRMC 2012:17-20). All five AOPs consist of are located on raised, dry landforms adjacent to creeks (Table 2, Figure 2) and are less than 20 m long by 10 m wide.

Based on the plans provided by KWL on March 10, 2023, none of the AOPs identified in the AOA are in direct conflict with proposed work areas. However, one of the proposed stockpile locations (Lickman Hay Field) is located within 50 m of AOP2, AOP3, and AOP4 and within 200 m of AOP1 (Figure 2).

Table 2. AOPs Identified by the 2012 SRRMC AOA.

AOP #	Size	Proximity to Project	In conflict with project components
1	20 m x 5 m	185 m E of Lickman Hay Field	No
2	10 m x 5 m	40 m N of Lickman Hay Field	No
3	15 m x 10 m	30 m NW of Lickman Hay Field	No
4	4 m x 4 m	30 m W of Lickman Hay Field	No
5	15 m x 10 m	285 m W of Giesbriecht Stockpile B	No

5.0 Recommendations

Based on the results of this review and plans provided to WSP on March 10, 2023, no protected archaeological sites or areas of potential, including those recorded since 2012, are in conflict with proposed project activities and therefor no further archaeological work is recommended. However, if ground disturbing activities are anticipated to occur within the AOPs as described in the AOA, then

WSP recommends that an AIA in advance of construction be undertaken under a Section 12.2 Heritage Conservation Act Heritage Inspection Permit in accordance with the BC Archaeological Impact Assessment Guidelines (Archaeology Branch 1998), recommendations in the AOA (SRRMC 2012:20), and Stó:lō Heritage Policy.

Regardless of the level of effort expended in advance of construction, or the findings of this report, there exists the potential for unanticipated impacts to unrecorded archaeological sites and it further recommended that an *Archaeological Chance Find Policy* be implemented for the project. In the event that archaeological materials are identified during project construction, an archaeologist and SRRMC should be contacted immediately.

6.0 Limitations and Closure

The findings and conclusions documented in this report have been prepared for the specific application to this project and have been developed in a manner consistent with that level of care customarily exercised by archaeological professionals currently practicing under similar conditions in this region. This study was conducted without prejudice to First Nations treaty negotiations, Aboriginal rights or title. Participation by Indigenous communities in this study does not indicate support of the proposed development by those communities.

WSP E&I Canada Limited

Prepared by:

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Reviewed by:

