ENVIRONMENTAL ASSESSMENT FOR THE KOOTENAY LAKE FERRY DREDGING PROJECT

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Cover photo: View looking west along the West Arm of Kootenay Lake. Kootenay Lake Balfour ferry terminal at right. May 2014.

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1 INTRODUCTION

1.1 Background

Masse Environmental Consultants was retained by the Ministry of Transportation and Infrastructure to conduct an environmental assessment to support permitting requirements for the Kootenay Lake ferry dredging project. This project involves deepening / widening the navigational channel for the Kootenay Lake ferry between the ferry terminal at Balfour and the entrance to the West Arm of Kootenay Lake.

The 9 km Kootenay Lake ferry route runs between Balfour and Kootenay Bay across Kootenay Lake. The westernmost 1.5 km of the ferry route is in the West Arm of Kootenay Lake, a shallow and narrow arm of the lake. The remaining 7.5 km of the ferry route crosses the main body of Kootenay Lake. Two ferries, the MV Osprey 2000 and the MV Balfour operate on the route. The larger MV Osprey 2000 runs year round. The MV Balfour is used during the summer peak season and when the MV Osprey is not in service for maintenance.

The existing Balfour to Kootenay Bay ferry route has a number of navigational challenges due to the narrow channel width and shallow depths in some areas of the West Arm of Kootenay Lake. One of these challenges is that the current navigation route through the West Arm has localized high spots, and does not meet Fisheries and Oceans Canada / Canadian Coast Guard minimum depth requirements for the ferries in use. More details regarding these navigational issues can be found in Advisian (2017).

MOTI is proposing to dredge these localized high spots so that the channel alignment and depth meet the DFO/CCG guidelines.

1.2 Contact Information

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2 DESCRIPTION OF PROJECT

2.1 Project Components

The project involves the following activities:

- Mobilization — Barges and dredging equipment will need to be transported to site and assembled.

- Dredging — An estimated 8,500m^3 of material will be removed from the lake bed using a backhoe or grab dredge located on a floating barge. Material will be placed on the barge for disposal.

- Disposal — Material will be disposed at designated disposal locations in the main body of Kootenay Lake.

2.2 Project Timeline

The expected duration of the project is 6-8 weeks, including mobilization. The preferred work window is between September 15 and November 30, 2018. This is after the peak summer season and will enable the work to be completed before the low water period that occurs in late winter.

Future work (i.e maintenance dredging) is not anticipated. A review of current and historical bathymetric surveys indicate that long-term infilling is not a concern, which is consistent with the lack of sediment load transported through the West Arm.

2.3 Project Location

The project is located in the West Arm of Kootenay Lake, between the Balfour ferry terminal and the main lake. The coordinates for the main areas where dredging is required and the potential disposal areas are provided in Table 1. A map showing these components is in Appendix 1.

Table 1. Coordinates of key components.

Component	UTM
Dredge 1	11U.504141.5497142
Dredge 2	11U.504127.5497030
Dredge 3	11U.503998.5496898
Dredge 4	11U.503942.5496846
Dredge 5	11U.503361.5496699
Dredge 6	11U.503479.5496658
Dredge 7	11U.503395.5496659
Disposal location	±11U.505990.5497911

2.4 Construction Materials, Methods and Equipment

2.4.1 Construction Details

The following provides a summary of the expected construction methods for the various components. Some details may change depending on equipment availability and river conditions; however the essence of the methods should remain similar.

2.4.1.1 Dredging

A backhoe or grab dredger on a floating pontoon has been recommended to carry out the dredging. A backhoe dredger is an excavator that can handle a wide variety of coarse material, although the amount of material that can be removed in each grab is limited by the size of the excavator bucket. A grab dredger has a grab bucket or clamshell that is lowered to the lake bed, the bucket is closed, and the dredged material hauled back to the surface. Excavated material will be placed on a barge until disposal.

2.4.1.2 Disposal

The excavated material will be disposed in the main lake. Material will be dumped from the barge.

