Nova Pacific Environmental

Proposed 2016 Vedder River Sediment Removal Project

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Prepared for:

Ministry of Forests, Lands and Natural Resource Operations

On behalf of:

Vedder River Management Area Committee

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Introduction

The Vedder River Management Committee seeks to manage the floodway capacity of the Vedder River through periodic sediment removals. For 2016, seven excavation sites are proposed. The volume proposed is approximately equal to the long term biennial net accumulation of sediments. Sediment removal locations within the Upper, Middle, Lower and Canal reaches (Figure 1) are selected to:

- effectively lower water levels where dyke freeboard is limited,
- trap gravel upstream of freeboard limited areas
- reduce excessive excavation requirements downstream, and
- provide optimum habitat outcomes while meeting flood protection objectives for sediment removal.

For a more detailed review of habitat assessment work conducted as part of the channel capacity maintenance program, the reader is referred to the habitat assessment report[1] attached to this submission. The assessment protocol includes detailed evaluation of habitat types both before and after the excavation. In addition, spawning locations for Pink and Chum Salmon have been tracked for the Vedder River for several previous rounds of these excavations. In 2014, this was scaled back to look at spawning only at the individual sites.

Previous assessment of excavations similar to the ones proposed has allowed for the development of sediment removal procedures that focus on providing optimal outcomes for fish and fish habitat. However, it is important to remember that the Vedder River is subject to significant natural changes arising from the deposition and erosion of the bed material. For detail on the hydrological rationale for the removals, the reader is referred to the Vedder River Hydraulic Profile 2016 report[2].

Each of the seven excavations proposed for 2016 is adjacent to actively used fish habitat which includes spawning, rearing, and migration habitats. The purpose of this document is to provide details of each proposed excavation and to review the adjacent fish habitats, expected fish utilization, potential impacts and mitigating measures included in the planning of each excavation.

[1] NPE, 2016. 2014 Vedder River Gravel Excavation-Habitat Changes and Environmental Impacts. Vedder River Management Area Committee.

[2] KWL, 2016. Vedder River Hydraulic Profile Update 2016. Vedder River Management Area Committee.

General Considerations for Fish Habitat

Both adult and juvenile salmonid migration can be affected by the proposed excavations and mitigation steps are undertaken. These consist primarily of deep wide openings to the excavations and avoiding leaving pits that could become isolated pools. Chum Salmon (Oncorhynchus keta) and Pink Salmon (O. gorbuscha) spawn in the river reaches where the excavations take place. Generally, Pink Salmon have been noted to spawn above riffles and excavations are designed to ensure that these riffle areas are not bypassed by the excavation footprint. Chum salmon more often spawn below riffles and in side channels where sub-gravel flows are emerging. Sockeye Salmon (O. nerka), Coho Salmon (O. kisutch) and Steelhead (O. mykiss) travel through on route to their preferred spawning areas. Occasionally, spawning Chinook Salmon (O. tshawytscha) or their redds are evident in the Vedder River. Excavations take place within the window where fish utilization is at its lowest, after most juvenile salmonids have migrated out of the area and before spawning. The excavations are planned to minimize changes that could detrimentally impact redds placed post excavation. In addition, excavations are being conducted in non-pink years.

Salmonids are rearing in many locations around the excavations; concentrations of juvenile salmonids have been noted in pools, downstream of riffles in glide tails, along channel edges where cover is available and within microchannels that are frequently found along the inside edge of gravel bars.

Habitat mapping is conducted annually during low flows and comparisons are made before and approximately one year after for each excavation site. Habitat maps showing conditions at each site are presented below. Due to substantial changes since the 2015 assessment at some of the proposed sites, the habitat maps no longer show current conditions. Where this has occurred, the reader is referred to the excavation design figure which includes a recent (March 2016) aerial photo background.

To ensure that the best possible suite of sediment removal sites is considered, a preliminary overview of 14 sites was conducted (Table 1). From these, a set of seven has been selected that best meet the VRMAC objectives to maintain floodway capacity while optimizing fish habitat value (Table 2). Figure 1 shows the location of the seven excavations covered by the proposal.

Table 1: List of Candidate Bars Considered for 2016 Sediment Removals

#	Bar Name	Plan Developed	Yield (m^3)	Comment
1	Garrison	N		Private land access. Minimal material.
2	Giesbrecht	Y	12,700	Long road to reopen plus tricky bridge access
3	Webster	N		Difficult access
4	Lickman (formerly Campground, north side)	Y	17,000	Stockpile and access affect recreational users.
5	Brown	Y	5,000	Pipeline presence concern
6	Bergman	Y	7,100	Large, easy access. Offers good habitat channel prospect.
7	Railway	Y	3,200	Usual refill pattern
8	D/S Rail Bridge	Y	14,250	Good opportunity but access is an issue
9	Yarrow	Y	14,300	Upstream location – direct flow across to left bank
10	Community B	N		No access
11	Greendale	N		Persistent secondary channel mid bar
12	Salad A	N		No emergent gravel
13	Salad B	N		Small, poor access
14	Keith Wilson	Y	17,200	Coordination requires with pump station discharge
	Total		**90,750**	

Table 2: Final Selection of Bars for Sediment Removal in 2016

#	Bar Name	Plan Developed	VRTC 1 comments	Yield (m^3)	Comment
1	Giesbrecht	Y	Proceed with site as back up	12,700	Long road to reopen plus tricky bridge access
2	Lickman -formerly Campground but now is on north side	Y	Look at volume increase (17,000m^3) by directing more flow to right	21,500	To offset hard erosion on left bank. Stockpile and access affect recreational users.
3	Bergman	Y	Try to increase volume (7,000m^3)	9,600	Large, easy access. Offers good habitat channel prospect.
4	Railway	Y	Link to Rail bridge site	3,200	Usual refill pattern
5	D/S Rail Bridge	Y	Expand volume (14,250m^3) significantly	26,850	Good opportunity but access is an issue
6	Yarrow	Y	Y	14,300	More upstream – direct flow across to left bank
7	Keith Wilson	Y	Y	17,200	Good candidate but need to coordinate with pump station discharge
	Total			**105,350**	

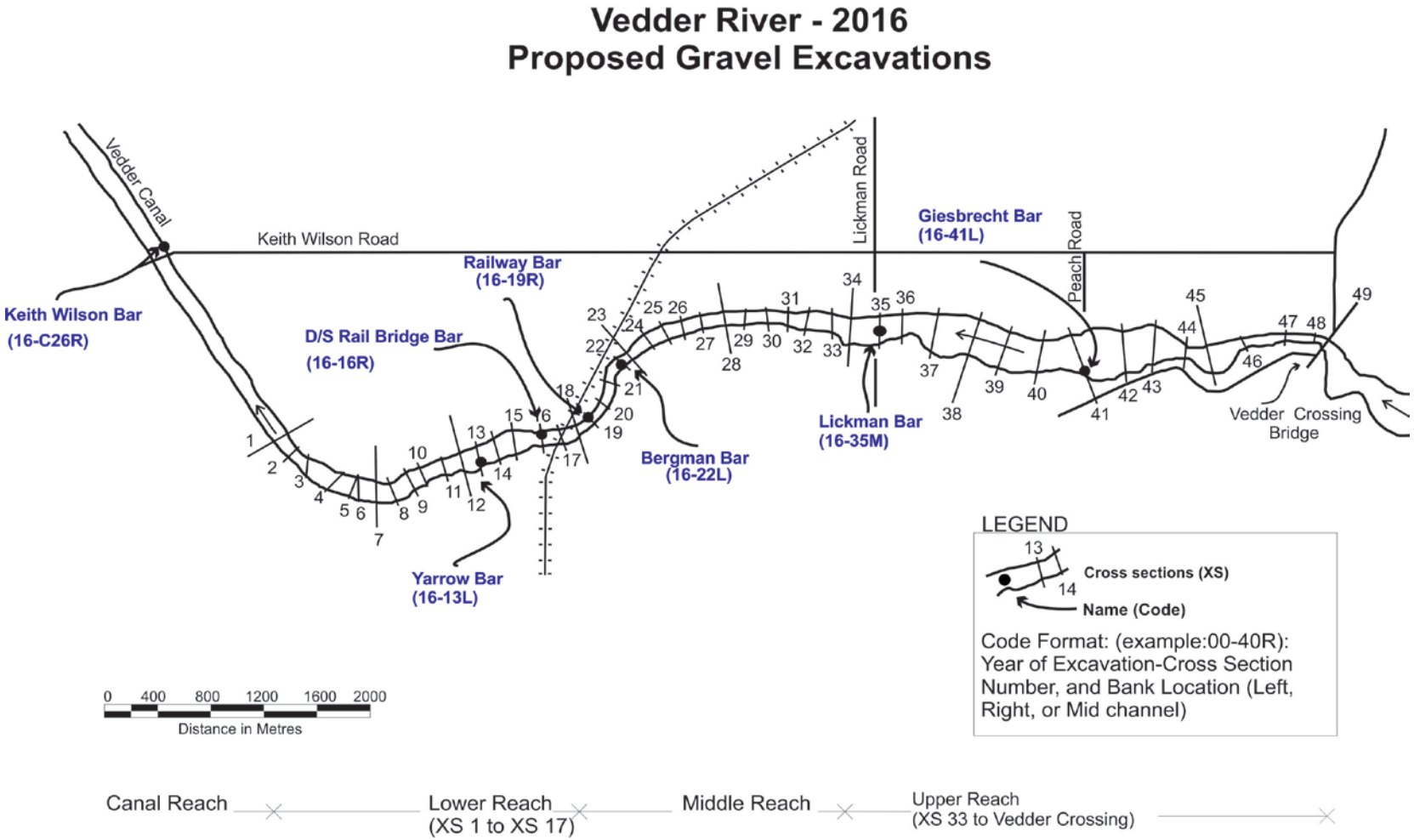

Figure 1: 2016 Vedder River Proposed Gravel Excavation Sites

Excavation Selection, Design, Monitoring and Assessment Process

Each excavation has been prepared in accordance with best management practices developed specifically for the Vedder River Sediment Removal Program[3]. These were developed in cooperation with the Vedder River Technical Committee and Vedder River Management Area Committee with significant contribution and collaboration with DFO staff in the years between 1994 and 2012. Amendments have been made to the design guidelines to expand the range of removal options and improve fish habitat outcomes. The latest version of the guidelines is presented in Table 3.

Generally, these guidelines are intended to optimize fish habitat outcomes as a result of the excavations. Several guidelines, such as adhering to the fisheries window and working in isolation of flowing water, are intended to avoid detrimental impacts during the excavation.

Sediment removals are planned every two years to avoid pink salmon spawning. Cross sections are surveyed and form the dataset for updating the hydraulic model and predicting water levels under flood conditions.

Planning and implementation of this biennial sediment removal program requires that planning be completed following the fall freshet but preceding the spring freshet. Cross sectional surveys are usually completed in February with hydraulic modeling, and site selection and design following in March and April. Coordination of the new information and optimization of the program is targeted for the beginning of May to allow as much time as possible for permitting and to allow removal contracts to be let. The start of excavations is dependent on dropping water levels as well as the July 15 to September 15 fishery window. Accordingly, the excavations usually begin around August 1 and continue to September 15. Detailed assessment of excavations and related habitat conditions is usually completed in the early fall and incorporates observations of spawning around the excavations. A follow up on conditions one year later completes the biennial cycle.

Potential sediment removal sites are identified independently, based on their potential to provide an effective removal while avoiding harm to fish and fish habitat. A set of guidelines (Table 3) has been developed through adaptive management to provide optimal habitat outcomes from the sediment removal program and inform the design, monitoring and assessment of the excavations over several iterations of sediment removal. These sites are then compared to the identified freeboard deficiencies and calculated volumes of material required to meet channel capacity objectives. Additional hydraulic modeling is completed

[3] B.F. Wright, 1999. Gravel Removal Constraints, Guidelines, and Planning Procedures for the Protection of Fish Habitat: The Vedder River Floodway Protection Program. Prepared for the Vedder River Management Area Committee, October 1999.

to determine the effect of the removals on high water levels and freeboard. A final set of target excavations is then selected to meet the flood reduction objectives while minimizing disruption to fish habitat.