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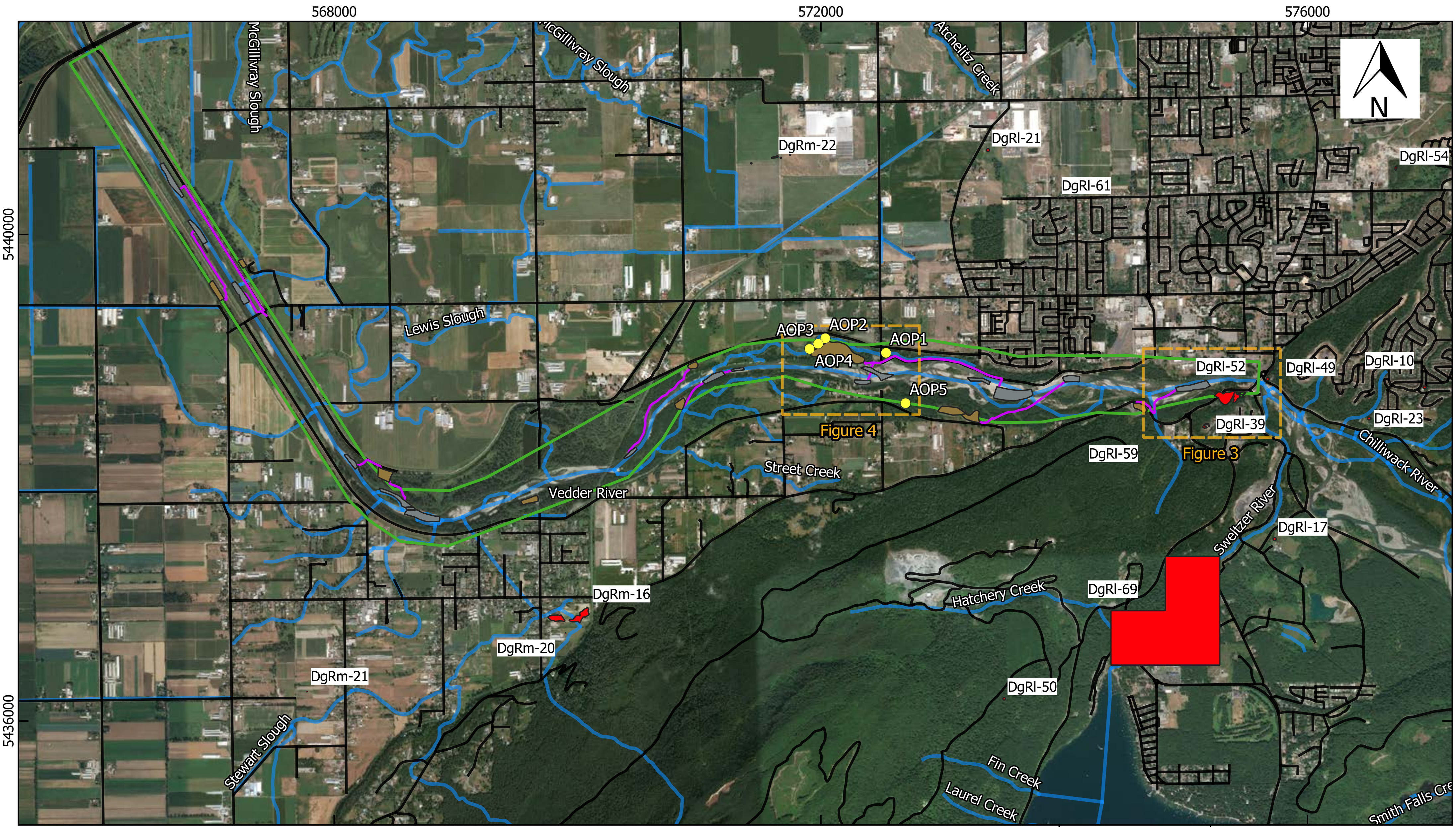
Archaeology Discipline Lead, BC/Yukon
christopher.verral@wsp.com

7.0 References

Archaeology Branch
1998 British Columbia Archaeological Impact Assessment Guidelines, Archaeology Branch, Ministry of Forests, Victoria, BC.

Stó:lō Research and Resource Management Center
2012 Archaeological Overview Assessment of the Vedder River Management Area. Report on file with Stó:lō Research and Resource Management Centre, Chilliwack, BC.

Government of British Columbia
2023 Vedder River. Accessed at https://apps.gov.bc.ca/pub/bcgnws/names/24376.html on March 7th, 2023.



