Fernie Annex Dike Improvements



Fish and Fish Habitat Assessment

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Prepared by

Lotic Environmental Ltd.
101 Kootenay St. N
Cranbrook BC
V1C 3T5

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Prepared by:

We trust that this document provides adequate information to describe the fish and fish habitat values within the Fernie Annex Dike project area. Please do not hesitate to contact us with any inquiries about this document.



Mike Robinson, MSc, RPBio
Senior Aquatic Ecologist
mike.robinson@lotic.co

Thor Smestad. MSc, P.Ag
Senior Reclamation Ecologist
thor.smestad@lotic.co

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1 Introduction

The City of Fernie is a community of approximately 5500 residents located in the Elk Valley, BC along Highway No. 3. The community is situated in Area A of the Regional District of East Kootenay (RDEK) along the Elk River at the confluences of Coal and Fairy Creek. As much of the community is situated along waterways, a system of dikes has been established that are registered under the *Dike Maintenance Act*. The Annex dike section relevant to the Fernie Annex Dike Improvement Project (the Project) was constructed in 1983 to provide protection to an estimated 1:200-year flood level with a freeboard allowance. In 2016-2017, Northwest Hydraulic Consultants (NHC) were contracted to conduct floodplain mapping of the Elk River and Fairy Creek, which is a tributary of the Elk River, to determine the potential extent of flooding and provide recommendations for flood construction levels (FCL). NHC also then completed the Elk River Flood Mitigation Plan that included an implementation plan for dike improvements and identified hazards associated with the flood risk. In 2019, the City of Fernie conducted a more comprehensive flood mitigation plan which included a detailed dike survey, geotechnical assessment and dike inspection which also included flood protection in West Fernie and on Coal Creek.

The City of Fernie assessments and flood mitigation plans concluded that there is potential for water to enter the city and flood surrounding areas during high flow events. Flood protection is considered low with dikes along the Elk River being 0.5-1.0 m below the recommended FCL level (NHC 2017). The goal of the Project is to improve the Fernie Annex dike by:

- Raising the dike height along 1800 m to identified flood construction levels;
- Reconstruct the dike slope and crest;
- Improve the existing erosion protection by repairing areas that have degraded.

Overall, the objectives of the Project are to improve the resiliency of the City of Fernie to flood hazards through upgrading the flood protection infrastructure which will provide additional protection for residential properties and municipal infrastructure.

2 Objectives

The purpose of this Fish and Fish Habitat Assessment is to provide an overview of the existing conditions within the project footprint that will require consideration for project approval by regulators.

3 Methods

3.1 Fish and Fish Habitat

3.1.1 Fish Habitat

Site visits were conducted by a Senior Aquatic Ecologist on April 15 and June 9, 2021. The site was reviewed to describe the instream habitat along the Fernie Annex area; the reach bounded upstream by the Leo T. Nimsick Bridge and downstream by the West Bridge on Highway 3 over the Elk River. Mainstem habitat units were delineated into primary unit types of pool, glide, and riffle, following Johnston and Slaney (1996). Channel widths were estimated in the field and

verified through mapping software. Channel depths were estimated from shore given the inability to wade the large channel. Off-channel habitat were also assessed wherever the project footprint interacted with these features. This included a feature referred to as the Duck Pond and a channel draining into the upstream end of the Pond.

Site data were used to quantify habitat availability by type and provide relative proportions over the project area. Additional habitat value provided by various cover elements was quantified and provided by habitat type. Habitat type was subsequently used to support the assessment of fish use.

3.1.2 Fish Use

Fish use was described using a combination of desktop assessment and data collected during the site visits conducted to describe available habitat. This approach was considered appropriate given the understanding that much, if not all, of the instream footprint could be avoided through the design process. A desktop review was conducted of available fisheries information for the area. The primary sources of information were the Provincial fisheries database and a telemetry study conducted by Prince and Morris (2003). These sources of information were used to describe species present and specific uses of the area. Existing fisheries information on fish use in the area was supplemented as needed to describe potential fish use by relating the species present, the ecology of these species, and with the results of habitat assessment. This method of describing potential use was considered conservative as it did not rely on actual fish detection. Fish use was summarized by life history activity (spawning, rearing, overwintering) for each species present. As use was related to habitat type, this approach also allowed for a determination of any potential high value or unique habitat that may exist within the vicinity of the project.

3.2 Riparian Habitat

The riparian assessment was completed by a qualified Professional Agrologist (T. Smestad) on June 13, 15 and 17, 2021. Water stage at time of assessment appeared to be at or slightly above (0.2-0.3m) the normal high-water mark. The assessment provides an inventory of the tree and shrub vegetation, along with a few selected herbaceous species,[1] in three zones along the dike. The basic stratification units for this survey are the same sections (A to J) indicated on the engineer's drawings.[2] The zones are as follows:

- Zone 1: The area/strip in front of/adjacent to the existing dike on the outboard/river side, out to the river high water mark or maximum 10 meters (HD). The highest elevation side of this zone was at times the toe of the existing bank/dike, but in other areas was higher on this bank/slope. See descriptions in table footnotes.
- Zone 2: The outboard/river side of dike, from the edge of the gravel walking path to the toe of existing dike/slope, or as defined in the table footnotes for each section. It is assumed all woody vegetation will be cut/removed from Zone 2 areas as part of the proposed dike improvements.

[1] Aside from those species included on the tables below an inventory of herbaceous vegetation was not done.
[2] City of Fernie. Annex Dike Improvement. McElhanney project 2441-01170-00, status: issued for 75% review.

- Zone 3: The inboard/town side of dike, from the edge of the gravel walking path to the toe of the existing dike/slope, and 2 meters more in areas designated to have existing vegetation removed this additional distance (as per the engineer's drawings). It is assumed all woody vegetation must be cut/removed from Zone 3 areas as part of the proposed dike improvements (referred to as the "cut area" below). Where it was estimated larger trees must be cut, this is noted on the tables.

In addition to tables describing vegetation in each zone, numerous photos are presented for each section along with recommendations. Worthy of note here – a small patch of invasive Japanese Knotweed was found in one location (Section A, see below). Other potential exotic invasives are noted for Section C.

Also note that within all sections there are a number of native shrubs growing along the top of Zone 2 and 3 (along the path) that could be lifted/salvaged using a mini excavator for transplantation to other parts of the proposed dike improvement area, or elsewhere (See Section 4.3 for a summary).

4 Results

4.1 Fish and Fish Habitat

4.1.1 Fish Habitat – Elk River

The total site length surveyed was 2,018 m long and consisted of a single meander of the Elk River. Flowing generally from north to south, the channel is restricted to the western side of the valley bottom with the City of Fernie occupying the eastern floodplain. The constriction and position on a meander led to much of the habitat being deep, slow units with laminar flow. The site was delineated into seven habitat units, six being glides, two pools, and one riffle (Figure 1). Proportionally by length, the habitat distribution followed this distribution (Table 1). The average channel slope was shallow at 0.3%.

Habitat quality of the channel was considered high with little observable disturbance. Other than the suspected restriction to the western side of the valley bottom, the only other notable disturbance were some mid-channel bars in the upper half of the surveyed reach. These deposits have been observed as developing downstream of the Leo T. Nimsick bridge and the mid-channel piling associated with the structure. This gravel deposit did result in the delineation of a tertiary channel beginning upstream of Highway 3 and extending for 260 m downstream of the crossing, along the east bank. Habitat in the tertiary channel alternated between riffle and glide.

The Elk River channel width averaged approximately 58 m throughout this reach. Depths ranged from 0.4 m in the tertiary habitat to an estimated >2 m deep in the pools. However, the majority of the reach would have a bankfull depth estimated between 1.25-1.75 m.

Cover in the reach was primarily provided by deep pool and glide habitat (considered where water depths >1 m). The large width of the stream made it such that the riparian vegetation was relatively ineffective at providing overhead cover. The riparian vegetation would provide more value in terms of shading, bank stability, and allochthonous nutrient inputs.

No stream tributary habitat or unique habitat types were observed in the surveyed reach. Off-channel habitat was present in the Annex Pond and influent channel (see Section 4.1.2).

Table 1. Habitat type by length and percent abundance.

Habitat type	Total linear distance (m)	% abundance
Glide	1509	75%
Pool	332	16%
Riffle	177	9%



Figure 1. Habitat delineation map.

4.1.2 Fish Habitat – Annex Pond and Park

The Project activities are largely focussed on improving erosion and flood protection on the setback dike (herein the Annex Dike). Situated between the Elk River and the Annex Dike are two important community features; the Annex Park and the Annex Pond. The Annex Park is a natural area, surrounded by trails for recreational enjoyment and includes a duck pond located on the west end of the Park. The Annex Pond is a 1.6 ha lentic waterbody surrounded by walking paths (Figure 2). There is one inlet channel flowing into the north end of the pond and an outlet into the Elk River located approximately 450 m upstream of the downstream Highway 3 bridge. The bottom of the pond has a dense cover of chara; a filamentous algae that grows much like an aquatic macrophyte. The shorelines have emergent sedges that trend into upland species and in much of the area, grasses from the park setting. Maximum depth of the pond was estimated at 1.5 m.

The inlet channel begins a seepage from under 12th Ave and flows for approximately 250 m before entering the pond (Figure 3). Channel widths ranged from 1.2-2.1 m and depths up to 0.5 m in some deeper sections. The habitat was almost entirely low gradient glide meso-habitat. One culvert was located near the upper end of the channel near the entrance to the Annex Park. The channel was lined with deciduous tree (cottonwood) and shrub (willow and red-osier dogwood) species.