Table 3: Guidelines and Constraints Followed during Excavations

No.	Guidelines
1	No excavations in pink spawning years in the reach where most Pink Salmon spawn
2	Avoid excavating in areas of sub-gravel percolation as this may impact Chum Salmon spawning and water levels in enhanced off-channel habitat
3	Work only in isolation from flowing water
4	Leave the upstream third of bars
5	Adherence to the fisheries windows
6	Avoid digging consecutive bars because of potential interaction between them
7	Excavate channels to replicate natural streambed shape to minimize post-excavation changes
8	Protect areas adjacent to points where secondary channels branch off from the main flow
9	Avoid excavating in areas adjacent to sensitive habitat
10	Avoid digging long pits associated with elevation drops or which can affect long sections of the river
11	Leave gently sloped inside edges on upper end of cuts to prevent head cutting and to leave stable habitat for Chum Salmon spawners
12	Open the upstream end of deep gravel pits so that headcutting can occur, and to encourage gravel flow into the pits
13	Construct internal, cross channel berms in long pits or where there is a significant elevation drop
14	Leave the downstream ends of bars since this will preserve tailouts which provide rearing and spawning opportunities
15	Ensure riffles are not bypassed by excavation
16	Adjacent dry channels should be deepened and stabilized with flow control structures such as LWD complexes
17	Leave pits with large head differences closed to prevent chum spawning within them or fish trapping
18	Open excavations thoroughly to avoid creating fish traps. Two deep openings adjacent to the main channel should prevent this problem
19	Use caution when designing excavation where the thalweg approaches the pit at an angle of more than a few degrees. Design mitigation may include options to reduce the opening or move the excavation or the opening downstream when this condition is encountered.

Each excavation site is designed to yield optimal habitat in its post excavation condition. Gentle slopes, strategic flow inlets and outlets and careful placement and delineation of the excavation footprint are employed to ensure habitat impacts are minimal. Habitat mitigation and enhancements are incorporated where appropriate and include placement of large woody debris (LWD), enhancement of secondary or micro-channels, and occasionally other initiatives such as constructing channels or riparian planting.

Access to the sites is also managed according to well established practices. Generally, all of the bars are accessible via existing routes and lack of suitable access usually results in exclusion. These include the tops of dykes and existing armoured banks with access roads already in place and other existing access roads and trails. The routes are maintained by trimming of obstructing vegetation but clearing is not normally required. Normally access to the bar surface requires a ramp down from the bank and often crossing of secondary or microchannels near the toe of the bank.

Culverts, if required, will be sized to ensure that they do not back up the river. An environmental monitor will supervise their installation. The culverts will be carefully placed and flow directed through them before any ramp construction begins. Typically, a single wet crossing by an excavator is allowed to access material for ramps and cover for the culverts. This material is usually obtained from the excavation footprint but on occasion it is necessary to use a borrow pit that is refilled once access to the footprint area is completed.

Traffic on the gravel bars will be confined to the footprint and a single access track.

Hydraulic modeling is used to confirm the rationale for the selected sites. A portion of the hydraulic model output prepared by Kerr Wood Leidal Associates Ltd. is provided in Appendix 2. This shows the modeled flood profile lowering achieved from the proposed excavations.

Once the final set of sediment removal sites is approved, removals are monitored to ensure that the excavations follow the design and that best management practices are followed. Assessment of the excavation includes follow up surveys to ensure that objectives are being met, and detailed habitat mapping to ensure that habitat changes are in balance with expectations.

Habitat mapping provides an objective method for tracking and rating habitat conditions before and one year after each sediment removal activity. More detail on this can be found in the assessment report for the 2014 excavations that has been included as Appendix 1. Note that this report is the latest in a series of reports that describe monitoring and assessment works completed on the river; a list of these reports is provided as Appendix 2.

Anticipated Effects from Excavations

Once the excavations are completed they are opened to the flowing water of the river. The downstream end is opened first to ensure that water levels do not increase in the pit. When the upstream end is opened, sediments are washed into the pit where they settle. The water in the pit, however, retains high turbidity and this creates a temporary increase in turbidity downstream as it is displaced, usually within a few hours.

With the onset of the fall freshet, higher flows will tend to modify the shape of the excavation. Filling begins immediately as openings widen and outer berms are eroded. In some cases, the erosion of the berm is encouraged by excavating to a steeper slope. Some head cutting is possible which can affect adjacent riffles near the upstream end of the excavation but this is normally avoided by leaving gentle slopes.

There are usually more wetted habitats when the detailed follow up assessment is completed one year later. Habitat diversity is often increased as a result of the excavations and the habitat ratings calculated provide a mix of increases and decreases to habitat value. These changes occur in an environment that is changing with each freshet and separating the effects of the excavation from the natural changes is challenging. However, the changes related to the excavations are similar to the natural changes and no net loss in habitat is anticipated.

To ensure that this remains the case and to ensure that longer term changes do not arise annual mapping of habitats is completed. The habitat in the vicinity of each excavation at the time of excavation is compared with conditions one year later. The most recent completed assessment is provided in Appendix 1. In addition to providing the results from the 2014 excavation, this report provides a detailed description of the habitats in the Vedder River as well as the methodology used for the assessment.

Excavation Layouts

Plans for each of the seven proposed excavations are provided in the following pages along with a brief description of location, access, stockpile sites, habitat concerns and mitigation plans.

Estimated quantities have been calculated to take sloped edges into account. Specific LWD placements have not been identified although it is expected that each excavation will include some LWD. Habitat excavations have been added to pits where appropriate and these will likely receive LWD as well.

Most excavations follow program guidelines for site selection and design. A rationale is provided where variations from the guidelines are warranted by specific site conditions or program objectives.

Each bar is identified with a unique identifier that includes the year, cross section and location within the channel. The first two digits show the year, the next two digits show the cross section, followed by a C for cross sections in the canal. The final letter shows position, R for bars adjacent or near the right bank, L for bars adjacent or near the left bank and M for mid channel bars.

Individual Excavation Details

Site Name: Giesbrecht **Site Number:** 1
Identifier: 16-41L
Location: 200 m downstream from Peach Road.
Ownership: Provincial Crown

Previous Excavations: 1996, 2006, 2008, & 2010 (approximate location by XS identifier)

Stockpile: Giesbrecht Stockpile

Length: 150 m
Width: 50 m
Depth: 3.5 m

Expected Gravel Yield: 12,700 m^3
May be small increase from scalping downstream tip of bar.

Bar Access:
Access from Giesbrecht Road via setback dyke to stockpile site and then along existing access road adjacent to recently cleared spurs. Site to stockpile is approximately 500 m. Will likely require crossing for backwater habitat.

Objectives and Effectiveness:
The purpose of this excavation is to trap gravel upstream of freeboard-limited area.

Anticipated Outcome:
It is expected that the pit will refill quickly but a low flow channel may be retained at this location.

Habitat Considerations:
Log jam and channel braiding provide a diversity of habitats in the area, particularly downstream of the excavation where riffle structure directs flow into 3 or 4 braids. Temporary channel on left bank below the excavation remains wetted but not flowing at low flows. This area exhibits good bank complexity including LWD and adjacent pools and steep banks for juvenile rearing at higher flows. The habitat map below covers a larger area than the figure showing the excavation. While the basic configuration is similar there has been additional infilling during the fall freshet of 2015.

Fish Habitat Utilization:
The proposed Giesbrecht Bar excavation is adjacent to several habitats that are important in supporting salmonids. Glide tail/edge and riffle habitats are located upstream and downstream of the proposed excavation footprint; these habitats

have been noted during numerous assessments since 1994 to support Pink and Chum Salmon spawning. Riffle habitats are located below each of the glide tail areas and support primary production of algae and macro-invertebrates, providing food to rearing salmonids. Chum Salmon redds were documented at locations in association with glide edge habitat, showing a preference for the shallow, fast flowing water along the edges of the gravel bars.

Although both Pink and Chum Salmon spawn in some of the habitat features identified around this bar, the distribution of these spawners tends to be further downstream with almost all Pink Salmon found to be spawning in the Middle and Lower reaches of the Vedder River and upstream half of the Vedder Canal. Most Chum Salmon are found in the Middle and Lower reaches with some in the upper part of the Vedder Canal and lower part of the Upper Reach of the river.

Mitigation Plans:
A riffle type entry is proposed at the upstream end to provide habitat value, limit amount of flow diverted into the excavation and retain habitats downstream. The inlet will be field designed to ensure that the river does not enter the pit where the slope changes from 5:1 to 10:1. This could include extending the 10:1 slope or gradually transitioning from the flatter to the steeper slope.

2016 Proposed Excavations: Geisbrecht Bar (16-41L)

Draft Plan: April 05, 2016 Photo: March 19, 2016

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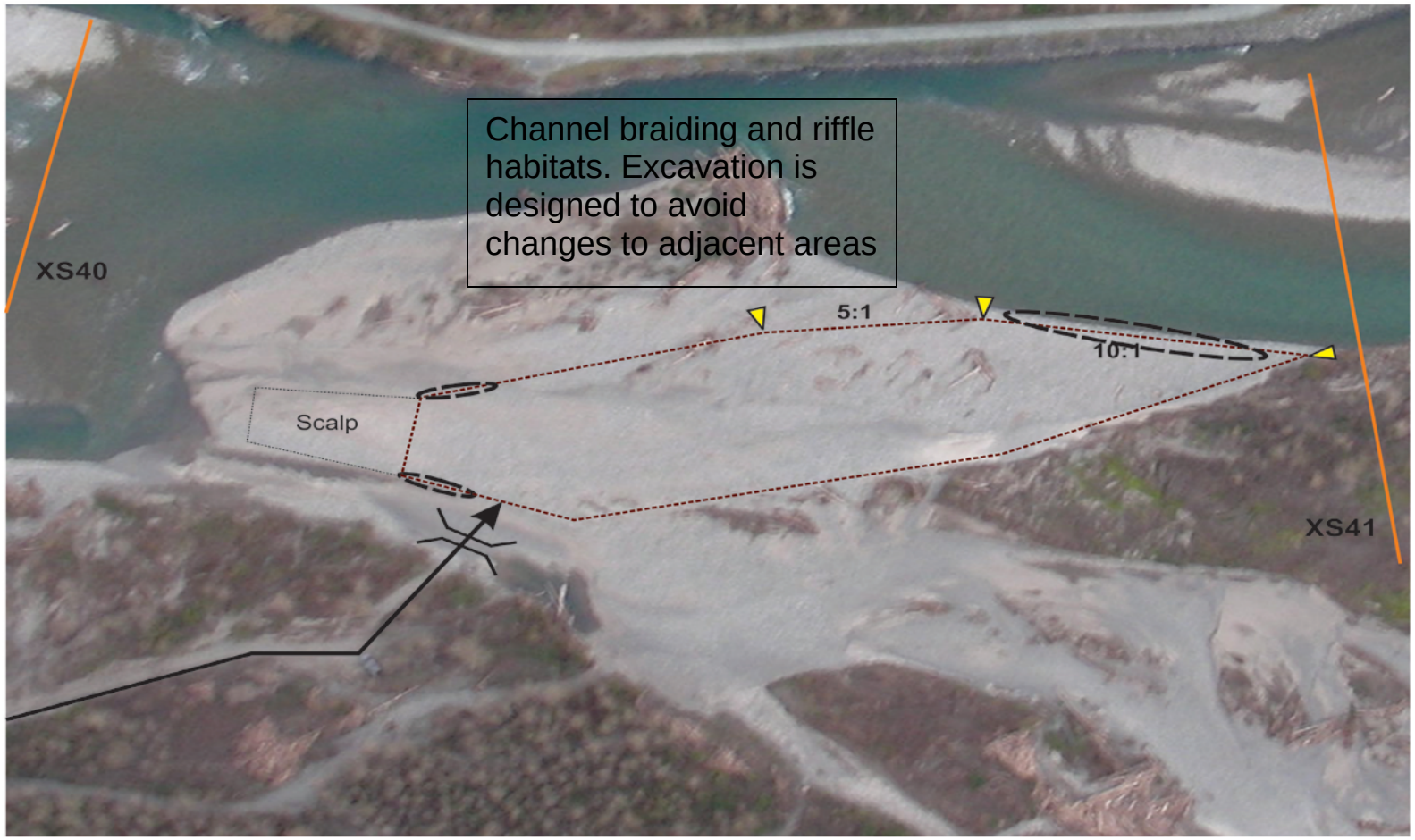