3 DESCRIPTION OF THE AQUATIC ENVIRONMENT

3.1 Kootenay Lake

Kootenay Lake is a large fjord-like lake with a surface area of approximately 400 km^2 that drains a watershed of almost 51,000 km^2 (Figure 1). The main body of the lake is comprised of the north and south arms, and is ~104 km long and 3–5 km wide. The average depth is 94 m and the maximum depth is 154 m (Basset *et. al* 2017). Most of the inflow into the lake is into the South Arm via the Kootenay River (Kootenai River in the USA). The Duncan River enters the North Arm and contributes ~ 10% of inflows. The West Arm of Kootenay Lake is the outlet for the main body of the lake (Photo 1), and extends for approximately 35 km from Balfour downstream to the Grohman Narrows, near Nelson. The West Arm has a mean depth of 12 m, and is separated from the main lake by a sill that lies at a depth of approximately 8 m (Daley *et. al* 1981).

The morphology of the West Arm is distinct from the main lake, and is best considered as a series of shallow basins connected by short narrow riverine sections (Daley *et. al* 1981). The first of these riverine sections is the 5 km section from the outlet of the main lake to Sunshine Bay (Photo 2). The Kootenay Lake ferry route navigates the upper 1.5 km of this section before it enters the main body of Kootenay Lake. This portion of the West Arm is between 350 – 500 m wide.

Figure 1. Kootenay Lake.

Photo 1. View east across Kootenay Lake from the entrance to the West Arm.

Photo 2. West Arm of Kootenay Lake from the entrance to the West Arm.

3.2 Hydrology

Water levels in Kootenay Lake vary seasonally, with the peak occurring in June or July, and the lowest water levels occurring in March (Figure 1). During periods when inflows to Kootenay Lake are very high (May – July) or very low (March-April), the level of Kootenay Lake is controlled by Grohman Narrows, a natural constriction of the Kootenay River at the downstream end of the West Arm. From August to March, water levels in Kootenay Lake are regulated by the Corra Linn dam, located on the Kootenay River ~ 10 km downstream of Grohman Narrows. Water levels in Kootenay Lake are kept higher in the fall and early winter to allow for more power generation, and are lowered in the early spring in anticipation for freshet. The minimum water level in Kootenay Lake is typically 530 m and occurs in late March or early April (FortisBC 2018).

Flow rates through the Corra Linn Dam, range from a low of ~ 500 m^3/s in late winter to highs of over 2,000 m^3/s during freshet (Advisian 2017). Flow rates through the West Arm at Balfour will be similar, since there is very little inflow along the West Arm of Kootenay Lake compared to the discharge that exits the main body of Kootenay Lake. The large volume of the water that transits the West Arm ensures that there is a noticeable current through the West Arm, particularly in the narrow riverine sections, at all times of the year. Water velocities of 2-3 knots (1–1.5 m/s) were observed in the project area during field work in October 2016 (Advisian 2017).