Figure 2. Annex Pond from Annex dike.



Figure 3. Downstream view of Annex Pond inlet channel, between culvert and pond.

4.1.3 Fish Use

The project area is located on the Elk River upstream of a migratory barrier that isolates it from the larger Kootenay River system. Fish species found in the Elk River and its tributaries upstream of the waterfall barrier at Elko, BC are listed below (BC MoE 2019). Based on this project footprint being located in large, mainstem habitat, it is assumed that Westslope Cutthroat Trout (WCT), Mountain Whitefish (MW), and Bull Trout (BT) are the primary fish species using this area.

- Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*),
- Bull Trout (*Salvelinus confluentus* interior lineage).
- Mountain Whitefish (*Prosopium williamsoni*),
- Longnose Dace (*Rhinichthys cataractae*),
- Longnose Sucker (*Catostomus catostomus*), and
- Eastern Brook Trout (*Salvelinus fontinalis)*, a non-native species.

WCT (interior lineage) are species of Special Concern in BC and under COSEWIC (BC CDC 2019). Additionally, WCT are a species of Special Concern throughout their range in British Columbia under the federal Species at Risk Act (SARA; BC CDC 2019). Mountain Whitefish, Longnose Dace, and Longnose Sucker are common throughout BC and the Elk River watershed, and are unlisted. Eastern Brook Trout are a non-native species originally stocked in BC waters. The Elk River and its tributaries have been designated as Classified Waters by the BC Government in response to high fishing pressure, and to maintain the high quality of angling experience. As a result of this designation, the river has special licencing provisions and angler targets. Overall, incorporating mechanisms to maintain healthy fish populations and habitats is important when designing and implementing erosion and flood protection projects.

The project footprint contains variable instream habitat types and variable riparian conditions. Instream habitat includes deep pools, as well as shallow riffle/glide portions along channel margins. Deep pool habitat provides ideal adult summer rearing for all salmonid species listed above (Prince and Morris 2003). Differences between adult and juvenile rearing habitat works to segregate younger age classes from adults. Where adults prefer deeper water, juvenile abundance is highest in shallower water (~0.3-0.4 m; Robinson 2012). However, even though this habitat type (i.e. glides and riffles) is present in mainstem Elk River, sampling suggests that juvenile rearing preference is limited in the mainstem Elk River, as these younger age-classes are routinely reported near absent from mainstems and more abundant in tributaries and off-channel habitat (Robinson 2011; Robinson 2014). In other words, while the preferred habitat can be found in mainstem habitat, juveniles tend to avoid these areas in preference of tributary habitat. Nonetheless, this assessment assumes moderate use where suitable depths exist and low use in deeper habitat where adult rearing would be dominant.

Fish use data collected from the Elk River system does not suggest overwintering requirements are different between adults and juveniles, meaning they depend on much of the same habitat requirements. Overwintering requirements, for both adults and juveniles, includes water that remains free of frazil and anchor ice, maintains suitable temperatures and adequate dissolved oxygen. It is expected that adult and juvenile segregation by water depth and mainstem versus tributary remains during overwintering. In that, it is assumed that adult overwintering requires deeper water, where juvenile overwintering of mainstem habitat is limited, occurring in the shallower margins if at all. While salmonid overwintering generally requires deep pool habitat,

not all deep pool habitat provides overwintering opportunity for these local salmonids. Prince and Morris (2003) documented WCT overwintering habitat in the Elk River watershed using telemetry studies from 2000-2002. The nearest overwintering location to Fernie was upstream near Hosmer and downstream near the confluence with Coal Creek. It is therefore considered that overwintering use in the project footprint is moderate for both adult and juvenile.

Spawning habitat requirements are variable among these salmonids relative to rearing and overwintering. WCT and BT typically select smaller channels provided tributaries and side channels (Prince and Morris 2003; Robinson and Duke 2013), while MW have been observed spawning in larger aggregations pool and deep glide habitat of the Elk River, Michel Creek, and Fording River. From the habitat available within the project footprint, spawning potential is considered low for WCT and BT throughout and moderate to good for MW where deep pool habitat occurs.

The lentic habitat provided by the Annex Pond defaults to fish bearing status due to a lack of migratory barrier between it and the Elk River. It is expected to provide habitat similar to other lentic/off-channel habitat in this part of the Elk River watershed. These habitats have been show to hold populations of longnose sucker (*Catostomus catostomus*), longnose dace (*Rhinichthys cataractae*), and redside shiner (*Richardsonius balteatus*). While the habitat of the inlet channel is moderate in quality and disconnected by the culvert, no barriers were found between the channel and the fish bearing pond. As per provincial fish inventory methods, the inlet channel also defaults to fish bearing status.

4.2 Riparian Habitat

Sections 4.2.1 to 4.2.10 summarize the vegetation data collected and photos taken for dike sections during this assessment. Note that Sections 4.2.9 and 4.2.10 are a summary of the Attack Armour areas proposed for Sections B and G.

4.2.1 Section A (0+000 to 0+435)

Photos 1 to 8 show Section A and Table 2 summarizes the vegetation data. See table and photo comments for important information, and Section A recommendations below.



Photo 1: Cluster of early mature (10-20m height) cottonwood in Section A, Zone 1. June 2021.



Photo 2: Clump-type willow in Section A, Zone 1 (growing at toe of bank) and Spreading-type willow growing on flood plain area in front. June 2021.



Photo 3: Gap in riparian vegetation along Section A, Zone 1. Potential to fill-plant these areas with willow and cottonwood live cuttings. June 2021.



Photo 4: Gap in riparian vegetation along Section A, Zone 1. Shovel handle marks where plantable using excavator, above this still rock underground. June 2021.



Photo 5: Vegetation in Section A, Zone 3 “cut area.” This patch includes large Mtn. Ash and Hawthorn, also cottonwood advanced regen (ht. 3-10m). June 2021.



Photo 6: Japanese knotweed in Section A, Zone 3 at about 0+280m. The mature cottonwood (ht. 20-35m) seen here at the toe of the bank are estimated to be in the “cut area.” June 2021.



Photo 7: Cottonwood advanced regen in Section A, Zone 3. June 2021.



Photo 8: Early mature birch, cedar and Douglas-fir in “cut area” along fence line at south end of Section A, Zone 3. June 2021.

Table 2. Section A - Vegetation Summary

Pre-Construction Vegetation Data for Proposed Fernie Annex Dike Improvements - **Section A (0+000 to 0+435)**
Date of data collection: June 13, 15, 17 - 2021

Section[a]	Zone[b]	Species		Growth Stage / Form[c]	Dist.[d]	Cover[e]	Median height (m)	Max. height (m)	Comments
		Common name	Latin name						
A	1	Cottonwood	*Populus trichocarpa*	M	—	—	—	—	None present.
A	1	Cottonwood	*Populus trichocarpa*	EM	P/E	4	15	20	Greater numbers at north and south end of section.
A	1	Cottonwood	*Populus trichocarpa*	AR	P	2	7	10	
A	1	Cottonwood	*Populus trichocarpa*	R	P	2	2	3	
A	1	Native willow	*Salix spp.*	C	P/E	3	2.5	4	Clumps often right at toe of bank.
A	1	Native willow	*Salix spp.*	S	E	5	2	3	Widespread in this floodplain area, includes S. exigua (sandbar willow).
A	1	Red-osier dogwood	*Cornus sericea*	C/S	P	2	1.5	3	Often right at toe of bank, also seen spread by air-layering onto riprap above.
A	1	Mountain ash	*Sorbus sitchensis*	C	P	1	3	5	Often right at toe of bank.
A	1	Native rose	*Rosa spp.*	S	P	2	1	1.5	
A	1	Choke cherry	*Prunus virginiana*	C	P	1	1	1.5	
A	1	Horsetail	*Equisetum spp.*	—	E	5	0.3	0.4	
A	1	Grass	—	—	E	4	0.5	0.7	
A	2	Cottonwood	*Populus trichocarpa*	M	—	—	—	—	None present.
A	2	Cottonwood	*Populus trichocarpa*	EM	—	—	—	—	None present.
A	2	Cottonwood	*Populus trichocarpa*	AR	P	1	4	6	
A	2	Cottonwood	*Populus trichocarpa*	R	P	2	1.5	3	
A	2	Red-osier dogwood	*Cornus sericea*	C/S	P	1	1.5	2	
A	2	Mountain ash	*Sorbus sitchensis*	C	P	1	3.5	4	
A	2	Saskatoonberry	*Amelanchier alnifolia*	C	P	1	2.5	3	Some planted along edge of path, these up to 1m height.
A	2	Hawthorth	*Crataegus douglasii*	C	P	1	1	1.5	Some planted along edge of path, these up to 1m height.
A	2	Twinberry	*Symphoricarpus albus*	S	P	1	0.7	1	Some planted along edge of path, these up to 1m height.
A	2	Choke cherry	*Prunus virginiana*	C	P	1	4	4	Some planted along edge of path, these up to 1m height.
A	3	Cottonwood	*Populus trichocarpa*	M	P	2	25	28	Estimate 12 in designated "cut area" at toe of bank or within 2m.
A	3	Cottonwood	*Populus trichocarpa*	EM	P	2	18	20	Estimate several in "cut area" at toe of bank.
A	3	Cottonwood	*Populus trichocarpa*	AR	E/P	3	8	10	
A	3	Cottonwood	*Populus trichocarpa*	R	E/P	2	1.5	3	
A	3	Douglas-fir	*Pseudotsuga menziesii*	EM	P	1	13	13	One tree only next to fence south end of section.
A	3	Birch	*Betula spp.*	EM	P	1	12	12	One tree only next to fence south end of section.
A	3	Cedar	*Thuja plicata*	EM	P	1	12	12	One tree only next to fence south end of section.
A	3	Native willow	*Salix spp.*	C	P	1	2	3	
A	3	Red-osier dogwood	*Cornus sericea*	C/S	P	3	1	1.5	
A	3	Mountain ash	*Sorbus sitchensis*	C	P	2	1	9	At least 2 large to cut.
A	3	Hawthorth	*Crataegus douglasii*	C	P	1	2	8	Several large to cut.
A	3	Native rose	*Rosa spp.*	S	P	1	1	1.2	
A	3	Twinberry	*Symphoricarpus albus*	S	P	1	1	1.5	
A	3	Choke cherry	*Prunus virginiana*	C	P	2	8	10	
A	3	Red twinberry	*Lonicera utahensis*	S	P	2	2	3	
A	3	Grass	—	C	E/P	5	0.5	0.7	
A	3	Alphalfa	—	C	E/P	2	0.4	0.5	
A	3	Japanese knotweed	*Fallopia japonica*	S	P	1	1.5	2	Patch approx 5m x 10 m at approx (0+280), just establishing now in partial shade. Did not see on adjacent private property.