Culvert Crossing

Perimeter of proposed excavation

Habitat excavation

Slope change point

Pit openings

Access Route

Pit Slopes are 1.5:1 unless otherwise shown

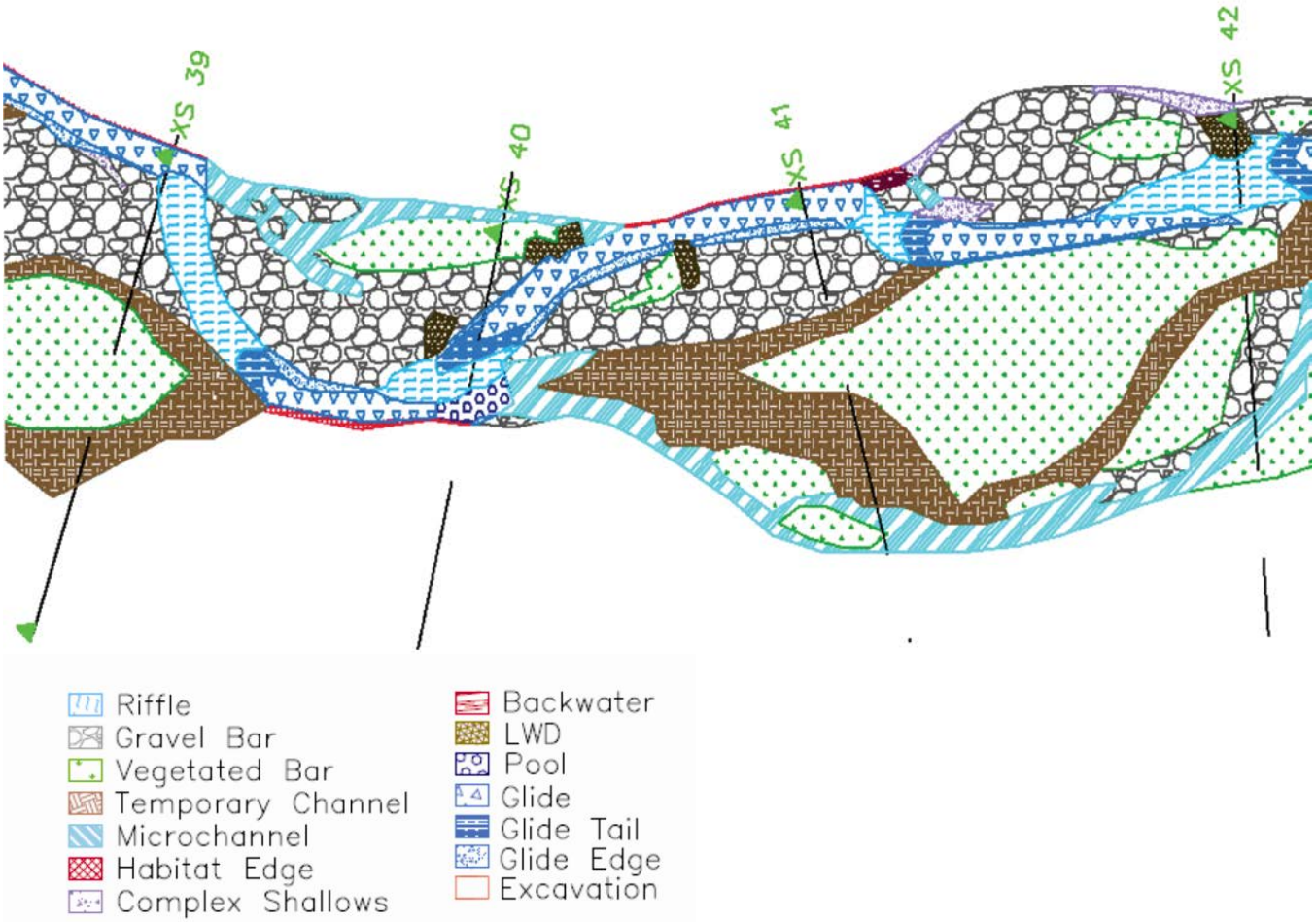
Volume = 12,700m^3

Avg. Length = 150m

Width = 50m

Depth = 3.5m

0m 25m 50m



August 2015 Habitat conditions observed at Giesbrecht Bar site (16-41L)

Site Name: Lickman Bar **Site Number:** 2
Identifier: 16-35M
Location: Fronting campground downstream of Giesbrecht Road
Ownership: Provincial Crown

Previous Excavations: Campground Bar was at this same approximate location but located on the left bank and was excavated in 2006 and 2008.

Stockpile: Lickman Road stockpile site is now subject to heavy recreational use so it is anticipated that this material will be hauled to the Hooge Stockpile or offsite.

Length: 105 m
Width: 70 m
Depth: 3.5 m

Expected Gravel Yield: 21,500 m^3

Bar Access:
South end of Lickman Road to Rotary Trail. A culvert crossing will likely be needed to avoid awkward turn and travel on Rotary Trail.

Objectives and Effectiveness:
Gravel trap at downstream end of Upper Reach. Limit left bank erosion opposite excavation.

Anticipated Outcome:
Most of the excavation will refill but expect some channel realignment which could help limit erosion on left bank.

Habitat Considerations:
The bar top includes microchannels and LWD although with recent changes there is little or no established vegetation. The excavation has been designed to maintain the basic bar configuration but to direct some of the flow toward secondary channels on the right and reduce the growing point bar that is directing flow to the left. The left bank across from the site is a steep cut bank that is contributing LWD to the river, however as it is unstable and eroding rapidly the loss of riparian habitat and contribution of sediment to the river limits habitat value contribution. As the main channel has moved left, the bar has expanded. The slope break downstream of the excavation will not be crossed to prevent erosion. Note that there has been a substantial change in the river configuration between the habitat mapping and excavation design.

Fish Habitat Utilization:
The proposed Lickman Bar excavation is adjacent to or near several habitats that are important in supporting salmonids.

Previous years assessments have shown Pink and Chum Salmon spawning in the vicinity of XS35 where the current excavation is proposed. For 2016, small pockets of Chum Salmon spawning could be expected in the secondary channels along the right bank and downstream of the excavation site. Previous observations have shown that areas below riffles tend to support Chum Salmon spawners.

Glide tail habitat is located near the downstream end of the proposed excavation footprint and this could support Pink Salmon spawning. Due to the consistency of spawning patterns observed over many years, spawning mapping was limited to excavation areas only in 2014 however, the Pink and Chum Salmon spawning patterns can be observed on the maps included in the 2012 and earlier assessment reports.[4]

Riffle habitats are located below the glide tail areas and within the microchannels crossing the bar. These areas support primary production of algae and macro-invertebrates, providing food to rearing salmon. The proposed Lickman Bar excavation is planned to limit changes to this basic geomorphology and so protect the basic habitat characteristics of this section of the Vedder River. Riffle habitat areas are avoided because if they are bypassed their control on water elevation upstream can be lost and this could induce potentially detrimental habitat changes.

Additional high habitat value for salmonids is evident in the microchannel located along the right bank and in other braidings on the bar surface. When conditions are suitable, rearing fry are often noted in these secondary channels and when salvaged, can yield large numbers of Coho Salmon and Rainbow Trout *(O. mykiss*). For Lickman Bar, a substantial buffer from the excavation has been left for most of these habitats although an exit from the pit to the secondary channel downstream will increase flows through the main secondary channel at this location.

The excavated ponds provide some holding habitat for returning adults. In the past, spawning habitat had inadvertently been created by leaving over-steep edges which allowed sub-gravel flows to encourage spawning. Since adopting guidelines that include flatter slopes for upstream edges of pits, spawning within the pits has been minor and where it has occurred, the configuration is more likely to be stable allowing successful incubation. Finally, two large openings

[4] NPE, 2014. 2012 Vedder River Gravel Excavation-Habitat Changes and Environmental Impacts. Vedder River Management Area Committee.

have been included in the design to ensure that fish do not get trapped within the pools.

The excavation at this location is expected to refill with most of the existing habitat features remaining largely unchanged.

Mitigation Plans:
Abundant LWD on site that can be keyed in around the excavation site. Detailed site design will limit flow exiting through right temporary channel. Wide openings will be excavated to the main channel to prevent trapping of fish.

2016 Proposed Excavations: Lickman Bar (16-35M)

Second Draft Plan: April 12, 2016 Photo: March 19, 2016

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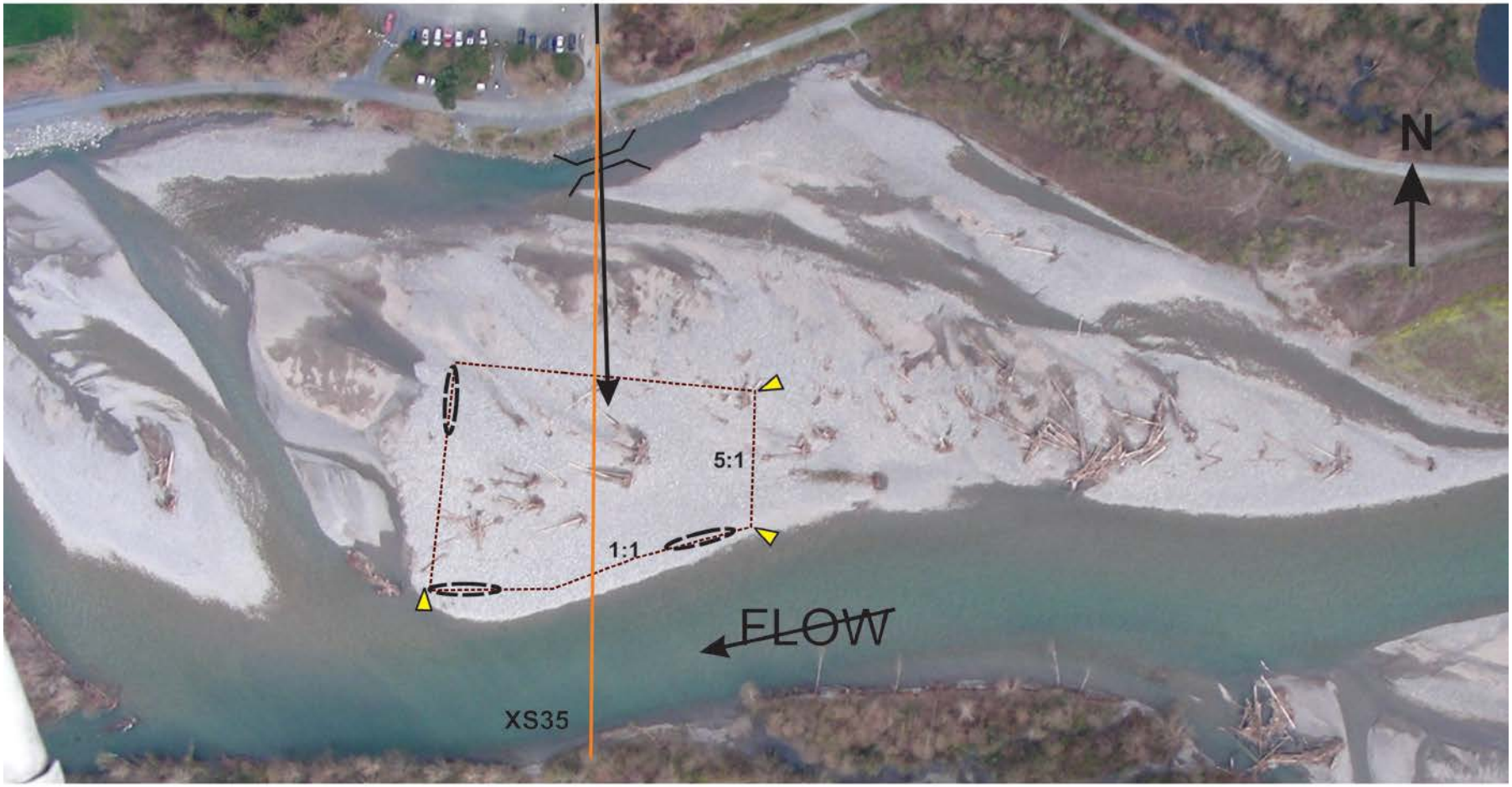