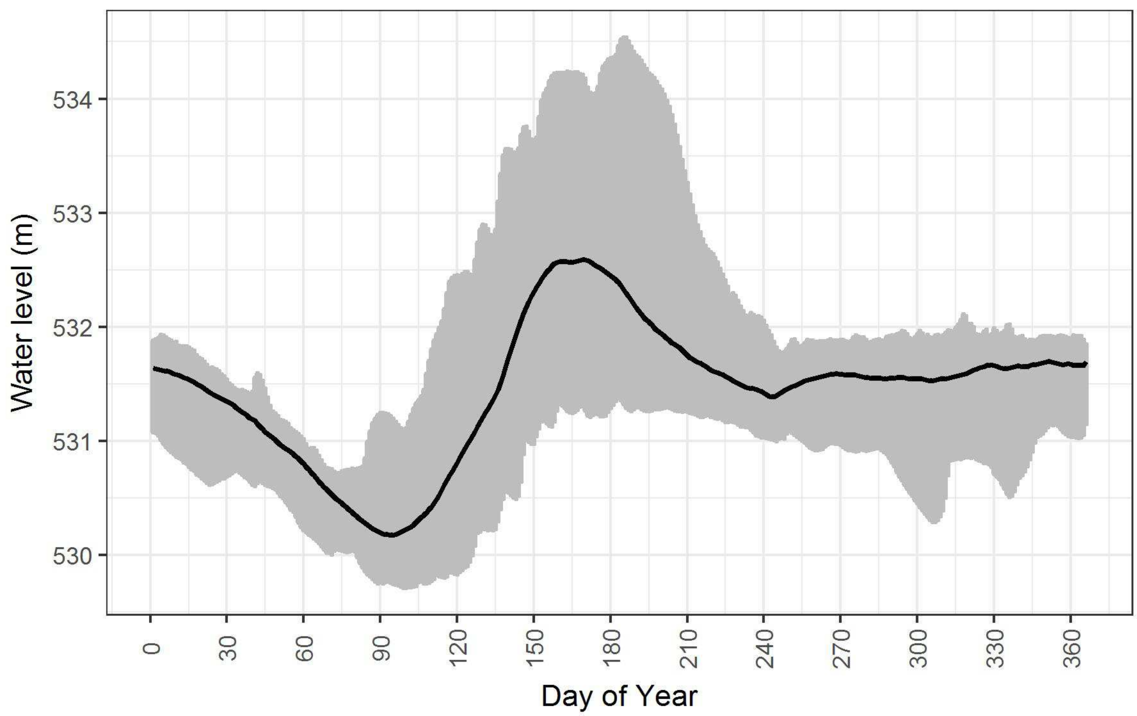

Figure 2. Kootenay Lake (Queens Bay) water levels (1975 – 2016). The grey shading shows the range; the black line is the average over the period of record.

3.3 Fish Habitat

3.3.1 West Arm of Kootenay Lake

The mouth of the West Arm of Kootenay Lake has high fisheries values. As the outlet of the main lake, food resources are entrained in the water column as the water flows over the sill into the narrower West Arm. The area also includes a diversity of habitat types, including large shallow shoals, small islands and gravel bars, deeper pockets within the thalweg, and deep areas in the main lake. The area has historically been used for spawning by burbot and kokanee, and is currently used by rainbow trout for spawning.

In the 1960s and 1970s, the West Arm between the mouth and Harrop Narrows supported a large fishery for kokanee and burbot. Both of these fisheries collapsed in the 1980s, and have yet to recover. Reasons for the collapse of the fisheries include overfishing, changes in flow regulation, and reduction in nutrients.

The lake bed within the project area is relatively coarse, consisting primarily of gravels and cobbles, with boulders up to 0.75 m in diameter observed (Advisian 2017). The coarse-grained nature of the substrate reflects the significant currents that flow through the area, and the lack of sediment inputs. The main body of Kootenay Lake is a natural settling basin, and there are no local tributaries that supply sediment to this portion of the West Arm. No aquatic vegetation was observed in areas where dredging is proposed.

Two areas, adjacent to the shoreline, are mapped as Section 16 Reserves for fish and wildlife management (iMapBC 2017, Appendix 1). Section 16 reserves on Kootenay Lake are areas identified by the Province as having significant fish habitat.

3.3.2 Main Body of Kootenay Lake

The main body of Kootenay Lake consists primarily of pelagic habitat. At the proposed disposal area, near the center of the lake, the depth is ~ 120 m. Kootenay Lake is a temperate lake and turns over in the spring and fall. During the summer, a thermocline develops to a depth of up to ~20 m. Water temperature in the hypolimnion is consistently 4-5 °C. The lake is oligotrophic, with naturally low levels of nitrogen and phosphorus. A long term nutrient restoration program to replace nutrients lost behind upstream dams has been carried out on the lake for 20 years (Basset *et. al* 2017), and the water chemistry of the lake is well characterized.

3.4 Fish Species

Twenty six different fish species and two species of mussel have been recorded in Kootenay Lake, with many of these species potentially present in the project area (Table 2). Key fish species potentially present in the area are discussed in more detail in the sections that follow.

Table 2. Fish species reported to be present in Kootenay Lake (FISS 2018).

Fish Species	Scientific Name	Comments
Burbot	*Lota lota*	Red-listed
Bull Trout	*Salvelinus confluentus*	Blue-listed
Carp	*Cyprinus carpio*	Introduced species
Bridgelip sucker	*Catostomus columbianus*	
Eastern Brook Trout	*Salvelinus fontinalis*	Introduced species
Kokanee	*Oncorhynchus nerka*	
Lake Chub	*Couesius plumbeus*	
Lake Whitefish	*Coregonus clupeaformis*	