a) Annex Dike Sections as per Engineer's Drawings
b) Vegetation zones assessed:
Zone 1 is the floodplain area from the toe of the existing riprap/bank to the river high water mark or 30m. The riprap extends out underground or partially buried past the present toe for at least 1 - 1.5m. Plants growing right at the toe of the bank that are also growing partially up through the riprap above are considered in Zone 1.
Zone 2 is the existing riprap outboard/river side of dike to toe of slope. Additional riprap is proposed to be placed over the existing here. Assume woody vegetation in Zone 2 will be cut/removed.
Zone 3 is inboard/town side of dike to the toe of the slope (assume woody veg. to be cut/removed here) + 2 m where existing veg. is to be removed as shown on engineer's drawings.
c) Cottonwood (Act) and other trees/conifers: R = regen. (<1 m ht.); AR = advanced regen. (1-10 m ht.); EM = early mature (10-20 m ht.); M = mature (20-35 m ht.); V = veteran (>35 m ht.)
Shrubs: C = Clumps (growth form single stems or well defined clumps); S = Spreading (growth form open spreading clumps or patches, includes where spread has occurred due to air layering and/or rhizomatous growth).
d) Distribution of plants. E = individual plants distributed evenly throughout zone; P = individual plants tend to be grouped in patches or clusters throughout the zone.
e) Estimated % cover: 1 = < 5%; 2 = 5-15%; 3 = 15-30%; 4 = 30-60%; 5 = 60-90%; 6 = > 90%.

Section A: Recommendations

- There are a few gaps in the riparian vegetation at the toe of the bank in Zone 1 (Photos 3 and 4). It would be possible to fill-plant these gaps with dormant willow and cottonwood live cuttings (pockets), using an excavator standing above.[3] The distance from the crest of bank/edge of path to the toe of the visible riprap is about 6m. A medium sized excavator (e.g., 160-240) could do this as it should be possible for the machine to

[3] Using an excavator to plant live cutting "pockets." To do this excavator inserts its bucket into soil to depth of about 1 m and then opens a planting slit/hole. The machine holds the slit open while live cuttings are inserted by a ground crew, after which the excavator extracts its bucket carefully closing the planting hole.

go out onto the riprap some distance. Several gaps present, perhaps 20-30 bucket-cuts/pockets required to fill.

- The knotweed patch seen in Zone 3 at about 0+280m should be treated. Recommend excavating to remove all roots/rhizomes and hauling this material to be disposed of as invasive weed waste at local landfill (at least one full truckload). Monitor in the future with cutting and glyphosate stem injection if plant re-appears. This patch did not appear to extend onto adjacent private land.

4.2.2 Section B (0+435 to 0+610)

Photos 9 to 16 show Section B and Table 3 summarizes the vegetation data. See table and photo comments for important information, and the Section B recommendations below.



Photo 9: Section B, Zone 2. Looking north from south end of this section. June 2021.



Photo 10: Section B, Zone 2. Looking south from about mid-way along this section. Lots of cottonwood advanced regen here.



Photo 11: Section B, Zone 2 and 3. Looking north from about mid-way along this section. Edge of pond goes right to bank of slope starting in center of photo. June 2021.



Photo 12: Section B, Zone 2 and 3. Looking south from north end of this section. A sediment barrier will be needed below proposed new dike fill and topsoil placement. June 2021.

	
Photo 13: Section B, Zone 3. Looking north from south end of this section. June 2021.	Photo 14: Wetland area at toe of slope, south end of Section B, Zone 3. Place sediment barrier below construction work here also. The mature cottonwood at toe of bank here were considered to be out of the "cut area."
	
Photo 15: Section B, Zone 3. Large cottonwood veterans at toe of bank here estimated to be inside proposed "cut area." June 2021.	Photo 16: Section B, Zone 3. These cottonwood veterans were estimated to be outside of the proposed "cut area." June 2021.

Table 3. Section B - Vegetation Summary

Pre-Construction Vegetation Data for Proposed Fernie Annex Dike Improvements - **Section B (0+435 to 0+610)**

Date of data collection: June 13, 15, 17 - 2021. **Note: between 0+560 and 0+610 X-section for Section C more relevant. Pond edge at toe of bank (5-7 m HD from edge of path on dike).**

Section[a]	Zone[b]	Species		Growth Stage / Form[c]	Dist.[d]	Cover[e]	Median height (m)	Max. height (m)	Comments
		Common name	Latin name						
B	1[f]	Cottonwood	*Populus trichocarpa*	M	P	1	25	25	
B	1	Cottonwood	*Populus trichocarpa*	EM	P	1	12	12	
B	1	Cottonwood	*Populus trichocarpa*	AR	P	1	3	6	
B	1	Native willow	*Salix spp.*	C	P	2	4	5	Along pond edge.
B	1	Red-osier dogwood	*Cornus sericea*	C/S	E	4	2.5	4	
B	1	Mountain ash	*Sorbus sitchensis*	C	P	1	2	3.5	
B	1	Saskatoonberry	*Amelanchier alnifolia*	S	P	1	1	1	
B	1	Alder	*Alnus spp.*	C	P	2	7	8	
B	1	Grass	—	S	P/E	3/4	0.5	0.6	
B	1	Sedges	*Carex spp.*	S	P/E	2	0.4	0.5	Along pond edge.
B	2	Cottonwood	*Populus trichocarpa*	EM	P	1	17	20	At toe of slope south end.
B	2	Cottonwood	*Populus trichocarpa*	AR	P/E	3	5	10	Lots to cut, esp. south end.
B	2	Cottonwood	*Populus trichocarpa*	R	P/E	2	2.5	3	
B	2	Red-osier dogwood	*Cornus sericea*	C/S	P	1	1	1.5	
B	2	Mountain ash	*Sorbus sitchensis*	C	P	1	4	5	
B	2	Twinberry	*Symphoricarpus albus*	S	P	1	1	1.5	
B	2	Grass	—	S	E	5	0.5	0.6	
B	2	Alphafa	—	C	P	1	0.4	0.5	
B	3[f]	Cottonwood	*Populus trichocarpa*	V	P	2	35	35	Estimate 3 large cottonwood in "cut area."
B	3	Cottonwood	*Populus trichocarpa*	M	P	1	20	25	Estimate 3 in "cut area."
B	3	Cottonwood	*Populus trichocarpa*	EM	P	1	12	17	Estimate 2 in "cut area."
B	3	Cottonwood	*Populus trichocarpa*	AR	P	2	5	8	
B	3	Cottonwood	*Populus trichocarpa*	R	P	2	1.5	3	
B	3	Native willow	*Salix spp.*	C	P	1	1.5	2	
B	3	Red-osier dogwood	*Cornus sericea*	C/S	P	2	2	3	
B	3	Mountain ash	*Sorbus sitchensis*	C	P	1	1.5	1.5	
B	3	Saskatoonberry	*Amelanchier alnifolia*	C	P	1	1	1.5	
B	3	Twinberry	*Symphoricarpus albus*	S	P	1	1	1.5	
B	3	Grass	—	S	E	5	0.5	0.6	
B	3	Alphafa	—	C	E	4	0.4	0.5	

a) Annex Dike Sections as per Engineer's Drawings

b) Vegetation zones assessed:

Zone 1 extends from bottom of existing dike/slope out 10m, except between 0+560 and 0+610 where the bottom 1/3 of the slope is also included in Zone 1.

Zone 2 is the existing outboard/river side of dike, except between 0+560 and 0+610 where it is the top 2/3 of the slope only, also see Zone 1 description. Assume woody vegetation in Zone 2 will be cut/removed.

Zone 3 is inboard/town side of dike to the toe of the slope (assume woody veg. to be cut/removed here) + 2 m where existing veg. is to be removed as shown on engineer's drawings. Wet area at toe of dike at south end of section (cattails present).

c) Cottonwood (Act) and other trees/conifers: R = regen. (<1 m ht.); AR = advanced regen. (1-10 m ht.); EM = early mature (10-20 m ht.); M = mature (20-35 m ht.); V = veteran (>35 m ht.).