Culvert Crossing

Perimeter of proposed excavation

Habitat excavation

Slope change point

Pit openings

Access Route

Pit Slopes are 1.5:1 unless otherwise shown

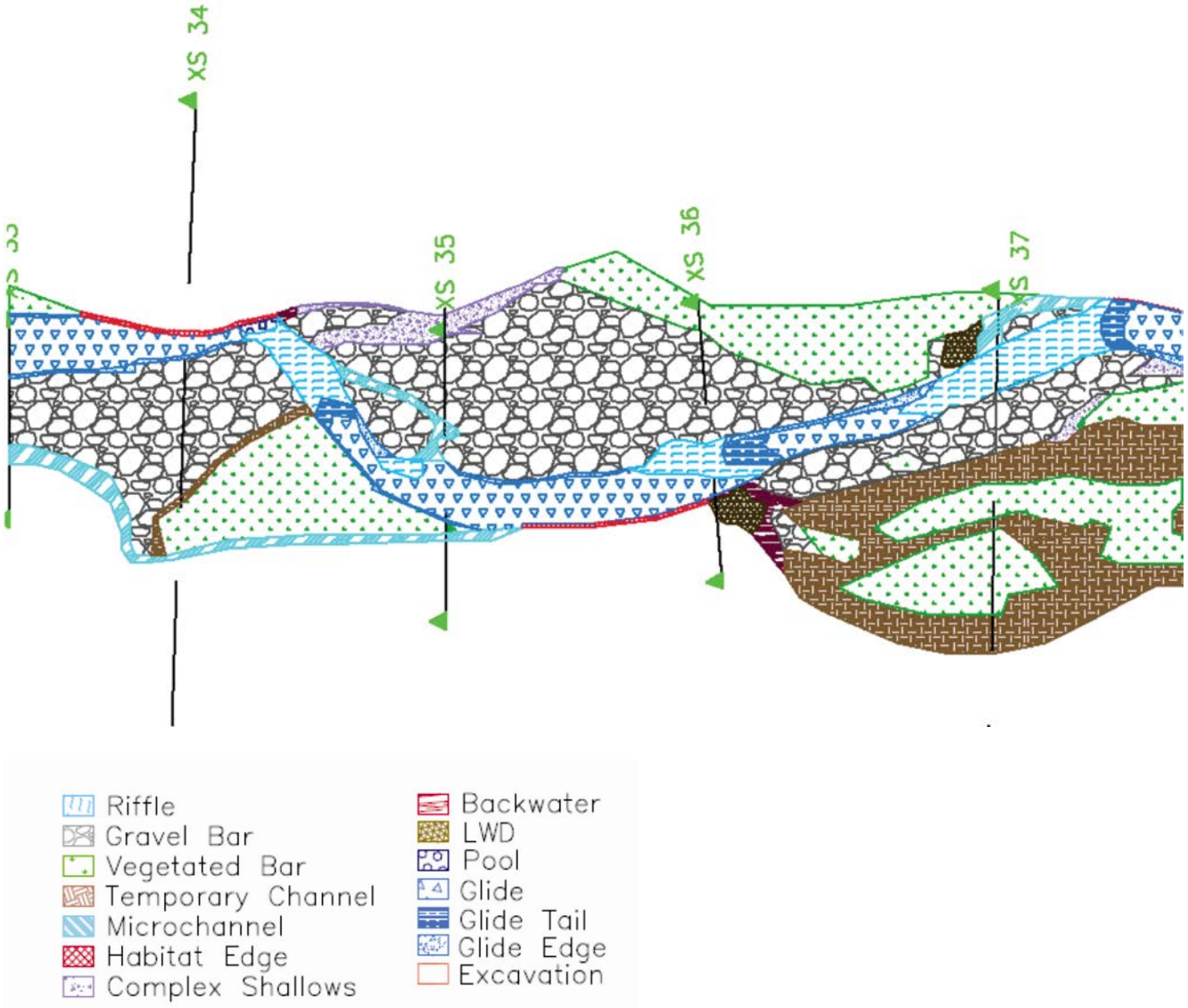
Volume = 21,500m^3

Avg. Length = 105m

Width = 70m

Depth = 3.5m

0m 25m 50m



August 2015 Habitat conditions observed at Lickman Bar site (16-35M)

Site Name: Bergman Bar **Site Number:** 3
Identifier: 16-22L
Location: Adjacent to Bergman Bar Stockpile
Ownership: Provincial Crown

Previous Excavations: 1994, 1998, 2000, 2002, 2006, 2010, 2014.

Stockpile: Bergman

Length: 135 m
Width: 25 m
Depth: 4 m

Expected Gravel Yield: 9,600 m^3

Bar Access:
North on Bergman Road, past setback dyke to Bergman Stockpile. Upstream end of bar can be accessed with a constructed ramp from top of armoured bank.

Objectives and Effectiveness:
The main purpose is to intercept gravel upstream of the area of freeboard limitation.

Anticipated Outcome:
Expected to refill rapidly.

Habitat Considerations:
The 2014 Bergman Bar sediment removal site has completely filled in leaving no remnants of the excavation. Due to aggradation at the bar head, the substantial area of microchannel habitat on the left bank has been replaced by temporary channel along the entire length of the bar.

Upstream riffle and glide tail and the eddy pool near the upstream end of the excavation will be protected by leaving a large buffer at the upstream end of the bar.

Fish Habitat Utilization
The configuration at Bergman Bar is fairly consistent despite frequent excavation. In particular, the riffle upstream of the site separating this area from the Peach Creek Bar is persistent and provides spawning opportunities for Pink and Chum Salmon.

In 2014, Chum Salmon spawning was observed downstream of the riffle at the downstream end of the bar, along the bar edge between the riffles, and in the left bank microchannel. In 2015, Chum Salmon spawning was also observed below the upstream riffle. Pink Salmon spawning was also observed in 2015 upstream

of the riffle at the bar head, in the main channel near large eddy pool, and in shallow areas near the bar tail. Spawning habitat within the left bank microchannel is also usually evident although it varies year to year with the surface and sub gravel flow entering the channel. This microchannel provides rearing habitat for salmonid fry which have been observed during past salvages of isolated pools associated with crossings or habitat enhancement works.

The excavation has been designed to maintain the bar's configuration and refill over time. This has been shown, through several excavations at this site, to be effective when the design guidelines are followed. The key features, riffle upstream, eddy pool below the riffle, glide along habitat edge and riffles below are unlikely to be modified by this excavation. As this area has been stable, the habitat maps from 2015 provide a good illustration of this description and are included below.

Mitigation Plans:
A habitat channel excavation is proposed for this location along the left bank upstream and downstream of the main pit. A small scalp has been appended to the habitat excavation to improve gravel yield. This work is intended to provide habitat that is independent of the surface flow at the upstream end of the bar. Previous efforts to maintain this channel have been limited to deepening the entrance however in recent excavations there has been enough aggradation to cut it off at low flows each year. Deepening the left bank microchannel in 2016 is proposed to maintain sub-gravel flow in case the inlet flow cut off. This would improve rearing capacity, provide additional Chum Salmon spawning habitat and reduce the potential for fry stranding.

Gentle slope and good pit flow through although standard practice are important at this location where sub-gravel flow has led to in-pit spawning of Chum Salmon.

2016 Proposed Excavations: Bergman Bar (16-22L)

Draft Plan: April 05, 2016 Photo: March 19, 2016

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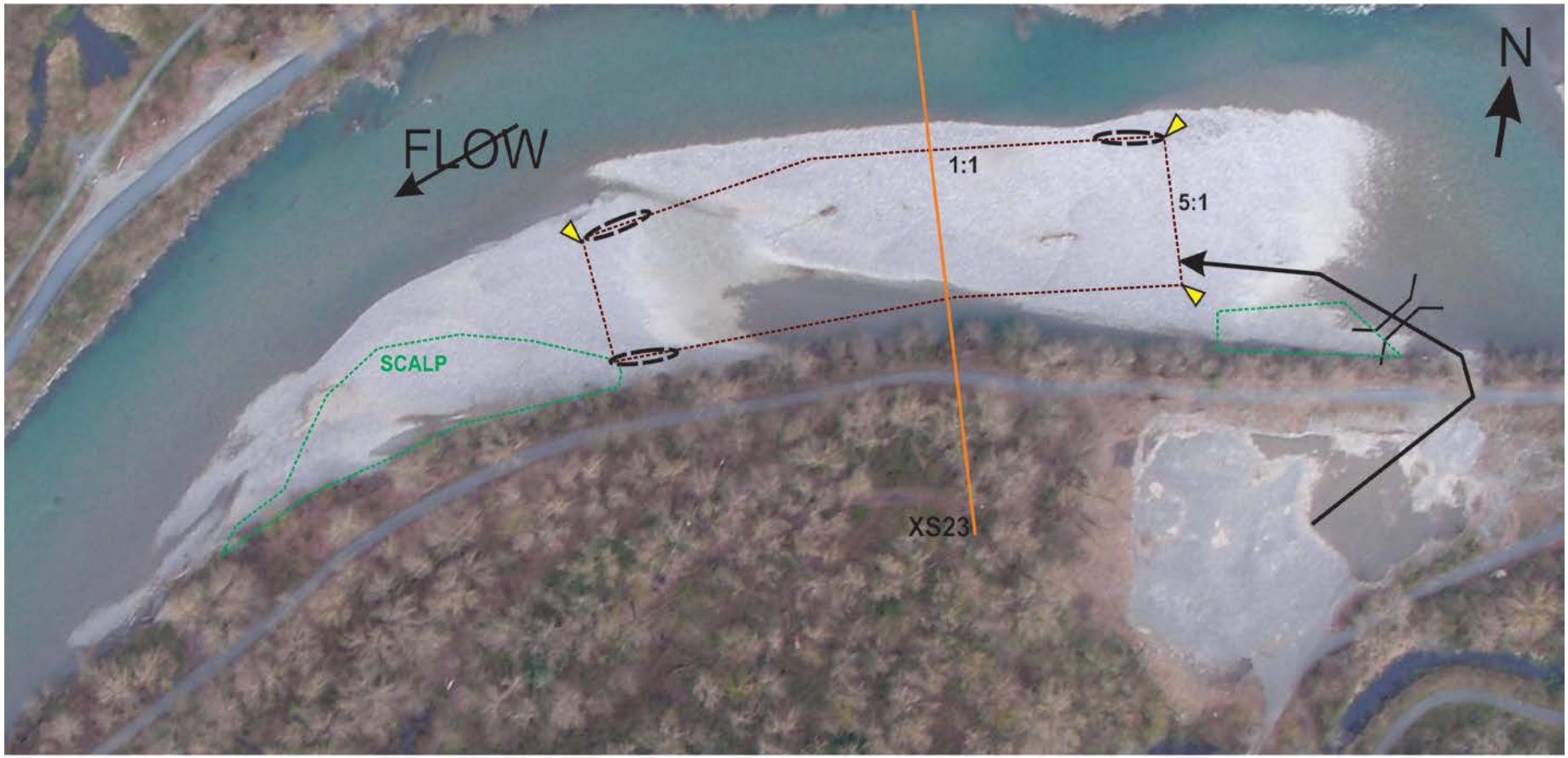


Culvert Crossing

Perimeter of proposed excavation

Habitat excavation

Slope change point

Pit openings

Access Route

Pit Slopes are 1.5:1 unless otherwise shown

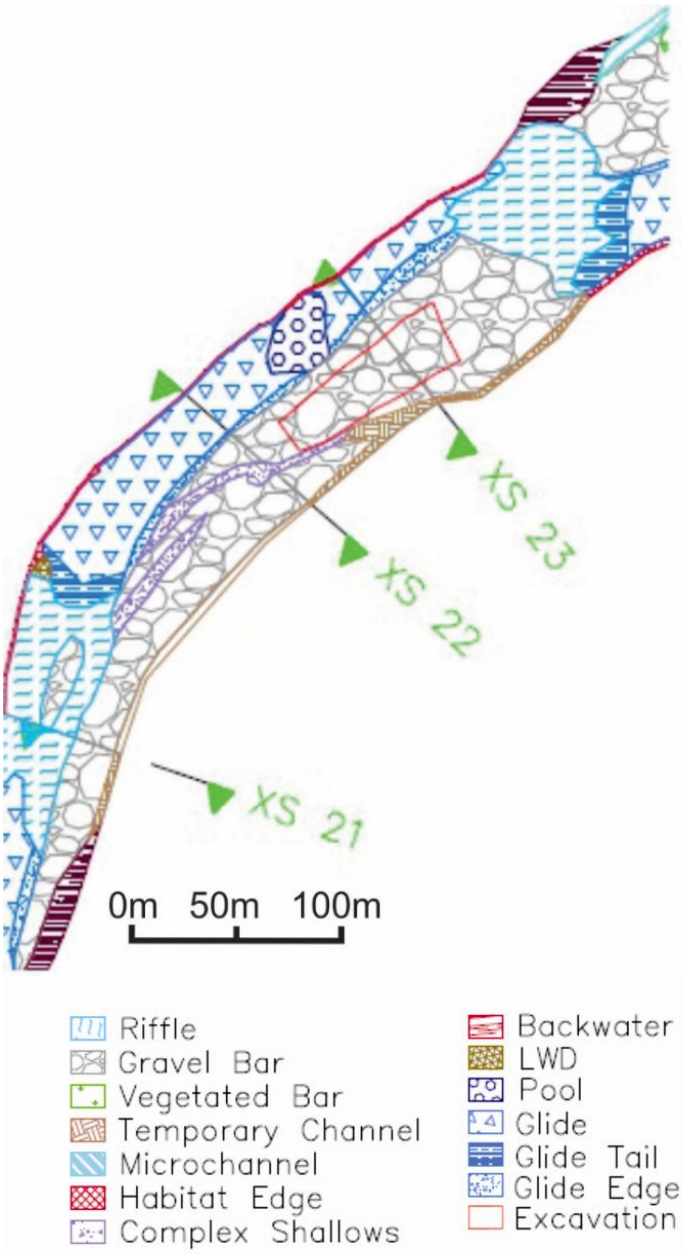
Volume = 9,600m ^{3}

Avg. Length = 135m

Width = 25m

Depth = 4.0m

0m 25m 50m



August 2015 Habitat conditions observed at Bergman Bar site (16-22L)

Site Name: Railway Bar **Site Number:** 4
Identifier: 16-19R
Location: Approximately 180m upstream from the railway bridge
Ownership: Provincial Crown

Previous Excavations: 1994, 1998, 2004, 2006, 2008, 2010, 2014.