Fish Species	Scientific Name	Comments
Largemouth Bass	*Micropterus salmoides*	Introduced species
Largescale Sucker	*Catostomus macrocheilus*	
Leopard Dace	*Rhinichthys falcatus*	
Longnose Dace	*Rhinichthys cataractae*	
Longnose Sucker	*Catostomus catostomus*	
Mountain Whitefish	*Prosopium williamsoni*	
Northern Pikeminnow	*Ptychocheilus oregonensis*	
Peamouth Chub	*Mylocheilus caurinus*	
Pumpkinseed	*Lepomis gibbosus*	Introduced species
Prickly Sculpin	*Cottus asper*	
Pygmy Whitefish	*Prosopium coulteri*	
Rainbow Trout	*Oncorhynchus mykiss*	
Redside Shiner	*Richardsonius balteatus*	
Slimy Sculpin	*Cottus cognatus*	
Torrent Sculpin	*Cottus rhotheus*	
Westslope Cutthroat Trout	*Oncorhynchus clarki lewisi*	
White Sturgeon	*Acipenser transmontanus*	Red-listed / SARA Schedule 1 (Endangered)
Yellow Perch	*Perca flavescens*	Introduced species
Mussel Species	**Scientific Name**	**Comments**
Western Floater	*Anodonta kennerlyi*	
California Floater	*Anodonta californiensis*	

3.4.1 White Sturgeon

The Kootenai river subpopulation of white sturgeon is a species at risk in Canada (Endangered) and the USA. The subpopulation is restricted to the Kootenay Lake/Kootenay River system between the Corra Linn dam and the Kootenai Falls in Montana. Critical habitat for White Sturgeon has been mapped (DFO 2014) and includes the portions of the Kootenay River and delta near Creston, the Duncan River Delta, and Crawford Bay. No critical habitat has been identified in the West Arm of Kootenay Lake; although they are occasionally present in the West Arm. Telemetry studies monitoring sturgeon movement have recorded White Sturgeon in the West Arm infrequently (Matt Neufeld, MLFNRO, pers. comm.). Other reports of White Sturgeon in the West Arm have come from the observation of mortalities, including one in Kootenay Canal in 2006 (Dean den Biesen, BC Hydro, pers comm) and near Harrop in 2013 (Matt Neufeld, MLFNRO, pers. comm.).

3.4.2 Burbot

The lower Kootenay (Kootenai River / Kootenay Lake) burbot population is red-listed in BC, and an active program to restore the population is underway. This program includes stocking hatchery reared burbot into Kootenay River and Kootenay Lake. A large fishery for burbot occurred at the inlet of the West Arm in the 1960's and 1970's. This stock collapsed in the early 1980's and has yet to recover. Overfishing and loss of spawning habitat due to flow regulation and stream channelization are considered the main reasons for the decline (Redfish Consulting 1998, Ahrens & Korman 2002).

Although low numbers of burbot are expected to be present in Kootenay Lake, one of the locations where juvenile burbot are currently stocked as part of the recovery program is the Government Dock at Balfour, 600 m downstream of the ferry terminal (Evans & Stephenson, 2017). The West Arm stock of burbot historically spawned on shoals near Balfour (Ahrens & Korman 2002).

3.4.3 Rainbow Trout

The West Arm of Kootenay Lake supports a population of rainbow trout that is considered distinct from the larger Gerrard-strain of rainbow trout that is present in Kootenay Lake. In 2014, aerial surveys identified numerous rainbow trout spawning areas in the West Arm. These were associated with narrow sections of the West Arm, where higher water velocities occur during the spawning period. In 2014, the spawning period was from late April until late May, with peak spawning occurring around the second week of May. A large area used for spawning in 2014 is present on the north side at the entrance to the West Arm, where a large shoal is present.

Emergence of rainbow trout fry is expected to occur 40-60 days (late June/early July) after egg deposition (Velsen 1987, McPhail 2007), as water temperature in the West Arm in May and June is between 6 and 8°C (Basset *et al.* 2018).

3.4.4 Kokanee

The West Arm of Kootenay Lake supports two distinct kokanee populations. The dominant population spawns in tributary streams in late summer (mid-August – September), with the primary spawning locations being the spawning channels constructed at Kokanee Creek and Redfish Creek. A smaller population of kokanee that spawn along the shore in September and October is also present. Recent shore spawning locations that have been identified include sites near Duhamel Creek, Sitkum Creek and Harrop Creek, although historical spawning areas were concentrated in the upper West Arm between Balfour and the Fraser Narrows. Emergence of kokanee fry (shore spawning) is expected to be in mid-late February (Redfish Consulting 2014).