Shrubs: C = Clumps (growth form single stems or well defined clumps); S = Spreading (growth form open spreading clumps or patches, includes where spread has occurred due to air layering and/or rhizomatous growth).

d) Distribution of plants. E = individual plants distributed evenly throughout zone; P = individual plants tend to be grouped in patches or clusters throughout the zone.

e) Estimated % cover: 1 = < 5%; 2 = 5-15%; 3 = 15-30%; 4 = 30-60%; 5 = 60-90%; 6 = > 90%.

Section B: Recommendations

- A sediment barrier will be needed in Zone 1, between construction activities (placement of new dike fill and topsoil) and the pond edge (between about 0+550 and 0+610), to prevent sediment delivery to water during and after construction. This will also be required above the wetland area in Zone 3 (Photo 14). Recommend using biodegradable coir silt fencing or 12” diameter coir logs.

- Planting a double row of willow brush layers in Zone 1 (lower 1/3 of the slope) between about 0+550 and 0+610 would be beneficial in terms of habitat creation.

- It may also be possible to transplant sandbar or other willow here – material salvaged from the Section B and G Attack Armour areas (see Section 2.9 and 2.10 below). Plant just above high-water line where no other woody vegetation present and leaving sedge vegetation in front. This would create a nicely vegetated shoreline to the pond in these areas.

4.2.3 Section C (0+610 to 0+920)

Photos 17 to 26 show Section C and Table 4 summarizes the vegetation data. See table and photo comments for important information, and the Section C recommendations below.



Photo 17: Section C, Zone 1 and 2. Looking north from south end of section. June 2021.



Photo 18: Section C, Zone 1 and 2. Looking north from about mid-way along this section. Pacific willow seen. June 2021.



Photo 19: Section C, Zone 1 and 2. Looking south from about mid-way along this section. Shovel marks toe of Zone 2, also potential elevation below which brush layers could be planted. June 2021.



Photo 20: Section C, Zone 1 and 2. Surface soil where shovel seen in Photo 19. Top 25 cm (maybe deeper, difficult to dig further due to rockiness) is a good growing medium (fines with high organic matter content). June 2021.



Photo 21: Section C, Zone 3. Looking south. June 2021.



Photo 22: Section C, Zone 3. Looking south. June 2021.



Photo 23: Section C, Zone 3. Looking north. June 2021.



Photo 24: Section C, Zone 3. Sumac species spreading from private yard onto dike. Locus species in background. June 2021.



Photo 25: Section C, Zone 3. Species of Locust/Acacia at north end of section. June 2021.



Photo 26: Section C, Zone 3. Immature seed pods on tree seen in Photo 25. June 2021.

Table 4. Section C - Vegetation Summary

Pre-Construction Vegetation Data for Proposed Fernie Annex Dike Improvements - **Section C (0+610 to 0+920)**

Date of data collection: June 13, 15, 17 - 2021

Section[a]	Zone[b]	Species		Growth Stage / Form[c]	Dist.[d]	Cover[e]	Median height (m)	Max. height (m)	Comments
		Common name	Latin name						
C	1	Cottonwood	*Populus trichocarpa*	AR	P	2	6	7	
C	1	Native willow	*Salix* spp.	C	P	4	3	4	Along pond edge.
C	1	Native Pacific willow	*Salix lasiandra*	C	P	1	4	8	This is a large tree-sized native willow. Along pond edge.
C	1	Red osier dogwood	*Cornus sericea*	C/S	P	1	2	3	
C	1	Twinberry	*Symphoricarpos albus*	S	P	2	0.8	1	
C	1	Native rose	*Rosa* spp.	S	P	1	1	1	
C	1	Grass	—	S	E	5	0.4	0.5	
C	1	Sedges	*Carex* spp.	S	E/P	4	0.7	0.9	Along pond edge.
C	2	Cottonwood	*Populus trichocarpa*	AR	P	1	4	4	
C	2	Cottonwood	*Populus trichocarpa*	R	P	1	2.5	3	
C	2	Twinberry	*Symphoricarpos albus*	S	P	1	1	1	
C	2	Grass	—	S	E	6	0.4	0.5	
C	2	Alphafa	—	C	E/P	3	0.3	0.4	
C	3	Domestic gardens	—	—	E/P	4	—	—	Wide variety of non-native plants (hebaceous, deciduous and conifers). Including one locust and sumac species, see below.
C	3								
C	3	Acacia / Locust (not Black locust)	Possibly: *Robinia* spp.	C	P	1	4	4	Seen in Zone 3 adjacent to private property at north end of section. Also growing on adjacent private property. Potentially/likely invasive.
C	3	Sumac	*Rhus* spp.	S	P	1	1	1.5	Spreading from adjacent private property into Zone 3. May be native *Rhus glabra* or some exotic species.
C	3	Grass	—	S	E/P	4	0.4	0.5	Some areas mowed regularly, other not.

a) Annex Dike Sections as per Engineer's Drawings

b) Vegetation zones assessed:

Zone 1 is the bottom 1/3 of the slope between the path edge and pond. Pond wetted edge only 5-7 m HD from edge of path.

Zone 2 is the existing outboard/river side of dike extending 1/3 of the way down the slope from the path edge to the pond. Assume woody vegetation in Zone 2 will be cut/removed.

Zone 3 is inboard/town side of dike from the path edge to the toe of the slope or private property line (generally about the same; some domestic gardens are presently located here). All vegetation must be removed here for the proposed wall to be constructed along this side of the dike.

c) Cottonwood (Rat) and other trees/conifers: R = regen. (<1 m ht.); AR = advanced regen. (1-10 m ht.); EM = early mature (10-20 m ht.); M = mature (20-35 m ht.); V = veteran (>35 m ht.).

Shrubs: C = Clumps (growth form single stems or well defined clumps); S = Spreading (growth form open spreading clumps or patches, includes where spread has occurred due to air layering and/or rhizomatous growth).

d) Distribution of plants. E = individual plants distributed evenly throughout zone; P = individual plants tend to be grouped in patches or clusters throughout the zone.

e) Estimated % cover: 1 = < 5%, 2 = 5-15%, 3 = 15-30% 4 = 30-60%, 5 = 60-90%, 6 = > 90%.

Section C: Recommendations

- A sediment barrier will be needed in Zone 1, between construction activities (placement of new dike fill and topsoil) and the pond edge (entire section) to prevent sediment delivery to water during and after construction. Recommend using biodegradable coir silt fencing or 12" diameter coir logs.
- Planting a double row of willow brush layers in Zone 1 (lower 1/3 of the slope) would be beneficial in terms of habitat creation.
- It may also be possible to transplant sandbar or other willow here – material salvaged from the Section B and G Attack Armour areas (see Section 2.9 and 2.10 below). Plant just above high-water line where no other woody vegetation present and leaving sedge vegetation in front. This would create a nicely vegetated shoreline to the pond in these areas.

- Acacia / Locust species in Zone 3 and adjacent private property is potentially/likely invasive. A large seed bank of this species would be present in the soil under and around these trees, seed which can remain viable for many years. Either excavate soil containing this seedbank in this area and dispose of properly,[4] or ensure buried under at least 0.5 m of fill during dike construction.
- Unknown id Sumac species spreading from private land is native or not. Treat as non-native, therefore excavate soil in this area and dispose of properly. Note: description of BC native sumac species (*Rhus glabra*) range in "Plants of S. Interior and the Inland N.W."[5] does not include Kootenays.

4.2.4 Section D (0+920 to 1+100)

Photos 27 to 34 show Section D and Table 5 summarizes the vegetation data. See table and photo comments for important information, and the Section D recommendations below.



Photo 27: Section D, Zone 1A and 2A. South end of section where ditch opens into pond, looking south. June 2021.



Photo 28: Section D, Zone 1A and 2A. Looking north from point Photo 27 taken. Fish likely enter into ditch at this end. June 2021.



Photo 29: Section D, Zone 1A. Close-up of ditch area seen in Photo 28. June 2021.



Photo 30: Section D, Zone 1A and 2A. Water filled ditch ends about here. June 2021.

[4] At landfill informing staff there material contains invasive weed. Will be buried deep.
[5] Authors: Parish, Coupe, Lloyd.



Photo 31: Section D, Zone 1B and 2B. June 2021.



Photo 32: Section D, Zone 1B and 2B. Cottonwood at north end of section. June 2021.



Photo 33: Section D, Zone 3. Looking north from south end of section. June 2021.



Photo 34: Section D, Zone 3. Looking south from north end of section. Large cottonwood in “cut area” here. June 2021.

Table 5. Section D - Vegetation Summary

Pre-Construction Vegetation Data for Proposed Fernie Annex Dike Improvements - **Section D (0+920 to 1+100)**

Note: Zone 1A and 2A - there is a water filled ditch / slough at toe of slope here. Zone 1B and 2B - no water in ditch/swale at toe of slope here.