Stockpile: Hooge stockpile

Length: 90 m
Width: 20 m
Depth: 3 m

Expected Gravel Yield: 3,200 m^3

Bar Access:
From Keith Wilson, South on Sinclair Rd. then east along the setback dyke to parking area. Proceed west along the trail atop the bank protection works. (Trail bypass remains but vehicle access has been closed off and the old haul route has been redeveloped as a trail).

Objectives and Effectiveness:
Improves channel capacity upstream of railway bridge and reduces the amount of gravel moving downstream into the reach of the river that is most freeboard limited.

Anticipated Outcome:
Anticipated to refill in 1 year with bar continuing to grow through the second freshet allowing for possible improved gravel yield.

Habitat Considerations:
Riffles are located above and below excavation and habitat edge is evident downstream. Slope is low enough that only minor localized changes are anticipated.

Fish Habitat Utilization
Railway Bar has not been accessible for vehicles since late 2015 when the dyke road was upgraded to a pedestrian trail and a locked gate was installed. The bar surface was often compacted as a result of previous years' traffic but now provides a more typical unvegetated gravel bar configuration. The 2014 bar excavation has completely filled in but remains slightly narrower. The habitat channel excavated at the tail of the bar continues to function with some flow through sub-gravel percolation.

Due to the flatter slope, the pattern of glide, glide tail and riffle is less evident but there is a glide tail and riffle downstream and upstream of the proposed

excavation. Immediately downstream of the excavation, on the right bank, there is an area of habitat edge with overhanging riparian vegetation, although it has tended to fill in. No recent fry trapping has occurred in this area; however, the habitat edges provide suitable rearing opportunities for salmonid fry. The opposite bank provides habitat complexity particularly where parts of the original bank armour has disintegrated providing cut bank and boulder clusters.

In 2014 and 2015, there was Chum Salmon spawning present in the constructed habitat channel at the downstream end of the bar. In 2015, the increased backwater area at the tail of the bar showed heavy Chum Salmon spawning. There was also heavy Pink Salmon spawning at the bar head above and through the riffles. Some Pink Salmon spawning was observed throughout the channel along the bar and in the backwater.

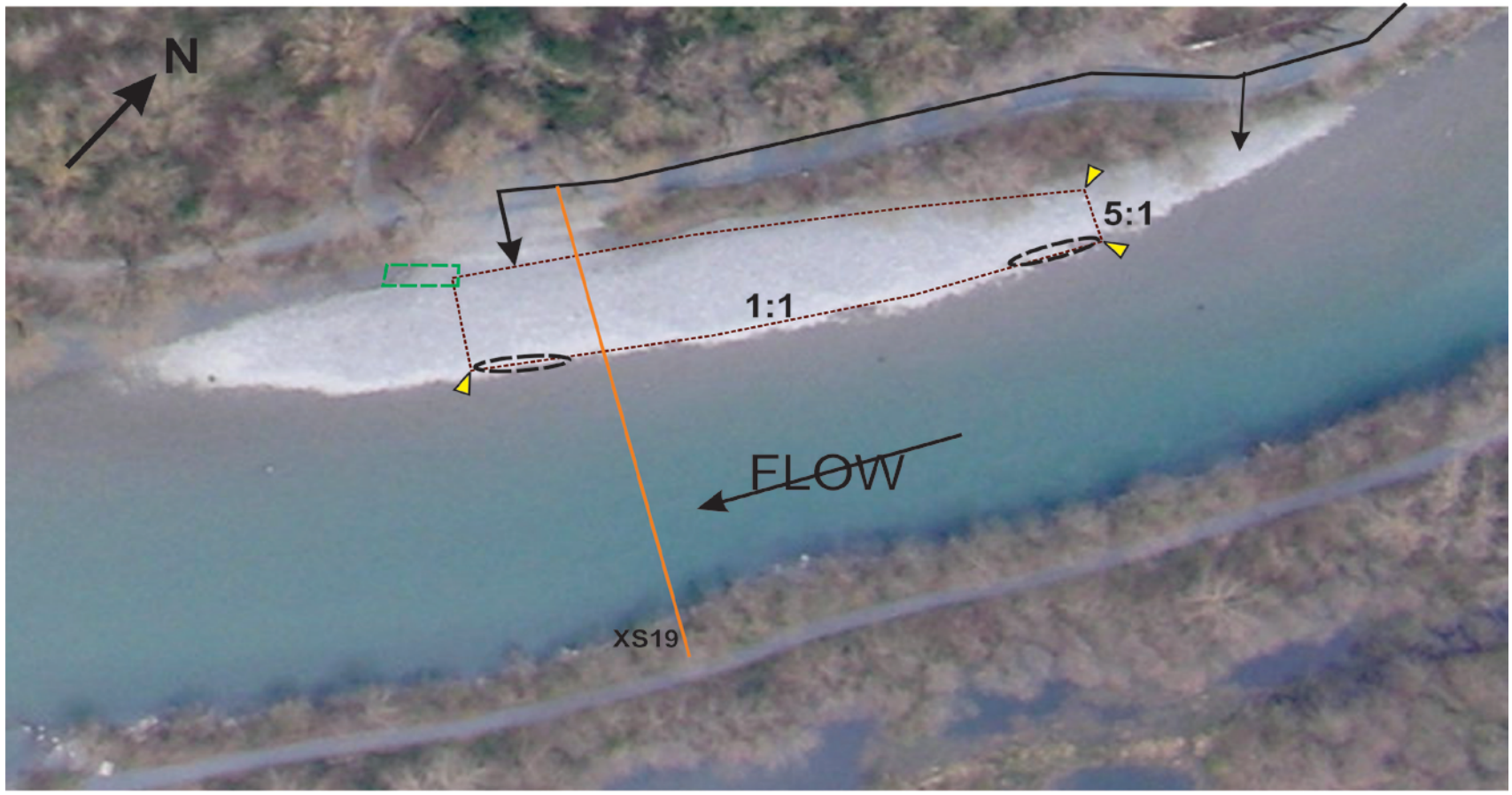
Railway Bar has been excavated several times in recent years as it tends to refill in the same pattern each year. Only minor changes to the surrounding habitat configurations are expected as a result of this removal.

Mitigation Plans:
Excavating the downstream corner of the pit along the bank to maintain habitat values of the small channel downstream of the excavation provides a simple enhancement that can be maintained on a regular basis. Wide openings will be constructed as usual to limit angler impacts associated with this excavation site.

2016 Proposed Excavations: Railway Bar (16-19R)

Draft Plan: April 05, 2016 Photo: March 19, 2016

Nova Pacific Environmental



Culvert Crossing

Perimeter of proposed excavation

Habitat excavation

Slope change point

Pit openings

Access Route

Pit Slopes are 1.5:1 unless otherwise shown

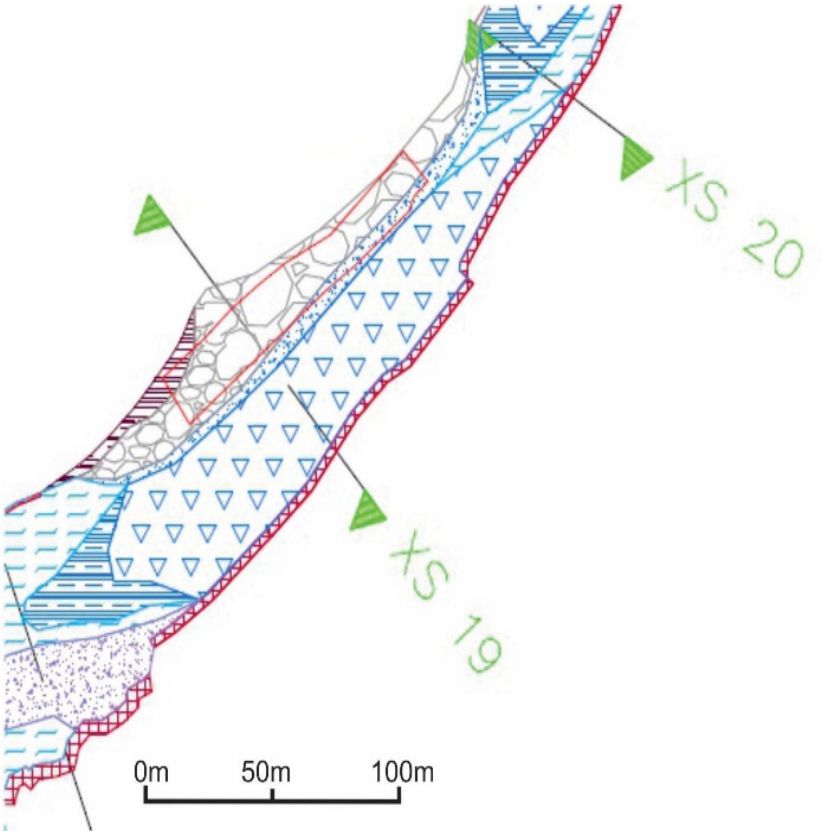
Volume =3200m ^{3}

Avg. Length = 90m

Width = 20m

Depth = 3m

0m 25m 50m



August 2015 Habitat conditions observed at Railway Bar site (16-19R)

Site Name: D/S Rail Bridge Bar **Site Number:** 5
Identifier: 16-16R
Location: Approximately 200 m downstream from the railway bridge
Ownership: City of Chilliwack

Previous Excavations: Previous excavations in this vicinity tended to be slightly further downstream and were associated with Yarrow Bar.

Stockpile: Hooge stockpile (shared with Railway Bar)

Length: 190 m
Width: 34 m
Depth: 3.75 m

Expected Gravel Yield: 26,850 m^3

Bar Access:
Access to this bar is a significant challenge. Option one requires access through the Great Blue Heron Reserve. The previous access is now somewhat overgrown, primarily by Himalayan Blackberry. Option two would require disturbing a small section of native riparian vegetation and constructing two ramps on either side of the BC Southern Rail Bridge. This would likely require approval by BC Southern Rail which may not be attainable. The third option, would require crossing the thalweg on a bridge. This has been done previously using a pair of flat deck railway cars but it is a challenging crossing that would likely require temporary bulkheads and incursion of ramps into the flowing channel. Determination of the best option for access is still in progress.

Objectives and Effectiveness:
This excavation will improve channel capacity within or immediately upstream of freeboard limited areas. This bar has been growing for several years and erosion along the left bank has been steady. The excavation may be effective in limiting or slowing the erosion.

Anticipated Outcome:
Excavation will refill quickly but some channel retention and the habitat excavation should improve habitat values.