Legend

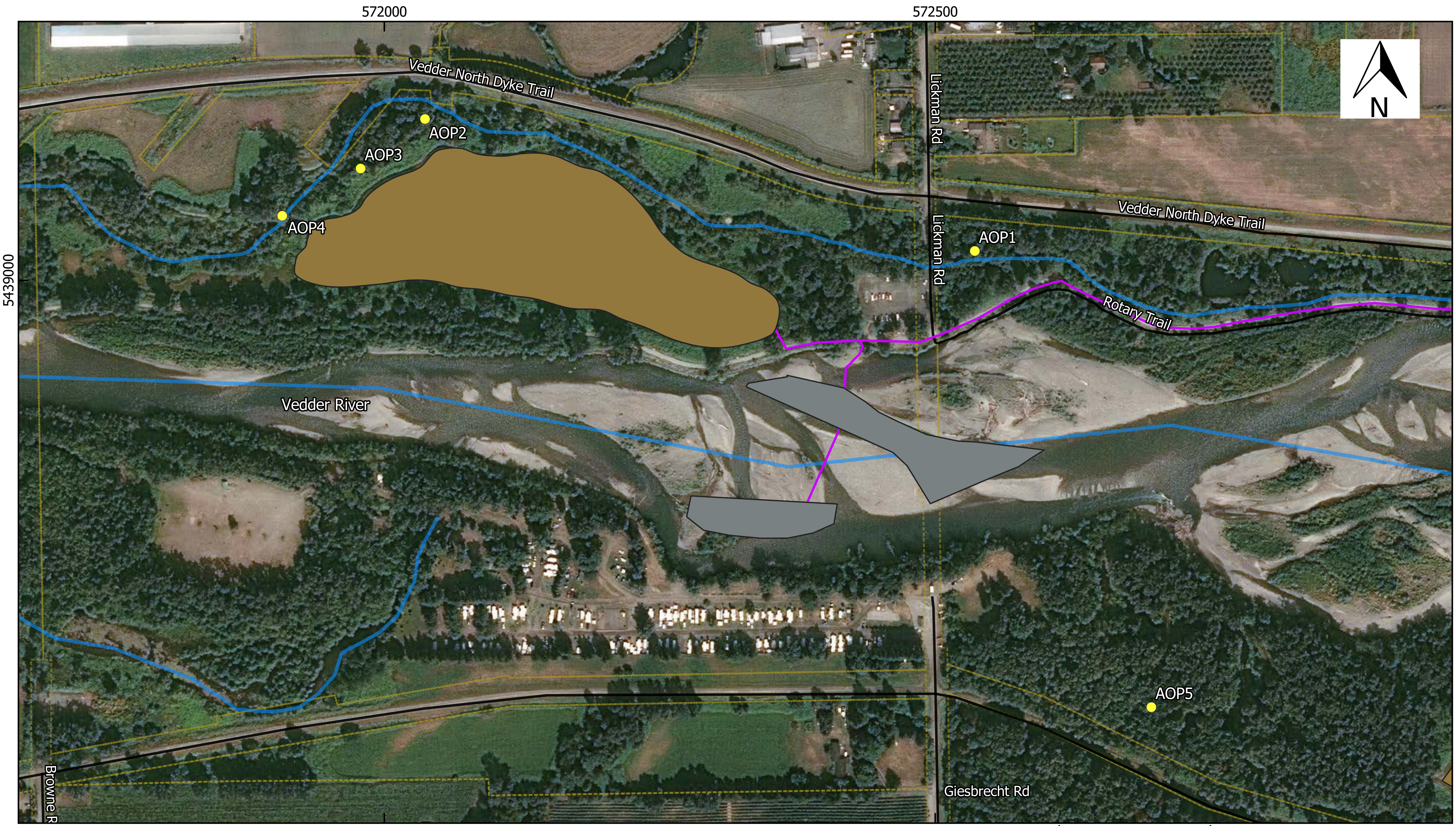
- Previously Recorded Archaeological Sites
- SRRMC 2012 AOPs
- Potential Stockpile Locations
- Proposed Gravel Excavations
- Access Routes
- Detail Map Locations
- Roads
- Waterways
- General Project Area

0 500 1000 m

Scale 1:45000

References:
Bing Imagery
DataBC Data Distribution Service
Open Government License
(http://www.data.gov.bc.ca/)
Geogratis/Geobase
Open Government License - Canada
(http://data.gc.ca/eng/about-datagcca)
MoF - Archaeology Branch
Archaeological Sites RAAD
(Remote Access to Archaeological Data

CLIENT	PROJECT NAME	
KWL	Vedder River Sediment Removal	
LAST DATE ON SITE N/A	DATE OF MAP CREATION 2023/03/10	ANALYST & QA/QC GDJ/CV
PERMIT NUMBER N/A	PROJECT NUMBER VE22419	wsp
COORDINATE SYSTEM NAD 83 UTM Zone 10	Figure 1	
MAP TITLE Project Overview		



Legend

- SRRMC 2012 Vedder River AOPs
- Potential Stockpile Locations
- Proposed Gravel Excavations
- Access Routes
- Roads
- Waterways
- Land Parcels

0 50 100 m

Scale 1:5000

References:
Bing Imagery
DataBC Data Distribution Service
Open Government License
(http://www.data.gov.bc.ca/)
Geogratis/Geobase
Open Government License - Canada
(http://data.gc.ca/eng/about-datagcca)
MoF - Archaeology Branch
Archaeological Sites RAAD
(Remote Access to Archaeological Data

CLIENT	PROJECT NAME	
KWL	Vedder River Sediment Removal	
LAST DATE ON SITE N/A	DATE OF MAP CREATION 2023/03/09	ANALYST & QA/QC GDJ/CV
PERMIT NUMBER N/A	PROJECT NUMBER VE22419	
COORDINATE SYSTEM NAD 83 UTM Zone 10	Figure 2	
MAP TITLE Detailed Map		