In recent years, operational changes to the lake levels have been implemented in order to reduce the likelihood that shore spawning kokanee redds are exposed when water levels decrease in late winter. The lake level is kept lower in September and October when shore spawning occurs, in an effort to ensure kokanee redds remain wetted until fry emergence.

3.4.5 Mussels

Two native freshwater mussel species have been observed in Kootenay Lake, Western floater (*Anodonta kennerlyi*) and California floater (*A. californiensis*) (K. Andreashuk, pers. comm.). Yukon floater (*A. beringina*) and Winged floater (*A. nuttalliana*) also potentially occur in Kootenay Lake; although have not been confirmed. Freshwater mussel habitat in lake environments typically are areas that have muddy substrates and are not prone to dewatering (Nedeau et al 2009); although in Kootenay Lake mussels have been found in areas where clean sand to midsize cobble exists and in areas where dewatering does occur (K. Andreashuk, pers. comm.). Mussels are important to food webs, water quality, nutrient cycling, and habitat quality of freshwater systems. They are also culturally important to First Nations, and are harvested as a food source.

4 POTENTIAL EFFECTS OF THE PROPOSED PROJECT

4.1 Identification of all Fish Species Affected by the Proposed Project

All species of fish present in Kootenay Lake are potentially present in the project area. The primary species of concern are rainbow trout, kokanee, and burbot. All three species are part of a recreational, commercial or Aboriginal fishery. Rainbow trout are known to use areas in the vicinity of the project for spawning and rearing. Kokanee and burbot historically spawned on shoals in the area, although there is limited information on the exact locations. No recent spawning in the area has been confirmed, although both species are the subject of current restoration efforts.

4.2 Identification of the Type of Fish Habitat Affected

4.2.1 West Arm of Kootenay Lake

4.2.1.1 Rearing / Feeding Habitat

The mouth of the West Arm provides rearing/feeding habitat. As the outlet of the main lake, food resources are entrained within the water column as water exits over the sill. These food resources remain mixed throughout the water column and may be more available to fish species in the West Arm compared to the main lake, where spatial segregation can occur (due to lake stratification).

4.2.1.2 Migration Corridors

Fish stocks in the West Arm are generally considered to be separate from those in the main lake, although larger fish species are expected to travel through the area between the main lake and the West Arm on occasion.

4.2.1.3 Spawning Habitat

The areas were dredging are proposed are not known to be used for spawning. However, rainbow trout spawning has been observed on a shallow shoal on the north side of the entrance to the West Arm (MEC 2014), adjacent to the areas where dredging is proposed. Historically, kokanee and burbot may have utilized similar areas for spawning, although no recent spawning in the area has been confirmed.

4.2.2 Disposal Area

4.2.2.1 Rearing / Feeding Habitat

The main body of Kootenay Lake is used by pelagic fish species for rearing/feeding. The lake bed is expected to consist of sediments and be relatively homogenous. At depths of 120 m, light does not penetrate and productivity is largely associated with detritus that falls to the lake bottom. Benthic communities typically consist of oligochaetes and chironomids, which are adapted to the lower oxygen concentrations found in bottom sediments (Wetzel 2001).

4.3 Description of the Effects

4.3.1 Methodology

The potential effects of the project on fish and fish habitat were identified using the DFO pathways of effects diagrams for dredging, disposal of material, and use of industrial equipment. The potential effects were then assessed in terms of the site specific conditions and knowledge of fish species and habitat present. Potential effects were then evaluated in terms of the probability of occurrence, magnitude, geographic extent and duration (Table 3). Professional judgement was used to identify those effects that are considered significant enough that management, mitigation or monitoring is required.

Table 3. Criteria used to evaluate effects.

Probability	Magnitude	Geographic extent	Duration
Low - unlikely to occur (< 5%), often because the conditions do not exist	Low - spatial extent <1,000 m^2, or effecting <10 fish	Local – limited to the area directly disturbed by physical activities	Short – effect is over when project ends
Moderate - may occur, although there is uncertainty whether the conditions exist or the actions are required	Moderate – spatial extent 1,000–10,000 m^2, or effecting 10-100 fish	Reach – potential for effects from the mouth of the West Arm to Sunshine Bay (first large setting basin)	Long – effect may persist after the project ends for months to a year.
High - highly likely or certain to occur, typically because the causative action is an essential part of project	High - spatial extent >10,000 m^2, or effecting >100 fish	Regional – Potential for effects throughout the West Arm	Irreversible – effect is permanent

4.3.2 Potential Effects of the Project

4.3.2.1 Change in Food Supply

The project will result in the loss of benthic food supply due to the removal of substrate during dredging, and the covering of substrate during dredgeate disposal. These effects are considered to be moderate in magnitude, since dredging will occur over ~ 8,500 m^2. The effects will occur on a local scale, and is expected to be long term but reversible, as periphyton and benthic invertebrates typically recolonize disturbed areas within 1-2 months.