Habitat Considerations:
High value for spawning of Pink and Chum Salmon in the area that may be protected by reducing erosion. Substantial erosion of left bank opposite bar has reduced riparian habitat and led to the loss of a microchannel noted to support spawning and rearing habitat. A small downstream section of the microchannel remains. Similar to the condition at Lickman Bar, the left bank across from the site is a steep cut bank that is contributing LWD to the river, however as it is

unstable and eroding rapidly the loss of riparian habitat and contribution of sediment to the river limits habitat value contribution.

Fish Habitat Utilization:
The plan layout below for this site shows low flow conditions in March of 2016. Despite ongoing change at this location, habitat maps prepared for conditions in August of 2015 have also been included as they still provide a good characterization of habitat conditions at this site.

D/S Rail Bridge Bar has shown steady growth over the last several years and this has tended to push the flow onto the left bank causing erosion and the formation of a steep cut bank. Due to fast flows and continuing erosion, this habitat is not likely to provide much rearing habitat value. The excavation strategy at his location seeks to slow this flow and associated bank erosion by increasing the channel cross section at this location. This would allow the habitat edge value to be realized. More persistent LWD would help support rearing salmonids and provide cover for migrating adults.

The bar has also infilled in an upstream direction toward the Railway Bridge. While this change has continued since the detailed post excavation habitat assessment in 2015, the basic configuration remains the same. Most of the habitat upstream of the bar is riffle and this provides valuable primary productivity and rearing opportunity for salmonids. The channel along the bar is glide habitat with a small section of riffle along the bar edge downstream.

There are temporary channels along the right bank which extend downstream to the mid-point of the Yarrow excavation site. These channels are characterized by bank complexity and quality riparian vegetation and could be expected provide good rearing habitat and refugia in higher flows. Excavation of the upstream section has been included as habitat improvement component to the work at this site but it has not been extended all the way downstream because this portion is more filled and the configuration would be expected to carry a high risk of stranding.

This section of the river supports significant spawning by Pink and Chum Salmon. In earlier assessments, the bar head above Yarrow Bar was regularly noted to be glide tail habitat that supported heavy Pink Salmon spawning but with the present configuration, this area is glide habitat which does not tend to support spawning.

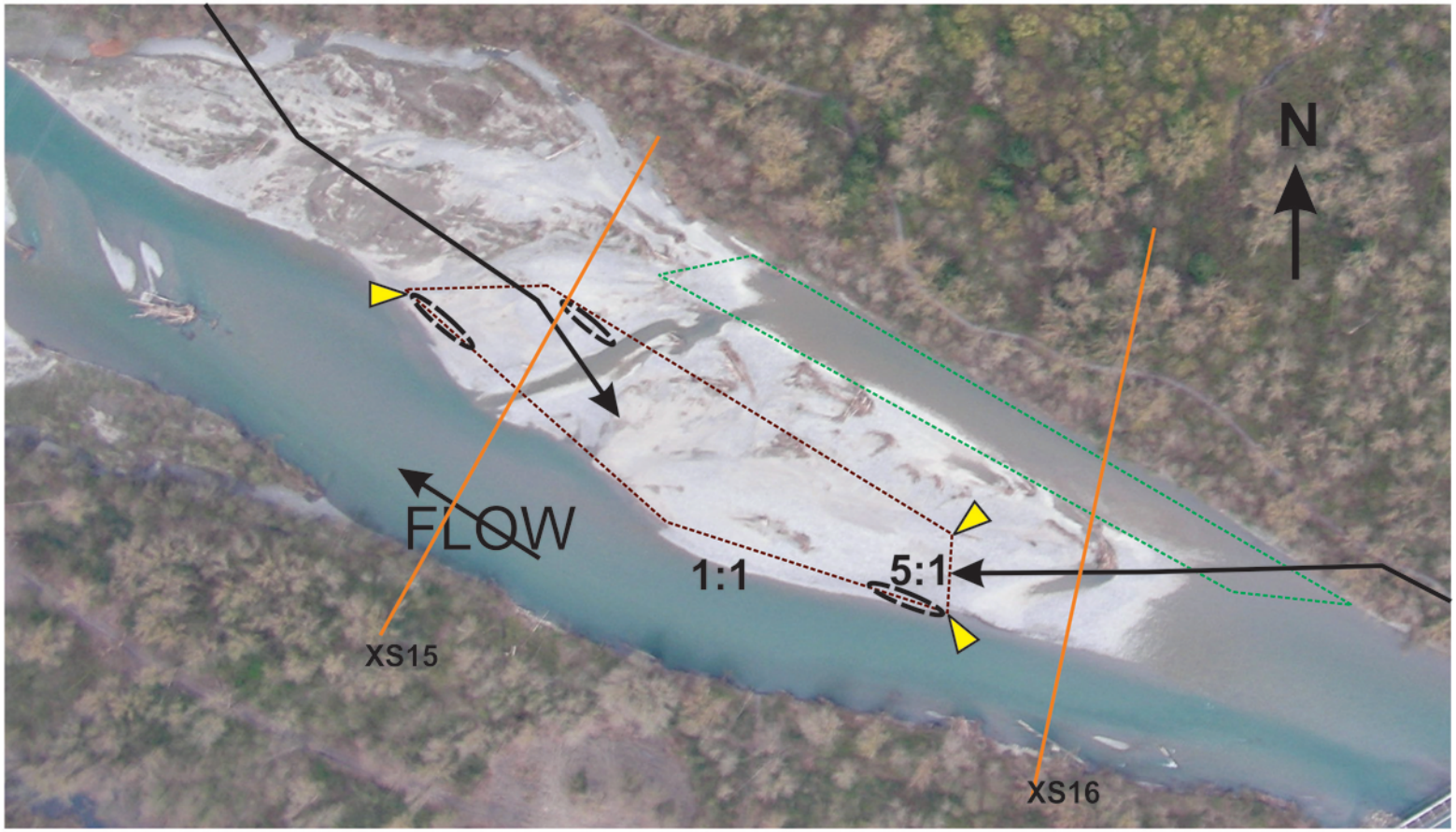
Mitigation Plans:
There is a substantial opportunity to improve habitat by deepening the right bank secondary channel and this has been included as a “habitat” type excavation for this site. Abundant LWD on site will be keyed into the habitat channel and adjacent areas.

Gentle slopes at the upstream end will help to ensure that the excavation does not impact the riffle habitat upstream. Overall, the excavation is expected to help to reduce erosion on left bank and protect remaining vegetated bank and microchannel. Lower flow and erosion should improve accessibility of cut bank habitat for fish. The access point, will be replanted as excavation here is infrequent.

2016 Proposed Excavations: D/S Rail Bridge Bar (16-16R)

Nova Pacific Environmental

Draft Plan: April 05, 2016 Photo: March 19, 2016



Culvert Crossing

Perimeter of proposed excavation

Habitat excavation

Slope change point

Pit openings

Access Route

Pit Slopes are 1.5:1 unless otherwise shown

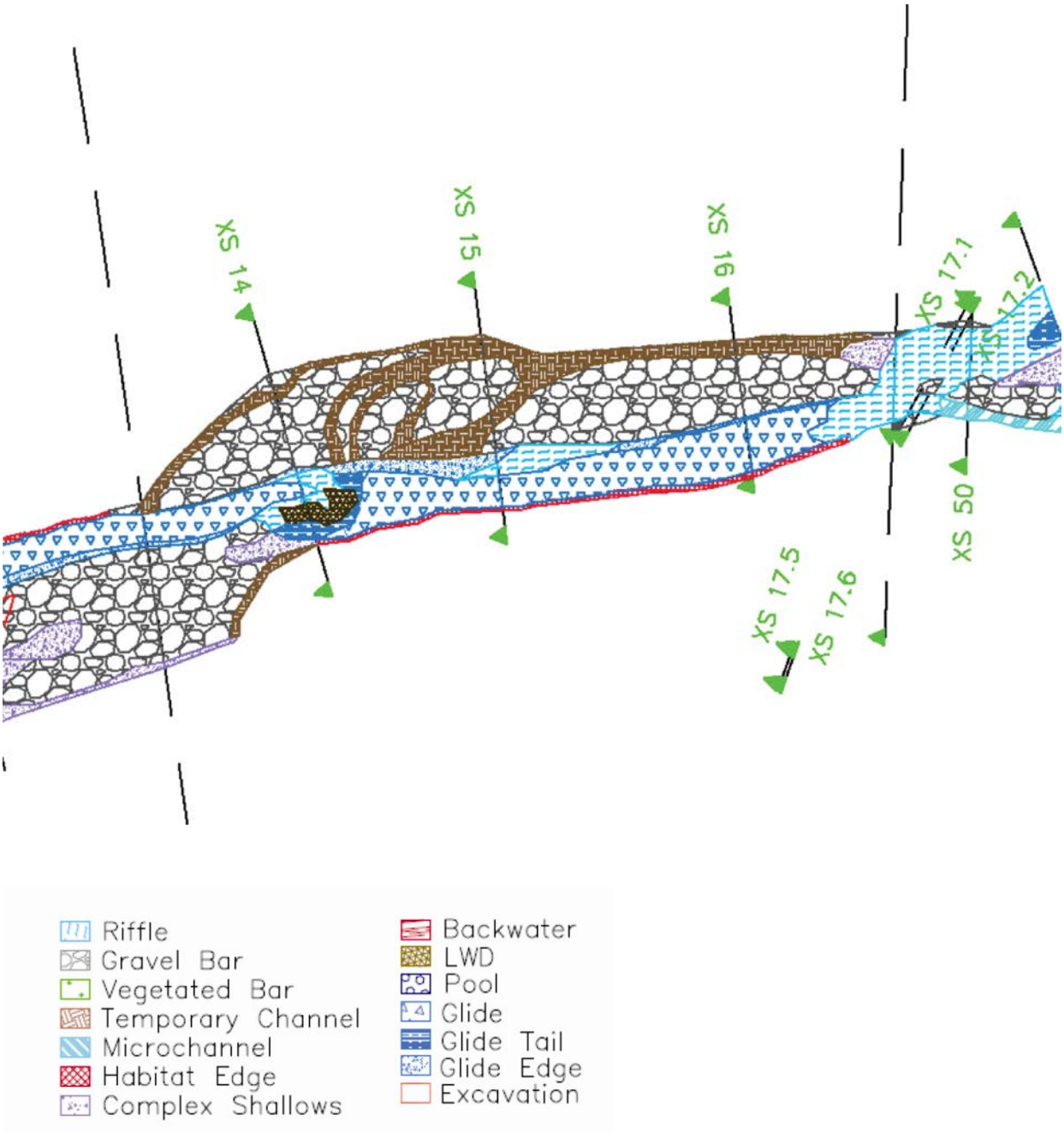
Volume = 26,850m^3

Avg. Length = 190m

Width = 34m

Depth = 3.75m

0m 25m 50m



August 2015 Habitat conditions observed at D/S Rail Bridge Bar site (16-16R)

Site Name: Yarrow Bar **Site Number:** 6
Identifier: 16-13L
Location: North foot of Wilson Road
Ownership: City of Chilliwack

Previous Excavations: 1994, 1995, 1996, 1998, 2000, 2004, 2006, 2008, 2010, 2012, 2014.

Stockpile: Wilson Road Stockpile or the recently restored stockpile along setback dyke near railway. Wilson Road stockpile is limited by presence of Yarrow Water Works wells. In 2014, Wilson Road stockpile was used and this was problematic. With the smaller volume proposed in 2016, the remaining usable area of the Wilson Road stockpile should be sufficient.

Length: 85 m
Width: 60 m
Depth: 3 m

Expected Gravel Yield: 14,300 m^3

Bar Access:
From Wilson Road through stockpile site

Objectives and Effectiveness:
This excavation is usually at or near the freeboard limited zone so may function as a gravel trap or serve to increase floodway capacity in freeboard-limited zone. A secondary purpose is to continue to mitigate the bank erosion concern downstream by directing flow onto Heron Bar instead of toward the left bank.

Anticipated Outcome:
As there are unfilled remnants from previous removals, this bar is expected to refill slowly. More of the flow is expected to cross the excavation site upstream of the current location improving low flow conditions and fish habitat values on the left bank.

Habitat Considerations:
Bar structures help to provide spawning habitat in this area. There is a large amount of riffle associated with the 2014 excavation remaining downstream of the proposed site.

Fish Habitat Utilization:
Yarrow Bar shows the typical pattern of fish habitats observed in the bars discussed above with riffle and glide tail upstream and downstream and a microchannel present along the inside of the bar at the left bank. A small remnant of the 2012 excavation has still not filled and a few Chum Salmon spawners were

noted in this pool in 2015. It still has an outflow from water provided through sub-gravel percolation but there is no inflow, and no distinct high-water inflow channel.