Legend

- Archaeologcal Sites within 1KM
- Potential Stockpile Locations
- Proposed Gravel Excavations
- Access Routes
- Roads
- Waterways
- Land Parcels

0 50 100 m

Scale 1:5000

References:
Bing Imagery
DataBC Data Distribution Service
Open Government License
(http://www.data.gov.bc.ca/)
Geogratis/Geobase
Open Government License - Canada
(http://data.gc.ca/eng/about-datagcca)
MoF - Archaeology Branch
Archaeological Sites RAAD
(Remote Access to Archaeological Data

CLIENT KWL	PROJECT NAME Vedder River Sediment Removal	
LAST DATE ON SITE N/A	DATE OF MAP CREATION 2023/03/09	ANALYST & QA/QC GDJ/CV
PERMIT NUMBER N/A	PROJECT NUMBER VE22419	wsp
COORDINATE SYSTEM NAD 83 UTM Zone 10	Figure 3	
MAP TITLE Detailed Map		

Appendix E

Archaeological and Heritage Chance Find Procedure

Archaeological and Heritage Chance Find Procedure

1.0 Purpose

Regardless of prior archaeological investigation, there remains the potential for unanticipated impacts to unrecorded archeological resources from project construction activities. To address such contingencies, this *Archaeological and Heritage Chance Find Procedure* document has been prepared as a guide in the event that unanticipated heritage resources, including archaeological materials and/or deposits, are encountered by project staff, contractors or subcontractors, or the general public. The objectives of this document are to:

1) manage and protect existing heritage resources within the property from unanticipated impacts, and
2) provide a framework to identify, manage, or mitigate as-yet undiscovered heritage resources encountered during construction activities.

2.0 Heritage Legislation

Archaeological sites in British Columbia are protected and managed by the *Heritage Conservation Amendment Act* (*HCAA*, 2019). The *Act* states that no site, nor any part of a site, may be altered or disturbed in any way without a permit (or permits) issued by the Archaeology Branch (Ministry of Forests, Lands, Natural Resource Operations and Rural Development). Sites are protected by the *Act* whether located on public or private lands. Archaeological sites are also protected if they have been designated as "provincial heritage sites" in accordance with Section 9 of the *Act,* or through automatic protection under Section 12.1 by virtue of particular historical or archaeological values.

Sites automatically protected in BC include:

- Archaeological sites occupied or used before AD 1846;
- Rock art with historical or archaeological value;
- Burial places with historical or archaeological value;
- Heritage ship and aircraft wrecks; and
- Sites of unknown attribution that could have been occupied prior to AD 1846.

Protected archaeological sites may not be altered or disturbed in any manner without permits issued under Sections 12.2 and 12.4 of the *HCAA*. Impacts to archaeological resources should also be treated as being of concern to Indigenous groups with asserted interest in the project area. As this project is located on unceded Indigenous territories, heritage permits enabling the recovery of archaeological materials would also be required if archaeological materials are encountered.

3.0 Stó:lō Heritage Policy

In addition to provincial legislation, the treatment of Stó:lō Heritage must adhere to the framework provided by the Stó:lō Heritage Policy (the policy). The policy defines Stó:lō Heritage as being all aspect of Stó:lō culture, whether tangible or intangible, and of any age, either archaeological or historical. As such, the policy applies to any material cultural objects or sites (i.e., physical objects and evidence of human activity) encountered during project activities.

In accordance with the policy and provincial legislation outlines in Section 2.0, project staff should be notified that, any heritage object (archaeological or historical) or materials should not be removed from sites by unauthorized personnel. Measures should ensure that all staff working on the project are informed of cultural heritage policies and commitments, procedures, and plans.

4.0 Archaeological Background

An archaeological site is a geographic place that contains physical evidence of past human activities. Some traditional activities, such as berry gathering and the collection of medicinal plants, leave little or no archaeological remains and thus are more appropriately addressed by a Traditional Use Study (TUS). As such, the boundary of an archaeological site does not constrain the spatial extent of traditional activities associated with that site. Archaeological sites in British Columbia are usually attributed to pre-AD 1846 Indigenous settlement and land use, but physical evidence of activities pre-dating World War II are recorded as historical archaeological sites. Historical sites will often have intact structural remains or "built heritage" (including residences, industrial structures, and farm outbuildings), but also include roads, railways, trails, vehicles or other objects, trees, and rubbish dumps.