Date of data collection: June 13, 15, 17 - 2021

Section[a]	Zone[b]	Species		Growth Stage / Form[c]	Dist.[d]	Cover[e]	Median height (m)	Max. height (m)	Comments
		Common name	Latin name						
D	1A	Cottonwood	*Populus trichocarpa*	AR	P	2	7	8	
D	1A	Cottonwood	*Populus trichocarpa*	R	P	2	2	3	
D	1A	Native willow	*Salix spp.*	C	P	3	4	6	
D	1A	Red-osier dogwood	*Cornus sericea*	C/S	P	4	2	3	
D	1A	Saskatoonberry	*Amelanchier alnifolia*	C	P	1	3	4	
D	1A	Twinberry	*Symphoricarpos albus*	S	P	1	1	1.5	
D	1A	Choke cherry	*Prunus virginiana*	C	P	1	0.7	1.2	
D	1A	Alder	*Alnus spp.*	C	P	1	6	6	
D	1A	Sedges	*Carex spp.*	S	P	2	0.5	0.7	In depression at toe of slope.
D	1A	Horsetail	*Equisetum spp.*	—	P/E	3	0.5	0.6	
D	2A	Cottonwood	*Populus trichocarpa*	R	P	1	2	3	
D	2A	Mountain ash	*Sorbus sitchensis*	C	P	2	3	5	
D	2A	Saskatoonberry	*Amelanchier alnifolia*	C	P	1	1	1.5	
D	2A	Hawthorth	*Crataegus douglasii*	C	P	1	1	1.5	
D	2A	Grass	—	S	E/P	5	0.4	0.5	
D	2A	Alphafa	—	C	P	3	0.3	0.4	
D	1B	Cottonwood	*Populus trichocarpa*	M	P	2	25	30	North end of Section D, near outside limby of Zone 1.
D	1B	Cottonwood	*Populus trichocarpa*	AR	P	1	8	10	North end of Section D.
D	1B	Cottonwood	*Populus trichocarpa*	R	P	2	2	3	North end of Section D.
D	1B	Mountain ash	*Sorbus sitchensis*	C	P	1	3	4	
D	1B	Saskatoonberry	*Amelanchier alnifolia*	C	P	2	2	3	
D	1B	Twinberry	*Symphoricarpos albus*	S	P	1	0.8	1.2	
D	1B	Grass	—	S	E	6	0.4	0.5	
D	1B	Alphafa	—	C	P/E	3	0.3	0.4	
D	1B	Horsetail	*Equisetum spp.*	—	P/E	3	0.3	0.4	In ditch at bottom of slope, now water at time of assessment.
D	2B	Cottonwood	*Populus trichocarpa*	AR	P	2	8	10	North end of Section D.
D	2B	Cottonwood	*Populus trichocarpa*	R	P	2	1.5	2.5	North end of Section D.
D	2B	Mountain ash	*Sorbus sitchensis*	C	P	1	1	1.8	
D	2B	Saskatoonberry	*Amelanchier alnifolia*	C	P	1	1	1.8	
D	2B	Hawthorth	*Crataegus douglasii*	C	P	1	1.5	2	
D	2B	Choke cherry	*Prunus virginiana*	C	P	1	2	3.5	
D	2B	Grass	—	S	E	6	0.4	0.5	
D	2B	Alphafa	—	C	P/E	3	0.3	0.4	
D	3	Cottonwood	*Populus trichocarpa*	M	P	2	25	30	At toe of bank between 1+050 and 1+000. Two counted.
D	3	Cottonwood	*Populus trichocarpa*	EM	P	2	17	17	At toe of bank between 1+050 and 1+000
D	3	Cottonwood	*Populus trichocarpa*	AR	P	2	5	9	
D	3	Cottonwood	*Populus trichocarpa*	R	P	3	2	3	
D	3	Red-osier dogwood	*Cornus sericea*	C/S	P	1	2	3	
D	3	Mountain ash	*Sorbus sitchensis*	C	P	1	2.5	4	
D	3	Saskatoonberry	*Amelanchier alnifolia*	C	P	2	1.3	1.8	
D	3	Hawthorth	*Crataegus douglasii*	C	P	1	1	1	
D	3	Twinberry	*Symphoricarpos albus*	S	P	1	1	1	
D	3	Native rose	*Rosa spp.*	S	P	1	0.8	1	
D	3	Choke cherry	*Prunus virginiana*	C	P	2	3	5	
D	3	Raspberry	*Rubus spp.*	S	P	1	1.5	2	At toe of slope in back garden - planted.

a) Annex Dike Sections as per Engineer's Drawings

b) Vegetation zones assessed.

Zone 1 (A and B) on outboard/river side of dike, from a point starting 2/3 of way down bank, and out 10 m HD.

Zone 1A (0+920-0+980) - water filled ditch/slough connected to the pond to the south runs along the base of the bank here (to 0+990). Engineer's x-section shows this ditch/area will be filled during the proposed dike construction. No fish were observed in this ditch during this assessment.

Zone 1B (0+990-1+100) - no water in ditch/swale at toe of slope here.

Zone 2 (A and B) is the existing outboard/river side of dike to to 2/3 way down bank from edge of gravel path. Assume woody vegetation in Zone 2A and 2B will be cut/removed.

Zone 2A (0+920-0+990).

Zone 2B (0+990-1+100).

Zone 3 is inboard/town side of dike to the toe of the slope (assume woody veg. to be cut/removed here) + 2 m where existing veg. is to be removed as shown on engineer's drawings.

c) Cottonwood (Act) and other trees/conifers: R = regen. (<3 m ht.); AR = advanced regen. (3-10 m ht.); EM = early mature (10-20 m ht.); M = mature (20-35 m ht.); V = veteran (>35 m ht.).

Shrubs: C = Clumps (growth form single stems or well defined clumps); S = Spreading (growth form open spreading clumps or patches, includes where spread has occurred due to air layering and/or rhizomatous growth).

d) Distribution of plants: E = individual plants distributed evenly throughout zone; P = individual plants tend to be grouped in patches or clusters throughot the zone.

e) Estimated % cover: 1 = < 5%; 2 = 5-15%; 3 = 15-30%; 4 = 30-60%; 5 = 60-90%; 6 = > 90%.

Section D: Recommendations

- Before the proposed dike construction begins must determine if water filled ditch at base of slope in Zone 1A is fish bearing or not. Fish likely do enter this ditch for some distance at the south end of this section. Closing off and fish trapping/removal may be required.

- Recommend leaving willow and red-osier dogwood at toe of slope in Zone 1 (A and B) when fill placed in this area (as per engineer's drawings). Also lift shoots up during fill placement so tip remain protruding after fill placement, this will establish and vegetation at the toe of the new dike here.

4.2.5 Section E (1+105 to 1+260)

Photos 35 to 42 show Section E and Table 6 summarizes the vegetation data. See table and photo comments for important information, and the Section E recommendations below.



Photo 35: Section E, Zone 1 and 2. Looking south from north end of Section E. June 2021.



Photo 36: Section E, Zone 1 and 2. Cottonwood seen in Photo 33. June 2021.



Photo 37: Section E, Zone 1 and 2. Outlet for culvert at 1+205 here. June 2021.



Photo 38: Section E, Zone 1 and 2. Equisetum-dominated wetland area at about 1+150 to 1+170. June 2021.



Photo 39: Section E, Zone 1 and 2. Wetland area between about 1+120 to 1+160, cattails seen here. June 2021.



Photo 40: Section E, Zone 1 and 2. Small pond below parking access road at 1+110. June 2021.



Photo 41: Section E, Zone 3. Looking north from south end of Section E. June 2021.



Photo 42: Section E, Zone 3. Looking south from north end of Section E. June 2021.

Table 6. Section E - Vegetation Summary

Pre-Construction Vegetation Data for Proposed Fernie Annex Dike Improvements - **Section E (1+105 to 1+260)**

Date of data collection: June 13, 15, 17 - 2021

Section[a]	Zone[b]	Species		Growth Stage / Form[c]	Dist.[d]	Cover[e]	Median height (m)	Max. height (m)	Comments
		Common name	Latin name						
E	1	Cottonwood	*Populus trichocarpa*	M	P	1	25	30	At toe of bank.
E	1	Cottonwood	*Populus trichocarpa*	EM	P	2	17	20	
E	1	Cottonwood	*Populus trichocarpa*	AR	P/E	4	7	10	
E	1	Native willow	*Salix spp.*	C	P	3	4	6	
E	1	Red-osier dogwood	*Cornus sericea*	C/S	P	4	2.5	3	
E	1	Mountain ash	*Sorbus sitchensis*	C	P	2	3	4	
E	1	Choke cherry	*Prunus virginiana*	C	P	1	3	5	
E	1	Alder	*Alnus spp.*	C	P	2	7	9	
E	1	Cattails	*Typha latifolia*	—	P/E	1	1.2	1.8	In wet/wetland area present at toe of bank approx. 1+110 to 1+200.
E	1	Horsetail	*Equisetum spp.*	—	P/E	3	0.4	0.5	In wet/wetland area present at toe of bank approx. 1+110 to 1+200.
E	2	Cottonwood	*Populus trichocarpa*	AR	P	1	3	4	
E	2	Cottonwood	*Populus trichocarpa*	R	P	1	2	3	
E	2	Red-osier dogwood	*Cornus sericea*	C/S	P	2	1.5	1.8	
E	2	Saskatoonberry	*Amelanchier alnifolia*	C	P	1	1.5	3.5	
E	2	Hawthorth	*Crataegus douglasii*	C	P	1	1	1.5	
E	2	Twinberry	*Symphoricarpos albus*	S	P	1	0.8	1	
E	2	Raspberry	*Rubus spp.*	S	P	1	0.8	1	
E	2	Choke cherry	*Prunus virginiana*	C	P	1	1.5	2	
E	3	No shrubs or trees.	*grassy slope only*	—	—	—	—	—	Wall proposed here.

a) Annex Dike Sections as per Engineer's Drawings
b) Vegetation zones assessed:
Zone 1 is on outboard/river side of dike, from a point starting 1/2 of way down bank, and out 10+m HS.
Zone 2 is the existing outboard/river side of dike from edge of gravel path to 1/2 way down bank. Assume woody vegetation in Zone 2 will be cut/removed.
Zone 3 is inboard/town side of dike - It is proposed that a wall be constructed here.
c) Cottonwood [Rot] and other trees/conifers: R = regen. (<1 m ht.); AR = advanced regen. (1-10 m ht.); EM = early mature (10-20 m ht.); M = mature (20-35 m ht.); V = veteran (>35 m ht.).
Shrubs: C = Clumps (growth form single stems or well defined clumps); S = Spreading (growth form open spreading clumps or patches, includes where spread has occurred due to air layering and/or rhizomatous growth).
d) Distribution of plants. I = individual plants distributed evenly throughout zone; P = individual plants tend to be grouped in patches or clusters throughout the zone.
e) Estimated % cover: 1 = < 5%; 2 = 5-15%; 3 = 15-30%; 4 = 30-60%; 5 = 60-90%; 6 = > 90%.