Following the 2014 excavation, much of the flow was diverted over the footprint of the excavation and deposition of material has mostly filled the pit. There are more wetted areas than prior to the excavation mainly due to the increase in riffle habitat over the excavation footprint. Infilling and accumulation of large woody debris (LWD) is evident in the area immediately upstream of the excavation. The added flow to the left bank appears to have created a large section of complex and desirable habitat for salmonids. There are several very large cottonwoods in the river downstream of this location due to bank erosion in the previous several years and this provides a high degree of habitat complexity along the left bank downstream of the proposed excavation.

In 2014, Chum Salmon spawning was noticed in the microchannel flowing from the remnant of 2012 excavation, at the head of the 2014 excavation and in the left bank secondary channel. In 2015, Chum Salmon spawning was observed along the inside edge of the bar and continued through to the tail of the bar. Heavy spawning of Pink Salmon was observed in 2015 in the glide tail areas at the upstream and downstream ends of the proposed excavation, and in similar habitats within the secondary channel.

Mitigation Plans:
A buffer zone for the left bank microchannel will be maintained. Habitat excavation upstream and downstream of the site can be used to improve flows along the left bank. The habitat channel upstream of this site has been breached by the left bank erosion and only a much shorter channel that is dry at low flows remains. Abundant LWD on site can be provided to DFO and used on site.

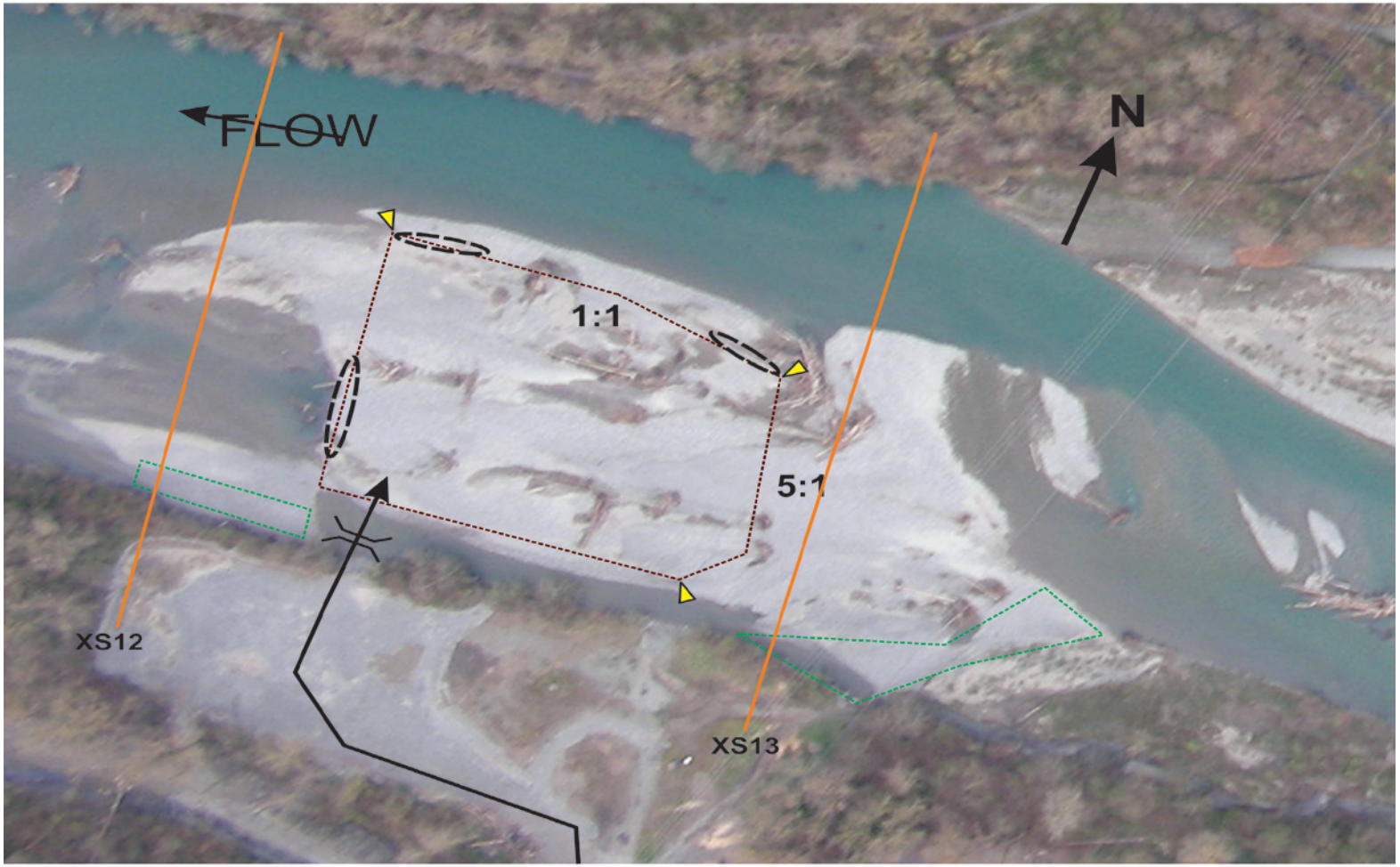
Although the erosion of the left bank appears to have stabilized, the design for this excavation continues to include consideration of this by directing flow within the channel parallel to the banks. Due to the slope drop across the bar from right to left, at this location this mitigates the tendency of the flow across the channel and onto the left bank.

Comments:
Overhead power lines are a hazard for this operation. Special care, including fencing to avoid well heads is required when accessing and stockpiling at this site.

2016 Proposed Excavations: Yarrow Bar (16-13L)

Draft Plan: April 05, 2016 Photo: March 19, 2016

Nova Pacific Environmental



Culvert Crossing

Perimeter of proposed excavation

Habitat excavation

Slope change point

Pit openings

Access Route

Pit Slopes are 1.5:1 unless otherwise shown

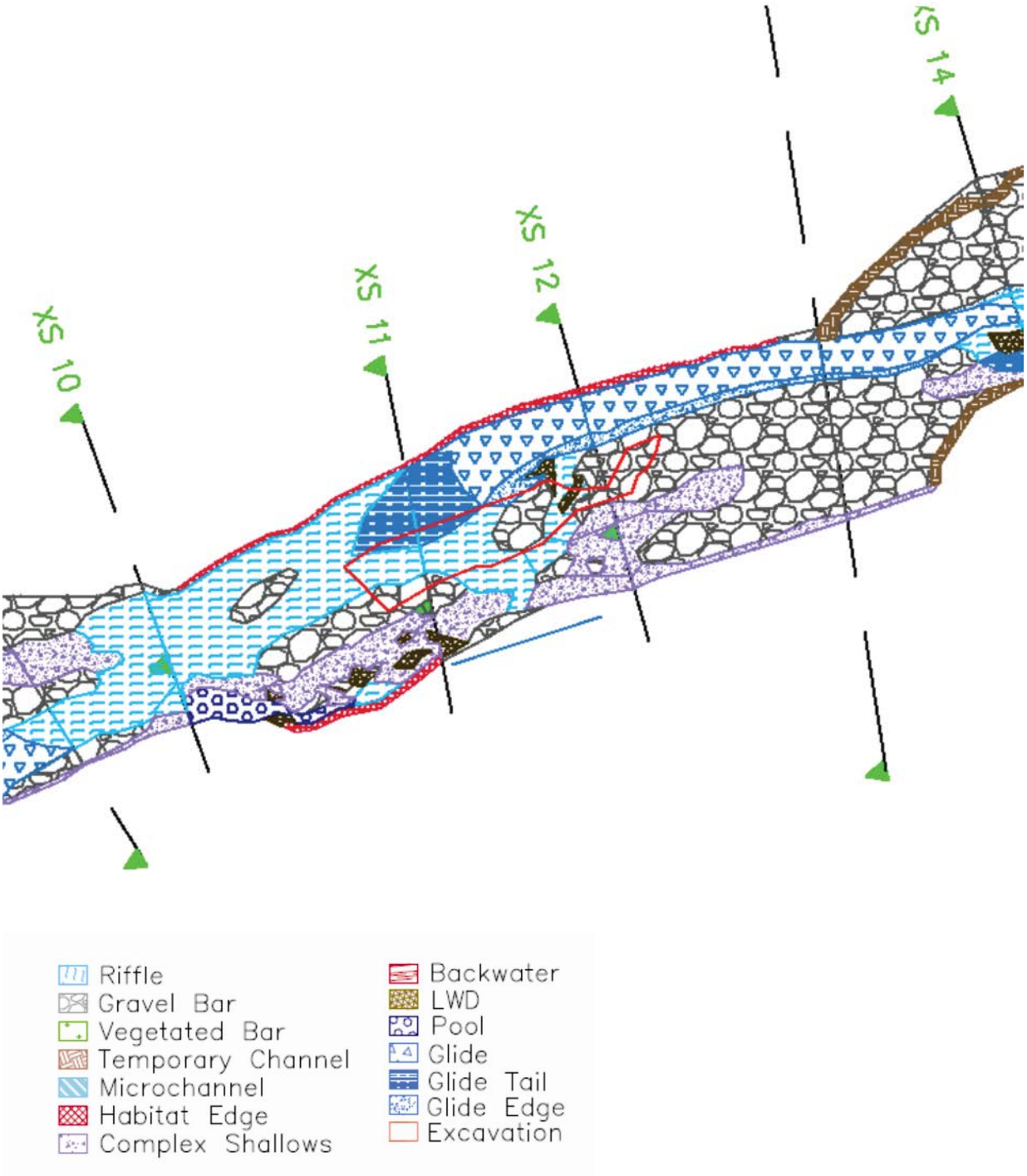
Volume = 14,300m^3

Avg. Length = 85m

Width = 60m

Depth = 3.0m

0m 25m 50m



August 2015 Habitat conditions observed at Yarrow Bar site (16-13L)

Site Name: Keith Wilson Bar **Site Number:** 7
Identifier: 16-C26R
Location: 150 meters downstream of Keith Wilson Bridge
Ownership: City of Chilliwack

Previous Excavations: 2002, 2006.

Stockpile: Greendale

Length: 190 m
Width: 35 m
Depth: 3 m

Expected Gravel Yield: 17,200 m^3

Bar Access:
From east end of Keith Wilson Bridge. Secondary channel near the left bank may need to be crossed to access this bar. Small culverts should be sufficient.

Objectives and Effectiveness:
To improve backwater curve reducing risk of dyke overtopping upstream.

Anticipated Outcome:
Bar will slowly refill. For a time at least, an improved outflow channel for the pump station and right bank microchannel will yield habitat benefits

Habitat Considerations:
Retain microchannel and habitat edge along bank.

Fish Habitat Utilization
Keith Wilson Bar still shows the typical gravel deposition pattern of the sites discussed above with a slight slope break upstream and downstream of the excavation and a deeper glide between. There is also a microchannel along the right bank although this is atypical because it is intermittently flooded with the discharge from the adjacent pump station.

The configuration is similar to the glide tail / riffle paired habitats noted in the sites discussed above. However, due to the lower flow velocity and flatter slope these habitat features are not obvious and do not meet the definitions or functionality of their upstream counterparts.

Keith Wilson Bar is located downstream of the zones in which Chum Salmon spawning has been noted. This is likely due to a combination of factors including streambed shape, flow velocities and substrate which is generally too fine for spawning. However, riffles, glide tail and pool habitat upstream of the bar provide spawning habitat for Pink Salmon.

The banks on both sides of the canal, while not heavily treed, still provide good riparian conditions due to a well-developed layer of shrubs, and non-woody plants. Snorkel surveys have noted salmon fry using this type of edge habitat within the Vedder Canal.