In the context of the West Arm, the area of disturbance is relatively small. The overall impact of the reduction in food supply is expected to be negligible, since the primary food source in this area is organisms entrained in the outflow from the main lake.

Changes in food supply due to disposal are considered to be negligible. The disposal location is at a depth of 120 m where very little benthic productivity occurs.
No residual effects are anticipated.

4.3.2.2 Change in Habitat Structure and Cover

A removal of substrate during dredging, and the placement of the dredgeate at disposal locations, has the potential to change habitat structure and cover. The substrate is primarily gravels, cobbles and boulders, with little woody debris, aquatic vegetation, or other cover elements. At the dredging locations, the potential effect is considered moderate in magnitude, the effects will occur on a local scale, and are expected to be short term, since the lake bed is expected to return to a similar condition as any fine material scours away.

Changes in habitat structure and cover at the disposal location are considered to be negligible since the lake bed bottom at a depth of 120 m does not provide significant fish habitat and the disposal area is small compared to the area of similar habitat in the main body of Kootenay Lake.

Overall, the project is not expected to result in a significant change in habitat structure or cover, provided that:

- Any large boulders / wood are returned to the West Arm, and
- The disposal location is not located in spawning habitat or where mussel beds are present.

4.3.2.3 Change in Sediment Concentrations

A short term increase of sediment load in the West Arm will occur during active work. The majority of the material is expected to be coarse grained, and therefore is expected to settle quickly and remain in the local area. If fine material (silt/clay) is encountered at depth, this will remain in suspension longer, although it is expected to settle within the first basin downstream (Sunshine Bay). Deposition of fine material downstream may affect habitat in these areas, although the large volume of water that flows through the West Arm is likely to rapidly dilute and disperse the sediment.

At the dredging locations, the potential effect is considered moderate in magnitude, since dredging will occur over ~ 8,500 m^2. The effects may occur on a reach scale, depending on the amount of fine material encountered, and is expected to be short term as it is associated with active work.

A short term increase of sediment will also occur at the disposal area. The potential effect of this is expected to be moderate, occur at a local scale due to the lower current in the main lake, and short term.

Site isolation during dredging is being considered, but may not be practical as the ferry transits the area every ~ 1.5 hours during the winter. Turbidity monitoring is recommended during dredging operations so that work can be adjusted if the increase in turbidity is considered unacceptable. If pockets of silt or clay are encountered, the handling of this material should be assessed, and additional mitigation (i.e. separate handling, land disposal) may be required.

4.3.2.4 Change in Contaminant Concentrations

Sediments can be a contaminant sink, and the disturbance of sediments can re-mobilize these contaminants, affecting water quality. Contaminants are typically associated with fine sediments, which have not been observed in the area as there is no depositional habitat. As Kootenay Lake acts as a large settling basin and there are no significant sources of potential contamination in the local area, the likelihood of encountering contaminants is considered low.

The use of industrial equipment has the potential to introduce contaminants in the event of fuel/oil spills. Mitigation to reduce the risk and potential impact of any spill includes:

- Equipment in good condition, clean and free of leaks,
- Spill response plan,
- Crew training,
- Suitable spill response materials, and
- Secondary containment or re-fuel/service equipment away from water.

4.3.2.5 Change in Nutrient Concentrations

Change in nutrient concentrations may occur through the use of explosives or through the release of nutrients during disturbance of the substrate. The substrates are predominantly gravels, cobbles and boulders, which do not require the use of explosives, nor are they likely to store nutrients.

No residual effects are anticipated.