Archaeological sites are defined according to the types of archaeological remains (e.g., artifacts and features) present, and according to the types of traditional activities suspected to have taken place. A particular site can be comprised of more than one type of archaeological remains and, generally speaking, it is expected that larger sites will be more complex than smaller ones. Expected archaeological remains found around the Burrard Peninsula environmental settings include:

- **Middens:** The most abundant archaeological remains in coastal settings, middens represent the physical remnants and refuse of ancient villages or seasonal resource-harvesting camps. Coastal middens typically consist of abundant shellfish remains in a matrix of charcoal-rich black loam; fire-altered rocks; ash, fish, bird, and mammal bones; artifacts, and; cultural features such as fire-hearths or post-moulds. Middens frequently were used as burial places by First Nations' people.
- **Artifact Scatters:** These sites are usually comprised exclusively of stone artifacts, representing transitory occupation oriented toward the exploitation of resources. The most common archaeological remains at such sites are chipped or ground stone tools, along with the waste products of stone-tool manufacture ("debitage"). Fire-altered rocks and localized spreads of charcoal and ash from cooking fires are sometimes present.
- **Burial Places:** Burial places are locations that were used by Indigenous people to inter their ancestors. Most frequently, they occur within middens, though were rarely interred at the same time as the midden itself was accumulating. In the period immediately prior to contact with European traders, Indigenous communities were interring their ancestors in above-ground settings, which leave few remains for the archaeological record. Between the time that midden burials were abandoned and the full adoption of surficial interment, a few Indigenous communities in this area buried their ancestors in earthen mounds that usually covered a stone substructure.
- **Wetsites:** A specialized combination of environmental factors can produce a waterlogged archaeological deposit known as a wetsite. These sites only occur in fine-textured, permanently saturated sediments. They are renowned for exceptional preservation of ordinarily perishable artifacts, such as basketry, matting, cordage, and wooden implements (e.g., yew-wood wedges). Wetsites are often associated with still-water environments such as sloughs or distributary channels along a river and are often found near a villages or large seasonal encampments.
- **Historical Sites:** These sites are comprised of post-contact remains, including artifacts, structures, and features of Euro-Canadian or Asian-Canadian manufacture, and denote settlement and land use in the historical (post-AD 1846) period.

Examples of various artifact types that may be encountered in the project area are presented in **Appendix A.**

5.0 Chance Find Procedures

5.1 Initial Action

Step 1: If suspected archaeological or historical deposits or materials are encountered, stop work immediately. Do not move or otherwise disturb the deposits or materials unless they are in imminent threat of being damaged or have already removed from original location.

Step 2: Immediately notify the proponent and archaeological contacts. WSP will immediately contact the Stó:lō Research and Resource Management Center (SRRMC).

Do not resume work until directed by WSP.

Step 3: Ensure that as much information as possible associated with the find is recorded and provide the information to WSP via email. Basic information will include:

- **Date** (when the find was encountered);
- **Observer** (name of the person recording the information about the find);
- **Find location** (detailed enough so that it can be located again. Use GSP coordinates if possible).
- **Type of find** (e.g., artifact, bone, burial);
- **Description of the obvious disturbance to the find** (by equipment, worker, erosion etc.).
- **Photographs of the find** (do not photograph suspected human remains, see Section 6.0)

Step 4: Await direction based on a review of the find location and related information.

Proponent Contact:	Archaeological Contact:
Lawrence Francois (KWL) Project Manager 604-293-3245/604-397-5504 LFrancois@kwl.ca	**Christopher Verral (WSP)** Archaeology Discipline Lead, BC/Yukon 778-928-0728 christopher.verral@wsp.com

Stó:lō Research and Resource Management Center:	
Cara Brendzy Heritage Stewardship & Archaeology Manager 604-824-5107 / 604-791-1982 cara.brendzy@stolonation.bc.ca	**Dave Schaepe** Director & Senior Archaeologist 604-819-1467 dave.schaepe@stolonation.bc.ca

Do not share photographs suspected archaeological materials on social media platforms.