Section E: Recommendations

- A sediment barrier will be needed in Zone 1, between construction activities (placement of new dike fill and topsoil) and the wetland (between start of section at 1+105 and about 1+205 (culvert location), to prevent sediment delivery to wetland during and after construction. Recommend using biodegradable coir silt fencing or 12” diameter coir logs.

4.2.6 Section F (1+260 to 1+605)

Photos 43 to 48 show Section F and Table 7 summarizes the vegetation data. See table and photo comments for important information. There are no special recommendations for Section F.



Photo 43: Section F, Zone 1A and 2A. South end of section looking north. June 2021.



Photo 44: Section F, Zone 1A and 2A (starting just past where grass is cut to). Looking south. June 2021.



Photo 45: Section F, Zone 1B and 2B. Looking north. June 2021.



Photo 46: Section F, Zone 1B and 2B. Looking south from north end of section. June 2021.



Photo 47: Section F, Zone 3. Looking north from south end of section. June 2021.



Photo 48: Section F, Zone 3. Looking south from north end of section. June 2021.

Table 7.Section F - Vegetation Summary

Pre-Construction Vegetation Data for Proposed Fernie Annex Dike Improvements - **Section F (1+260 to 1+605)**

Date of data collection: June 13, 15, 17 - 2021

Section[a]	Zone[b]	Species		Growth Stage / Form[c]	Dist.[d]	Cover[e]	Median height (m)	Max. height (m)	Comments
		Common name	Latin name						
F	1A	Cottonwood	*Populus trichocarpa*	M	P	1	30	30	One only noted about 5 m from toe of existing bank.
F	1A	Cottonwood	*Populus trichocarpa*	EM	P/E	2	15	20	
F	1A	Cottonwood	*Populus trichocarpa*	AR	P	1	5	10	
F	1A	Cottonwood	*Populus trichocarpa*	R	P	1	2.5	3	
F	1A	Native willow	*Salix spp.*	C	P	1	4	6	
F	1A	Red-osier dogwood	*Cornus sericea*	C/S	P	2	1.5	2	
F	1A	Twinberry	*Symphoricarpus albus*	S	P/E	2	1	1.5	
F	1A	Grass	—	S	P/E	5	0.5	0.7	
F	1A	Horsetail	*Equisetum spp.*	—	P/E	2	0.3	0.4	
F	2A	Cottonwood	*Populus trichocarpa*	AR	P	1	4	7	
F	2A	Native willow	*Salix spp.*	C	P	1	4	5	
F	2A	Red-osier dogwood	*Cornus sericea*	C/S	P	1	1.5	2	
F	2A	Saskatoonberry	*Amelanchier alnifolia*	C	P	1	2	3	
F	2A	Twinberry	*Symphoricarpus albus*	S	P	1	1	1.5	
F	2A	Grass	—	S	P/E	5	0.7	0.7	
F	2A	Alphalfa	—	C	P/E	3	0.4	0.7	
F	1B	Grass	*playing field*	E	E	9			playing field 1+305 to end of section at 1+605.
F	2B	Saskatoonberry	*Amelanchier alnifolia*	C	P	1	1.5	3	Very few scattered plants.
F	2B	Hawthorth	*Crataegus douglasii*	C	P	1	1	1.5	Very few scattered plants.
F	2B	Twinberry	*Symphoricarpus albus*	S	P	1	1	1.5	Very few scattered plants.
F	2B	Grass	—	S	E	9	0.6	0.8	
F	3	Grass	*lawn only here*						

a) Access Dike Sections as per Engineer's Drawings

b) Vegetation zones assessed:

Zone 1 (A and B) is the outboard/river side of dike, from the toe of the existing dike/slope and out 10 m HD.

Zone 1A (1+260-1+305) - abundant woody veg. here.

Zone 1B (1+305 to end of section at 1+605) - only lawn here (playing field).

Zone 2 (A and B) is the existing outboard/river side of dike, from the edge of the gravel path to the toe of the dike/slope. Abundant woody vegetation in Zone 2 will be cut/removed.

Zone 2A (1+260-1+305) - more abundant woody veg. here.

Zone 2B (1+305 to end of section at 1+605) - only grass and very few scattered shrubs here.

Zone 3 is inboard/town side of dike, from the edge of the gravel path to the toe of the slope. Only lawn here at time of assessment.

c) Cottonwood (Act) and other trees/conifers: R = regen. (<1 m ht.); AR = advanced regen. (1-10 m ht.); EM = early mature (10-20 m ht.); M = mature (20-35 m ht.); V = veteran (>35 m ht.).

Shrubs: C = Clumps (growth from single stems or well defined clumps); S = Spreading (growth form open spreading clumps or patches, includes where spread has occurred due to air layering and/or rhizomatous growth).

d) Distribution of plants. E = individual plants distributed evenly throughout zone; P = individual plants tend to be grouped in patches or clusters throughout the zone.

e) Estimated % cover: 1 = < 5%; 2 = 5-15%; 3 = 15-30%; 4 = 30-60%; 5 = 60-90%; 6 = > 90%.

4.2.7 Section G (1+605 to 1+745)

Photos 49 to 52 show Section G and Table 8 summarizes the vegetation data. See table and photo comments for important information. There are no special recommendations for Section G.





Photo 49: Section G, Zone 1 and 2. June 2021.	Photo 50: Section G, Zone 3A. June 2021.
	
Photo 51: Section G, Zone 3B. Looking north. June 2021.	Photo 52: Section G, Zone 3B. Looking south from north end of section. June 2021.

Table 8. Section G - Vegetation Summary

Pre-Construction Vegetation Data for Proposed Fernie Annex Dike Improvements - **Section G (1+605 to 1+745)**

Date of data collection: June 13, 15, 17 - 2021. Note: Zones 1 and 2, only veg between 1+605 and 1+670 shown here - see Section G Attack Armor, Zones 1 and 2 for vegetation on outboard side of dike between 1+670 and end of section G (1+745).

Section[a]	Zone[b]	Species		Growth Stage / Form[c]	Dist.[d]	Cover[e]	Median height (m)	Max. height (m)	Comments
		Common name	Latin name						
	1	Grass	lawn here						From 1+605 to 1+670 only.
	2	Grass	—	—	E	8	0.5	0.7	From 1+605 to 1+670 only.
	2	Alphafa	—	—	P/E	3	0.4	0.7	From 1+605 to 1+670 only.
G	3A	grass / 16th st.	only lawn here	—	—	—	—	—	1+605 to 1+660.
G	3B	Cottonwood	Populus trichocarpa	V	—	—	—	—	Large veteran cottonwood estimated to be just outside of "cut area" around 1+720.
G	3B	Cottonwood	Populus trichocarpa	EM	P	2	15	18	
G	3B	Cottonwood	Populus trichocarpa	AR	P	2	8	10	
G	3B	Cottonwood	Populus trichocarpa	R	P	1	1	1	
G	3B	Aspen	Populus tremuloides	C	P	1	7	8	
G	3B	Native willow	Salix spp.	C	P	3	4	5	
G	3B	Red-osier dogwood	Cornus sericea	C/S	P	2	2	2.5	
G	3B	Mountain ash	Sorbus sitchensis	C	P	1	0.7	1	
G	3B	Saskatoonberry	Amelanchier alnifolia	C	P	2	4	5	
G	3B	Hawthorth	Crataegus douglasii	C	P	2	5	7	
G	3B	Twinberry	Symphoricarpos albus	S	P	2	1	1.5	
G	3B	Choke cherry	Prunus virginiana	C	P	1	1.5	1.5	
G	3B	Alder	Alnus spp.	C	P	3	6	8	
G	3B	Grass	—	S	P/E	5	0.5	0.7	
G	3B	Alphafa	—	C	P/E	3	0.4	0.5	
G	3B	Horsetail	Equisetum spp.	—	P/E	3	0.4	0.5	

a) Annex Dike Sections as per Engineer's Drawings
b) Vegetation zones assessed:
Zone 1 is the outboard/river side of dike, from the toe of the existing dike/slope and out 10 m HD (1+605 to 1+670 only here, past 1+670 see Section G Attack Armor).
Zone 2 is the existing outboard/river side of dike to the toe of the slope (1+605 to 1+670 only here, past 1+670 see Section G Attack Armor).
Zone 3A is the inboard/town side of the existing dike from the edge of the gravel path to the toe of the slope (1+605 to 1+660).
Zone 3B is inboard/town side of dike to the toe of the slope (assume woody veg. to be cut/removed here) + 2 m where existing veg. is to be removed as shown on engineer's drawings (between 1+660 to end of section at 1+745).
c) Cottonwood (Act) and other trees/conifers: R = regen. (<3 m ht.); AR = advanced regen. (3-10 m ht.); EM = early mature (10-20 m ht.); M = mature (20-35 m ht.); V = veteran (>35 m ht.).
Shrubs: C = Clumps (growth form single stems or well defined clumps); S = Spreading (growth form open spreading clumps or patches, includes where spread has occurred due to air layering and/or rhizomatous growth).
d) Distribution of plants, E = individual plants distributed evenly throughout zone; P = individual plants tend to be grouped in patches or clusters throughot the zone.
e) Estimated % cover: 1 = < 5%; 2 = 5-15%; 3 = 15-30%; 4 = 30-60%; 5 = 60-90%; 6 = > 90%.