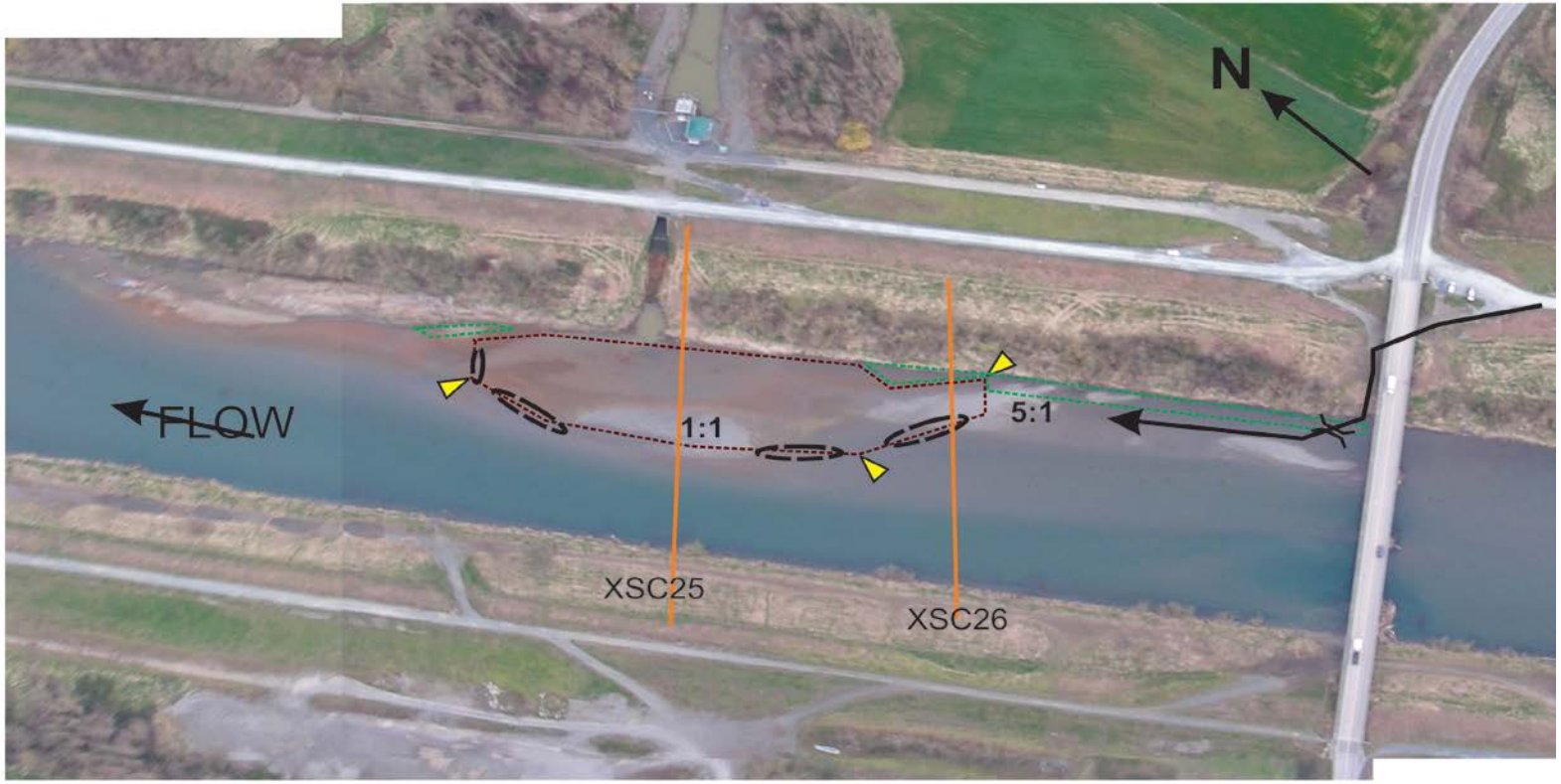
Mitigation Plans:
It is proposed to enhance the right bank microchannel by excavating pools and sections of microchannel along the right bank. An upstream inlet will be excavated and excess LWD from the eastern Keith Wilson Bridge Pier will be keyed in.

The main pit will include a riffle type inlet and outlet as well as deep openings along the sides to ensure no trapping of fish.

2016 Proposed Excavations: Keith Wilson Bar (16-C26R)

Draft Plan: April 05, 2016 Photo: March 19, 2016

Nova Pacific Environmental



Culvert Crossing

Perimeter of proposed excavation

Habitat excavation

Slope change point

Pit openings

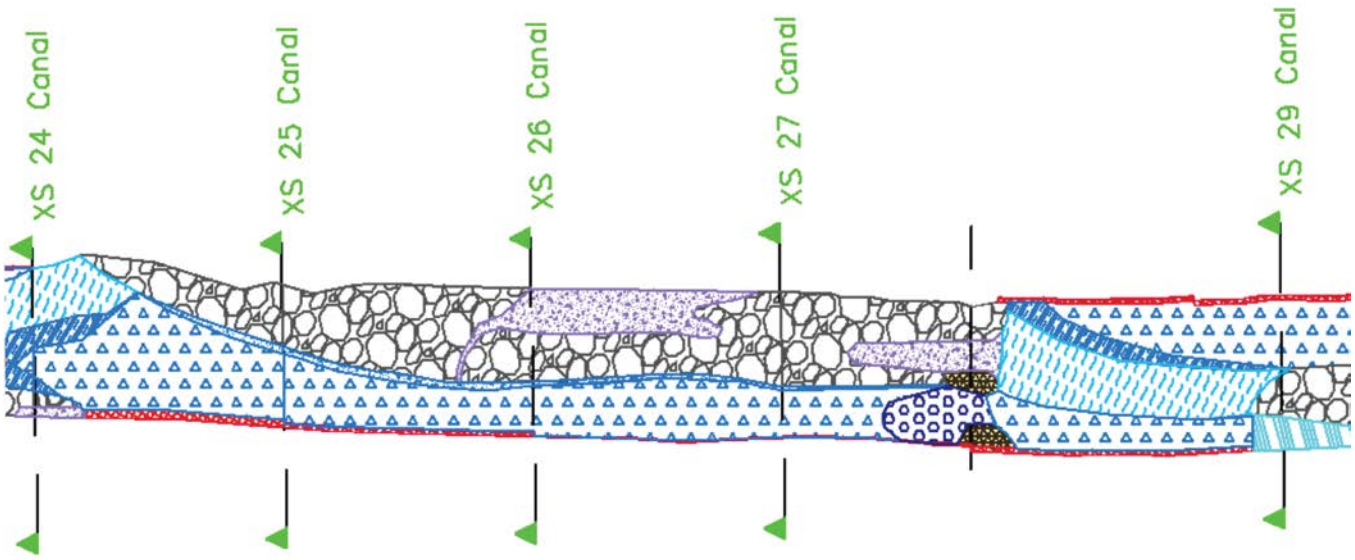
Access Route

Pit Slopes are 1.5:1 unless otherwise shown

Volume = 17,200m^3

Avg. Length = 190m
Width = 35m
Depth = 3.0m

0m 50m 100m



August 2015 Habitat conditions observed at Keith Wilson Bar site (16-C26R)

Conclusion

Fish utilize a wide variety of habitats in the Vedder River and are present in wetted habitats adjacent to each proposed excavation. The pattern of that usage is correlated to habitat types that are the focus of the ongoing assessment and management of the Vedder River Sediment Removal Program. The program relies on careful and detailed application of the excavation design guidelines to avoid detrimental impacts to these habitats and to ensure that high habitat values are maintained in the Vedder River despite the high rate of natural and anthropogenic change.

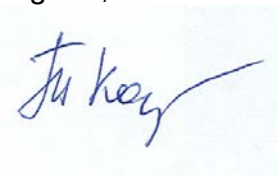
Date and Signature Page

The effective date of this proposal titled “Proposed 2016 Vedder River Sediment Removal Project” is May 9, 2016.

Signed,

Bruce F. Wright, BSc, MBA, RPBio Dated: May 9, 2016

Signed,



Tatiana Kozlova, PhD, RPBio Dated: May 9, 2016

Signed,

Duncan Campbell, BSc Bio, BSc Geo, BIT Dated: May 9, 2016

APPENDIX 1: 2012 Vedder River Gravel Excavation Report – Habitat Changes and Environmental Impacts

APPENDIX 2: Nova Pacific Environmental Vedder River reports from 1994-2014

1. Wright, B.F. and M. Robinson. (1994). Environmental Monitors Report Vedder River Gravel Removal Project 1994. Prepared for Ministry of the Environment and Vedder River Management Committee. 16 p.
2. Wright, B.F. and M. Robinson. (1995). Assessment of the Environmental Impacts from 1994 Vedder River Gravel Bar Excavations. Prepared for Ministry of Environment Lands and Parks, District of Chilliwack, City of Abbotsford. 13 p.
3. Wright, B.F. and M. Robinson. (1995). Vedder River Gravel Removal Environmental Monitor's Report 1995. Prepared for Ministry of Environment Lands and Parks, District of Chilliwack, City of Abbotsford. 14 p.
4. Wright, B.F. (1997). Evaluation of Habitat Changes and Environmental Impacts Following the 1995 Gravel Excavations. Prepared for B.C. Ministry of Environment Lands and Parks. 24p.
5. New Pacific Ventures. (1999). Habitat Changes and Environmental Impacts Following 1996 Gravel Excavations on the Vedder River. Prepared for The Vedder River Management Committee. 22 p.
6. New Pacific Ventures. (1999). Habitat Changes and Environmental Impacts Following the 1997 Gravel Excavations on the Vedder River. Prepared for The Vedder River Management Committee. 9 p.
7. Scholz, P.S., Wright, B.F., M.C. Robinson, and V. Galay. (2001). Habitat Changes and Environmental Impacts Following 1998 Gravel Excavations on the Vedder River. Prepared for The Vedder River Management Area Committee. 45 p.
8. Wright, B.F. (1999). Gravel Removal Constraints, Guidelines, and Planning Procedures for the Protection of Fish Habitat: The Vedder River Floodway Protection Program 1994 to 1998 Working Document. Prepared for The Vedder River Management Area Committee. 48 p.
9. Wright, B.F. and P.S. Scholz. (2003). Habitat Changes and Environmental Impacts Following 2000 Gravel Excavations on the Vedder River. Prepared for The Vedder River Management Area Committee. 35 p.
10. Scholz, P.S. and B.F. Wright. (2003). Environmental Monitors Report on 2002 Excavations of Gravel Bars on the Vedder River. Prepared for The Vedder River Management Area Committee. 72 p.
11. Patton, T., Scholz, P.S. and B.F. Wright. (2005). Habitat Changes and Environmental Impacts Following 2002 Gravel Excavations on the Vedder River. Prepared for The Vedder River Management Area Committee. 33 p.
12. Carl, C., Wright, B.F. and T. Patton. (2005). 2004 Vedder River Gravel Excavations Environmental Monitors Report. Prepared for The Vedder River Management Area Committee. 21 p.
13. Murray, R. and B.F. Wright. (2007). Assessment of Fish Habitat Changes in the Vedder River Following Gravel Excavations in 2004 and a Review of the

Assessment Methodology. Prepared for The Vedder River Management Area Committee. 35 p.

14. Coe, K., Wright, B.F. and R. Murray. (2007). 2006 Vedder River Gravel Excavations Environmental Monitors Report. Prepared for The Vedder River Management Area Committee. 29 p.
15. Nova Pacific Environmental. (2008). Post Excavation Assessment of 2006 Vedder River Gravel Excavations. Prepared for The Vedder River Management Area Committee. 57 p.
16. Nova Pacific Environmental. (2008). 2008 Vedder River Gravel Excavations Environmental Monitors Report. Prepared for The Vedder River Management Area Committee.
17. Wright, B.F., P.S. Scholz and K. DeBoer. (2010). 2008 Vedder River Gravel Excavations Habitat Changes and Environmental Impacts. Prepared for The Vedder River Management Area Committee.
18. DeBoer, K. and B.F. Wright. (2010). 2010 Environmental Monitors Report. Prepared for The Vedder River Management Area Committee. 48 p.
19. Wright, B.F., and T. Kozlova. (2012). 2010 Vedder River Gravel Excavation – Habitat Changes and Environmental Impacts. Prepared for The Vedder River Management Area Committee.
20. Kozlova, T. and B.F. Wright. (2010). 2012 Vedder River Sediment Removal Environmental Monitors Report. Prepared for The Vedder River Management Area Committee.
21. Wright, B.F., T. Kozlova, and C. Hegele. (2014). 2012 Vedder River Gravel Excavations Habitat Changes and Environmental Impacts. Prepared for The Vedder River Management Area Committee.
22. Wright, B.F., T. Kozlova, and D. Campbell. (2016). 2014 Vedder River Gravel Excavations Habitat Changes and Environmental Impacts. Prepared for The Vedder River Management Area Committee

APPENDIX 3: Vedder River Hydraulic Profile Update 2016