5.2 Further Action

WSP will determine if the find is archaeological, protected-historical, or of no concern. Depending on the nature of the site and the situation of the chance find, one of the following responses is likely:

Response #1: No Concern

- Based on a telephone and/or email description of the encounter and review of available images as well as a possible site visit, WSP and SRRMC may determine that there are no archaeological concerns, allowing related construction activities to continue as planned.

Response #2: Confirmed Archaeological or Historical Resource

- If the find is determined to be an archaeological or historical resource or is potentially of concern to affected Indigenous groups, WSP will notify (via phone or email) the proponent, who will in turn communicate with any staff or contractors who may have been involved in the find.
- If the archaeological or historical resource was identified during construction, crews may continue to work on other portions of the project while the archaeological or historical resource is being managed at the discretion of WSP. Construction in the vicinity of the find (within 20 m) may not resume until directed by WSP.
- In the event that the find is confirmed to be an archaeological or historical resource, a field visit will be conducted by WSP (if one has not already taken place) and the find location will be staked or flagged off to prevent additional disturbances. If excavated fill has been loaded into a truck, it will be emptied at a nearby secure location for inspection by WSP.
- Depending on the nature and location of the find, an archaeological impact assessment (AIA) may be recommended. An AIA will require provincial permits issued by the Archaeology Branch. Assessment and management options for the find will be drafted by WSP in consultation with SRRMC, these may include one or more of the following:
    - Archaeological monitoring of additional construction activities in the vicinity of the site;
    - Subsurface testing in the vicinity of the site;
    - Site avoidance through project redesign (if further construction is required in the vicinity of the site);
    - Site protection (protective covering, stabilization, or physical barriers); or
    - Systematic data recovery or excavation.

5.3 Follow Up Action

- WSP will advise the proponent when project activities at the find location can restart.
- WSP will implement management recommendations.
- WSP file a BC Archaeological Site Inventory Form for entry to the Provincial Heritage Register.
- All work will be summarized by in a report or technical memo, distributed to all relevant parties, including the proponent, SRRMC, and the Archaeology Branch.

6.0 Found Human Remains

Should suspected human remains be discovered, procedures should follow the Archaeology Branch Policy Statement "Found Human Remains" (Archaeology Branch 1999[1]) and the Stó:lō Heritage Policy. Local policing authority (e.g., RCMP, municipal police) may also be informed in the event of found human remains.

6.1 Initial Action

Step 1: If confirmed or suspected human remains are encountered, stop work immediately. **Do not photograph the remains.**

Step 2: Immediately notify the proponent and WSP. Do not touch, move, or disturb the remains. If the remains are suspected to be non-archaeological (i.e., modern forensic remains), WSP will contact the local police authority and SRRMC as required.

Step 3: **Secure the site.** Limit access to the find location. Cover any exposed bones with plastic sheeting, blankets, or other clean covering (**do not back fill any open excavations**). If the affected location is busy or has high public visibility, an employee or contractor should be assigned to stand watch until local policing authority or WSP arrives on site.

If the remains are determined to be human and archaeological in origin WSP will contact the Archaeology Branch, SRRMC, and affected Indigenous communities to provide detailed location information and images of the find location. Based on subsequent discussions with Indigenous groups, SRRMC, and the Archaeology Branch, WSP will advise the proponent on further action required.

6.2 Potential Further Actions

Depending on the details of the specific situation, one of the following responses is likely:

Response #1: No Concern

- If it is determined that remains are not human and that there are no further concerns, construction activities can continue as planned.

Response #2: Confirmed Human Remains - Forensic

- If forensic, the local policing authority (e.g., RCMP or Coroner) will assume management of the scene and liaise directly with WSP and the proponent.

Response #3: Confirmed Human Remains - Archaeological

- If archaeological, but not of Indigenous ancestry, WSP will notify the proponent and attempt to identify and contact an organization representing the descendant cultural group, in consultation with the Archaeology Branch.
- If archaeological, and of Indigenous ancestry, WSP will determine a management plan in consultation with SRRMC, the Archaeology Branch, and affected Indigenous groups, including:
  - Interim site management of potential impacts from activities at the find location, such as staking or flagging-off the affected location and continuing to cover any exposed bones with plastic sheeting, blanket, or other clean covering (not back fill);
  - Documentation of the burial site;
  - Appropriate treatment of human remains in line with the Stó:lō Heritage Policy;
  - Management of future impacts; or

[1] This policy is currently under review and is subject to change without notice.