4.2.8 Sections H and J (1+745 to 1+910)

Photos 53 to 62 show Sections H and J (assessed together, no Section I) and Table 9 summarizes the vegetation data. Note that these sections are presently mostly covered in riprap. See table and photo comments for important information, and the Section H+J recommendations below.



Photo 53: Section H, Zone 1 and 2. View from south end of section H looking north. June 2021.



Photo 54: Section H, Zone 1 and 2. From about middle of section H looking north. June 2021.



Photo 55: Section H, Zone 1 and 2. From about middle of section H looking south. June 2021.



Photo 56: Section H, Zone 1 and 2. Looking south from near north end of section H. June 2021.



Photo 57: Section J, Zone 1 and 2. Looking south from near bridge. June 2021.



Photo 58: Section J, Zone 1 and 2. Area just south of bridge. June 2021.



Photo 59: Section H, Zone 3. Looking north from south end of section H. June 2021.



Photo 60: Section H, Zone 3. Culvert opening at 1+750. Wetland areas adjacent. June 2021.

	
Photo 61: Section H, Zone 3. Looking north from about middle of section H. Wetland area/ponds adjacent at toe of slope. June 2021.	Photo 62: Section H and J, Zone 3. Large cottonwood at north end of section H/section J. June 2021.

Table 9. Section H & J - Vegetation Summary

Pre-Construction Vegetation Data for Proposed Fernie Annex Dike Improvements - **Section H & J (1+745 to 1+910).**

Date of data collection: June 13, 15, 17 - 2021. Notes: 1) there is no Section I, 2) Zone 1 and 2 assessed together.

Section[a]	Zone[b]	Species		Growth Stage / Form[c]	Dist.[d]	Cover[e]	Median height (m)	Max. height (m)	Comments
		Common name	Latin name						
H + J	1 & 2	Cottonwood	*Populus trichocarpa*	R	P	3	1.5	2	
H + J	1 & 2								
H + J	1 & 2	Native willow	*Salix spp.*	C	P	2	3	5	
H + J	1 & 2	Red-osier dogwood	*Cornus sericea*	C/S	P	2	3	5	
H + J	1 & 2	Moutain ash	*Sorbus sitchensis*	C	P	1	1.5	2	
H + J	1 & 2	Saskatoonberry	*Amelanchier alnifolia*	C	P	2	1.5	2.5	
H + J	1 & 2	Hawthorth	*Crataegus douglasii*	C	P	1	1.5	2.5	
H + J	1 & 2	Twinberry	*Symphoricarpos albus*	S	P	2	1.2	1.8	
H + J	1 & 2	Native rose	*Rosa spp.*	S	P	1	0.8	1.8	
H + J	1 & 2	Choke cherry	*Prunus virginiana*	C	P	1	1.5	2	
H + J	1 & 2	Black Twinberry	*Lonicera involucrata*	C	P	1	1.2	1.8	appeared planted
H + J	1 & 2								
H + J	1 & 2	Grass	—	S	P/E	4	0.5	0.7	
H + J	3	Cottonwood	*Populus trichocarpa*	V	P	1	32	32	Estimate at lease 3 in cut area. These at south end of Section J.
H + J	3	Cottonwood	*Populus trichocarpa*	M	P	1	22	22	Estimate at lease 2 in cut area.
H + J	3	Cottonwood	*Populus trichocarpa*	EM	P	1	12	12	
H + J	3	Cottonwood	*Populus trichocarpa*	AR	P/E	2	7	10	
H + J	3	Cottonwood	*Populus trichocarpa*	R	P/E	1	1	1.5	
H + J	3	Aspen	*Populus tremuloides*	AR	P/E	1	4	6	
H + J	3	Aspen	*Populus tremuloides*	R	P	1	1	1.5	
H + J	3	Spruce	*Picea spp.*	AR	P	1	2.5	2.5	
H + J	3	Spruce	*Picea spp.*	R	P	1	1	1	
H + J	3	Native willow	*Salix spp.*	C	P	3	1.5	4	
H + J	3	Red-osier dogwood	*Cornus sericea*	C/S	P/E	2	1.2	2	
H + J	3	Moutain ash	*Sorbus sitchensis*	C	P	1	1	1.5	
H + J	3	Saskatoonberry	*Amelanchier alnifolia*	C	P	1	1.2	2	
H + J	3	Hawthorth	*Crataegus douglasii*	C	P	1	1	1	
H + J	3	Twinberry	*Symphoricarpos albus*	S	P	2	0.8	1.2	
H + J	3	Alder	*Alnus spp.*	C	P/E	4	5	7	
H + J	3	Soopolalie	*Shepherdia canadensis*	C	P	2	1	1.2	
H + J									
H + J	3	Grass	—	S	E/P	5	0.5	0.7	
H + J	3	Alphalfa	—	C	E/P	3	0.4	0.5	
H + J	3	Horsetail	*Equisetum spp.*	—	E/P	4	0.5	0.7	

a) Arnaus Dike Sections as per Engineer's Drawings

b) Vegetation zones assessed:

Zone 1 and 2 assessed together here. This the outboard/river side of the dike, from the edge of the gravel path to the river high water line (water at high water during assessment, at most about 15 m).

Zone 3 is inboard/town side of dike to the toe of the slope + 2 m (engineer's drawings show cut area extending out 2 m all along Zone 3 here).

c) Cottonwood (*Bot*) and other trees/conifers: R = regen. (<3 m ht.); AR = advanced regen. (3-10 m ht.); EM = early mature (10-20 m ht.); M = mature (20-35 m ht.); V = veteran (>35 m ht.).

Shrubs: C = Clumps (growth form single stems or well defined clumps); S = Spreading (growth form open spreading clumps or patches, includes where spread has occurred due to air layering and/or rhizomatous growth).

d) Distribution of plants. E = individual plants distributed evenly throughout zone; P = individual plants tend to be grouped in patches or clusters throughout the zone.

e) Estimated % cover: 1 = < 5%; 2 = 5-15%; 3 = 15-30%; 4 = 30-60%; 5 = 60-90%; 6 = > 90%.

Section H + J: Recommendations

- A sediment barrier may be needed in Zone 3 of Section H, where water/wetland areas seen at toe of slope or just beyond - to prevent sediment delivery to water during and after construction. Recommend using biodegradable coir silt fencing or 12” diameter coir logs.

4.2.9 Section B Attack Armour

Photos 63 to 68 show the vegetation in the proposed Section B Attack Armour area (Zones 1 and 2 only), and Table 10 presents the vegetation data collected here. See table and photo comments for important information, and the section recommendations below.



Photo 63: Section B, Zone 1 and 2 – Proposed Attack Armor area. Cottonwood at far north end of section. June 2021.



Photo 64: Section B, Zone 1 and 2 – Proposed Attack Armor area. M and EM cottonwood in Zone 1 (north end of section).
June 2021.



Photo 65: Section B, Zone 1 and 2 – Proposed Attack Armor area. Sandbar willow along river. June 2021.



Photo 66: Section B, Zone 1 and 2 – Proposed Attack Armor area. June 2021.



Photo 67: Section B, Zone 1 and 2 – Proposed Attack Armor area. Looking south at south end of section. June 2021.



Photo 68: Section B, Zone 1 and 2 – Proposed Attack Armor area. Sandbar willow along water, south end of section. June 2021.