  - If applicable, the off-reserve reburial of remains, involving leaving the remains in-place or moving them to a location in a place agreed upon by Indigenous communities, the Archaeology Branch, and the proponent.

6.3 Follow up Action

- **If forensic**, the local policing authority will advise the proponent when project activities at the find location can restart.
- **If archaeological**, WSP will implement management recommendations and communicate to the proponent when project activities at the find location can restart.
- WSP file a BC Archaeological Site Inventory Form for entry to the Provincial Heritage Register.
- All work will be summarized by in a report or technical memo, distributed to all relevant parties, including the proponent, SRRMC, and the Archaeology Branch.

7.0 Communication Information

As per the procedures for encountering unanticipated archaeological and heritage resources within the property, the following communication protocols will be followed (Figure).

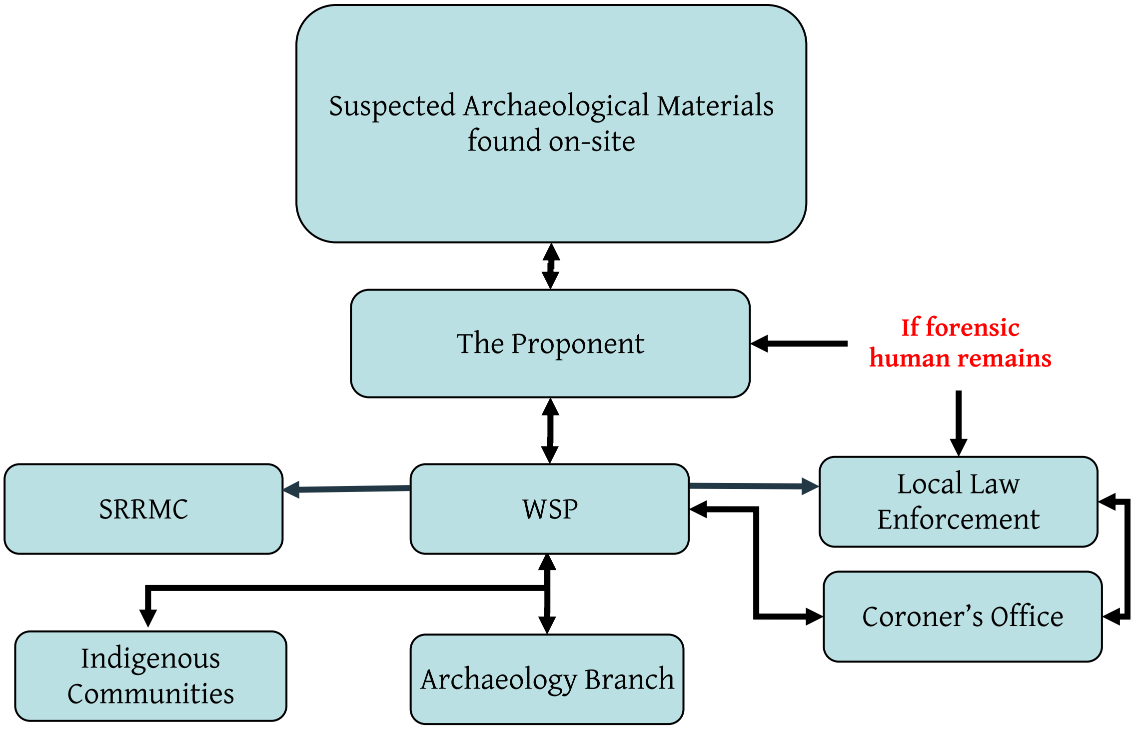


Figure 1: Chain of Communication for Cultural Heritage Chance Find Procedure

8.0 References

Archaeology Branch, Ministry of Forests, Lands, Natural Resource Operations and Rural Development
1999 Archaeology Branch Policy Statement "Found Human Remains," Victoria, BC.

Stó:lō Nation
2003 *Stó:lō Nation Heritage Policy Manual. On-file at WSP, Vancouver, BC*

Appendix A:
Artifact and Sediment Examples for
Archaeological Chance Find Procedure

Chipped Stone Artifacts

Flaked cobble tool

Core and fragments

Projectile point

Chipped biface

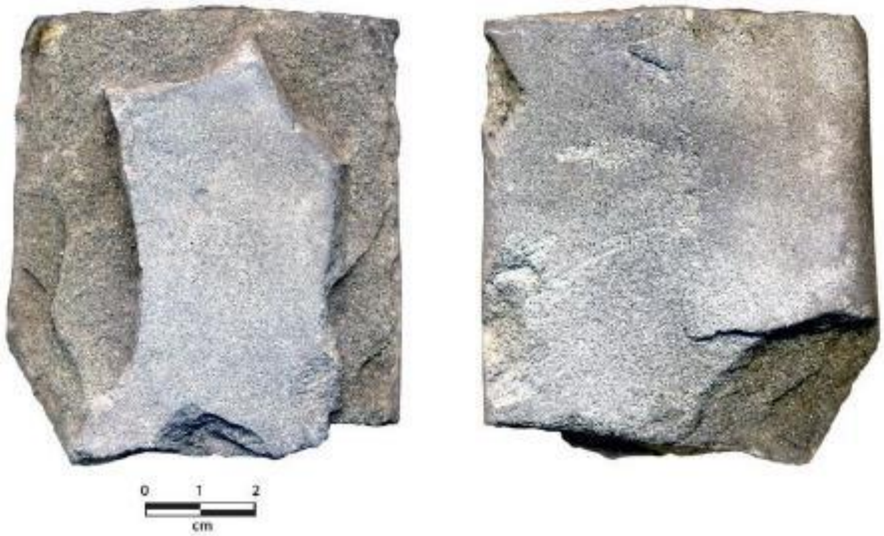
Microblades

Stone flakes (“debitage”)

Chipped and ground stone point

Ground Stone Artifacts

Ground slate point



Ground abrader

Beads

Stone maul fragments

Ground stone adzes

Ground stone bowl

Ground stone ornament

Stone anchor

Net weight preform

Bone Artifacts

Bone awls

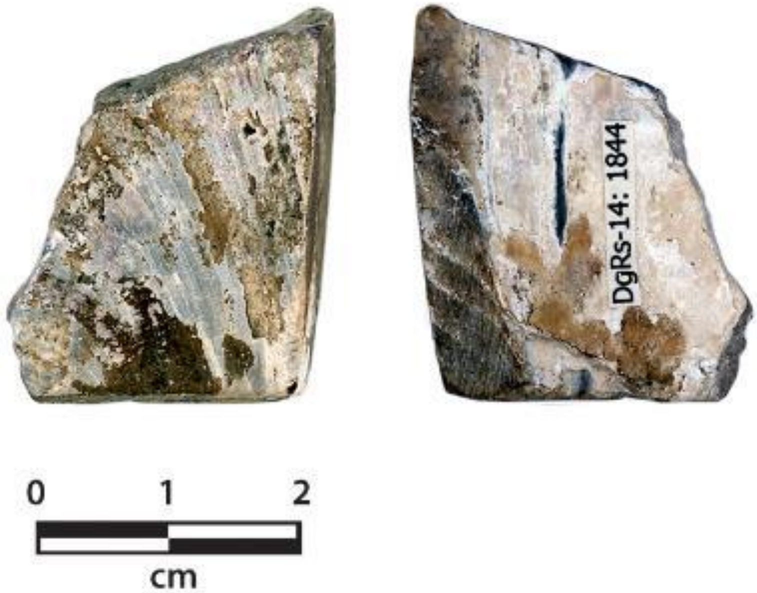
Bone valves

Bone pendant

Bone needles

Bone Chisel

Shell Artifacts



Worked Shell

Shell pendants

Shellfish showing harvesting damage (vertical gouges cross-cutting the shell growth rings)

Wetsite Material

Bark strips

Cedar basket

Cedar rope

Cedar net

Archaeological Sediments

Shell midden profile

Shell midden

Historical Materials

Historical glass

Historical ceramic

Historical metal

More examples of historical metal

Historical bone (deer humerus)

Historical bone (deer humerus. Note fine saw marks)

wsp