Table 10. Section B Proposed Attach Armour - Vegetation Summary

Pre-Construction Vegetation Data for Proposed Fernie Annex Dike Improvements - **Section B Proposed Attack Armour area.**
Date of data collection: June 13, 15, 17 - 2021

Section[a]	Zone[b]	Species		Growth Stage / Form[c]	Dist.[d]	Cover[e]	Median height (m)	Max. height (m)	Comments
		Common name	Latin name						
B - AA	1	Cottonwood	*Populus trichocarpa*	M	P	1	20	23	
B - AA	1	Cottonwood	*Populus trichocarpa*	EM	P	3	17	20	
B - AA	1	Native willow	*Salix spp.*	C	P	3	4	6	
B - AA	1	Sandbar willow	*Salix exigua*	S	E/P	3	1.7	2	This is sandbar willow all along the river high water line.
B - AA	1	Red-osier dogwood	*Cornus sericea*	C/S	P	2	1.5	2	
B - AA	1	Choke cherry	*Prunus virginiana*	C	P	1	4	4	
B - AA	2	Cottonwood	*Populus trichocarpa*	EM	P	2	15	20	
B - AA	2	Cottonwood	*Populus trichocarpa*	AR	P	1	7	10	
B - AA	2	Cottonwood	*Populus trichocarpa*	R	P	1	1	3	
B - AA	2	Red-osier dogwood	*Cornus sericea*	C/S	P	1	1	1.5	
B - AA	2	Moutain ash	*Sorbus sitchensis*	C	P	1	2	5	
B - AA	2	Saskatoonberry	*Amelanchier alnifolia*	C	P	1	2	2.5	
B - AA	2	Hawthorth	*Crataegus douglasii*	C	P	1	2	4	
B - AA	2	Grass	*lawn*	S	E/P	3	—	—	Patch of lawn in Zone 2, see photos.
B - AA	3	Not assessed.							

a) Annex Dike Sections as per Engineer's Drawings. B-AA = Section B Attack Armour area.
b) Vegetation zones assessed:
Zone 1 is on the outboard/river side of the dike, from a point starting 5 m (HD) from the path edge, to the river wetted edge (high water line). The distance from the path edge to the river wetted edge is 8-10 m all along this section. Assume all woody vegetation in Zone 1 will be cut/removed here due to riprap placement here.
Zone 2 is the existing outboard/river side of dike from the path edge out 5 m (HD). Assume all woody vegetation in Zone 2 will be cut/removed here due to riprap placement here.
Zone 3 – not assessed.
c) Cottonwood (*Bal*) and other trees/conifers: R = regen. (<3 m ht.); AR = advanced regen. (3-10 m ht.); EM = early mature (10-20 m ht.); M = mature (20-35 m ht.); V = veteran (>35 m ht.)
Shrubs: C = Clumps (growth form single stems or well defined clumps); S = Spreading (growth form open spreading clumps or patches, includes where spread has occurred due to air layering and/or rhizomatous growth).
d) Distribution of plants. E = individual plants distributed evenly throughout zone; P = individual plants tend to be grouped in patches or clusters throughout the zone.
e) Estimated % cover: 1 = < 5%; 2 = 5-25%; 3 = 15-30%; 4 = 30-60%; 5 = 60-90%; 6 = > 90%.

Section B Attack Proposed Attack Armour Area: Recommendations

- Consider salvaging excavator buckets-sized plugs of the sandbar and other willow along the water in this section for transplant along the toe of the bank/edge of pond in Section B and C.

  In Section B and C plant just above high-water line where no other woody vegetation present and leaving sedge vegetation in front.

4.2.10 Section G Attack Armour

Photos 69 to 76 show the vegetation in the proposed Section G Attack Armour area (Zones 1 and 2 assessed together as one), and Table 11 presents the vegetation data collected here. Note that existing riprap extends into the north half of this section. See table and photo comments for important information, and the section recommendations below.



Photo 69: Section G, Zone 1 & 2 – Proposed Attack Armor area. Looking north from south end of section. June 2021.



Photo 70: Section G, Zone 1 & 2 – Proposed Attack Armor area. Shoreline in cottonwood area at south end of section. June 2021.



Photo 71: Section G, Zone 1 & 2 – Proposed Attack Armor area. Powerlines at about 1+660. Looking north from end of cottonwood area. June 2021.



Photo 72: Section G, Zone 1 & 2 – Proposed Attack Armor area. Looking north from under powerlines. June 2021.



Photo 73: Section G, Zone 1 & 2 – Proposed Attack Armor area. Looking south from under powerlines. June 2021.



Photo 74: Section G, Zone 1 & 2 – Proposed Attack Armor area. Shoreline at north end of section, Sandbar willow seen here.
June 2021.



Photo 75: Section G, Zone 1 & 2 – Proposed Attack Armor area. Looking south from north end of section. June 2021.



Photo 76: Section G, Zone 1 & 2 – Proposed Attack Armor area. Looking south from north end of section. June 2021.

Table 11. Section G Proposed Attack Armour Area - Vegetation Summary

Pre-Construction Vegetation Data for Proposed Fernie Annex Dike Improvements - **Section G Proposed Attack Armour area.**
Date of data collection: June 13, 15, 17 - 2021

Section[a]	Zone[b]	Species		Growth Stage / Form[c]	Dist.[d]	Cover[e]	Median height (m)	Max. height (m)	Comments
		Common name	Latin name						
G - AA	1 & 2	Cottonwood	*Populus trichocarpa*	M	P	1	25	25	All in 50m stretch at south end of section.
G - AA	1 & 2	Cottonwood	*Populus trichocarpa*	EM	P/E	2	18	20	All in 50m stretch at south end of section.
G - AA	1 & 2	Cottonwood	*Populus trichocarpa*	AR	P/E	2	4	10	All in 50m stretch at south end of section.
G - AA	1 & 2	Cottonwood	*Populus trichocarpa*	R	P/E	2	2	3	All in 50m stretch at south end of section.
G - AA	1 & 2								
G - AA	1 & 2	Willow	*Salix spp.*	C	P	1	4	6	
G - AA	1 & 2	Sandbar Willow	*Salix spp.*	S	P	3	2.5	3	Along edge of river.
G - AA	1 & 2	Red-osier dogwood	*Cornus sericea*	C/S	P	3	2	2.5	
G - AA	1 & 2	Saskatoonberry	*Amelanchier alnifolia*	C	P	1	2	3	
G - AA	1 & 2	Hawthorth	*Crataegus douglasii*	C	P	2	4	6	
G - AA	1 & 2	Twinberry	*Symphoricarpus albus*	S	P	4	1	1.2	
G - AA	1 & 2	Native rose	*Rosa spp.*	S	P	1	1	1.5	
G - AA	1 & 2	Choke Cherry	*Prunus virginiana*	C	P	1	5	6	Under powerlines.
G - AA	1 & 2	Grass	—	S	E/P	5	0.5	0.7	
G - AA	3	Not assessed.							

a) Armor Dike Sections as per Engineer's Drawings. G-AA = Section G Attack Armour area.
b) Vegetation zones assessed:
Zone 1 and 2 are the outboard/river side of the dike, from the edge of the gravel path to the river high water mark (<15m). These two zones were assessed together here as one.
Assume all woody vegetation in this area will be cut/removed due to riprap placement here.
Zone 3 – not assessed.
c) Cottonwood (Act) and other trees/conifers. R = regen. (<3 m ht.); AR = advanced regen. (3-10 m ht.); EM = early mature (10-20 m ht.); M = mature (20-35 m ht.); V = veteran (>35 m ht.).
Shrubs: C = Clumps (growth form: single stems or well defined clumps); S = Spreading (growth form open spreading clumps or patches, includes where spread has occurred due to air layering and/or rhizomatous growth).
d) Distribution of plants. E = individual plants distributed evenly throughout zone; P = individual plants tend to be grouped in patches or clusters throughout the zone.
e) Estimated % cover: 1 = < 5%; 2 = 5-15%; 3 = 15-30%; 4 = 30-60%; 5 = 60-90%; 6 = > 90%.

Section G Attack Proposed Attack Armour Area: Recommendations

- Consider salvaging excavator buckets-sized plugs of the sandbar and other willow along the water in this section for transplant along the toe of the bank/edge of pond in Section B and C.

4.3 Native shrubs that could potentially be salvaged

Table 12 below summarized native shrubs along the top of Zones 2 and 3 that could potentially be salvaged with a min-excavator and transplanted elsewhere (within easy reach of mini-excavator). These should be dug up when dormant, with the root ball wrapped in burlap along with some peatmoss (then moisten). Shoot pruning should also be done at the time of lifting (prune off about 50% of shoots). Also pick out grass roots/shoots. Photos 77 and 78 give two examples.



Photo 77: Mt. Ash that could be salvaged in Section D. June 2021.



Photo 78: Hawthorn and Saskatoon berry that could be salvaged in Section D. June 2021.

Table 12. Estimate of potentially salvageable shrubs.

Number of shrubs that could potentially be salvaged. Grand total = 208																												
	Hawthorn *Crataegus douglasii* Heights (m)				Choke Cherry *Prunus virginiana* Heights (m)				Saskatoon berry *Amelanchier alnifolia* Heights (m)				Mt. Ash *Sorbus sitchensis* Heights (m)				Twinberry *Symphoricarpus albus* Heights (m)				Native rose *Rosa spp.* Heights (m)				Soopolalie *Shepherdia canadensis* Heights (m)			
Section	<1	1-1.5	1.5-3	>3	<1	1-1.5	1.5-3	>3	<1	1-1.5	1.5-3	>3	<1	1-1.5	1.5-3	>3	<1	1-1.5	1.5-3	>3	<1	1-1.5	1.5-3	>3	<1	1-1.5	1.5-3	>3
A	1			1	2	1		1	3	3				1		2	1											
B									1							1	13				4							
C																	18											
D	2	3	2		5	1	2	1	5	9	1		1	1	9	1												
E	1	2				1	1		1		2	1					4											
F	1	1			2				2	3	2						30											
G					2	1			3	2															1			
H+J	2	3	1			2	1		10	9	1		7				10								3			
Total	**7**	**9**	**3**	**1**	**11**	**6**	**4**	**2**	**25**	**26**	**6**	**1**	**8**	**2**	**9**	**4**	**76**	**0**	**0**	**0**	**4**	**0**	**0**	**0**	**4**	**0**	**0**	**0**
Comments	some planted				some planted				some planted				large one at toe of bank, parking access				Assume can break clumps in several plants.											

5 References

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