4.3.2.6 Direct Injury or Death of a Fish

The direct injury or death of a fish includes the physical impacts to fish as part of the project, as well as the disturbance of incubating eggs or embryos or mussel beds. There is the potential for large numbers of fish to be present in the dredging and disposal area, due to the availability of food at the mouth of the West Arm. The areas requiring dredging and the disposal locations are not located in any known spawning areas. It is unlikely that significant numbers of mussels are present in the dredging areas if the ferries have caused disturbance to the substrate over the long term.

The potential effect is considered moderate in magnitude, since there is potential for large numbers of fish to be present in the dredging area. The effect would occur on a local scale as it is limited to the immediate work areas. Any mortality is by definition permanent.

Site isolation to exclude fish from the dredge work area is not considered practical, due to the size of work area and because the ferry transits the area on average every 1.5 hrs. The type of dredging equipment that will be used is relatively slow, and most fish would be expected to leave the immediate work area once they are disturbed. A survey of the work area to ensure large schools of fish are not present is recommended before dredging. A mussel survey would confirm the presence or absence of mussel. If mussels are present in the areas requiring dredging, a mussel salvage will be required.

Table 4. Summary of effects assessment.

Effect	Cause	Probability	Magnitude	Geographic Extent	Duration	Mitigation Required
Change in food supply	Direct loss of benthic food supply due to removal of substrate	high	low	local	short	No
Change in food supply	Direct loss of benthic food supply due to covering of substrate	high	low	local	short	No
Change in habitat structure and cover.	Change in habitat due to removal of substrate	high	low	local	long	Yes
Change in habitat structure and cover.	Change in habitat due to placement of dredgeate	high	low	local	long	Yes
Change in habitat structure and cover.	Change in habitat due to removal of aquatic vegetation or organic debris (LWD)	low	low	local	long	No
Change in habitat structure and cover.	Change in habitat due to sedimentation	high	mod	reach	short	Yes
Change in sediment concentrations	Increased sedimentation during to dredging activities	high	mod	reach	short	Yes
Change in sediment concentrations	Increased sedimentation during placement of dredgeate	high	mod	local	short	No
Change in sediment concentrations	Increased erosion of banks due to mobilization activities	low	mod	local	short	No
Change in contaminant concentrations	Disturbance of contaminated sediment	low	low	reach	short	No
Change in contaminant concentrations	Contamination due to use of industrial equipment (fuel/oil/grease spills)	mod	mod	local	short	Yes
Change in nutrient concentrations	Increase in nutrients due to use of explosives	low	low	reach	short	No
Change in habitat structure and cover.	Changes in nutrient levels due to disturbance of lake bed	low	mod	reach	short	No
Direct injury or death of a fish	Injury/death of a fish during dredging or placement of dredgeate	mod	mod	local	permanent	Yes
Direct injury or death of a fish	Direct disturbance to eggs/embryos	low	mod	local	permanent	Yes

4.4 Measures and standards to avoid or mitigate effect

4.4.1 Avoidance Measures

The following avoidance measures were incorporated during the project design:

- The navigation channel alignment was developed to minimize the interaction with localized high spots in order to minimize the volume of dredging required.
- Disposing the material in the main lake of Kootenay Lake avoids environmentally sensitive areas such as spawning grounds, mussel beds, and significant feeding or rearing areas.

4.4.2 Mitigation measures

4.4.2.1 Project Timing

The preferred timing to complete this work from an engineering/logistics point of view is from mid-September to mid-November, 2018. This is a period of the year when only one ferry is operating, water levels are expected to be relatively low (± 531 m), and weather conditions are typically stable. This would also ensure that the work is completed before the February/March low water period when the navigational issues are of most concern.

The period of least risk for instream works for the West Arm and its tributaries, as defined by the Ministry of Environment, is from July 16 – August 15, due to the presence of both rainbow trout and kokanee (MoE 2009). Instream works during this period is generally considered to pose the lowest risks to fish species, primarily by avoiding the most sensitive life stages from spawning until fry emergence (MoE 2009), as well as the winter months when fish are less active due to the colder water temperatures.

Although the preferred project timing is outside of the period of least risk, the preferred project timing minimizes risks to sensitive life stages as follows:

- Project timing avoids the rainbow trout spawning, incubation and fry emergence period (April 15 – July 15).
- Project timing occurs when adult kokanee (stream/shore spawners) are absent from the project area as they will be at spawning locations.
- The nearest confirmed kokanee shore spawning location is at Harrop Narrows, 8 km downstream of the project. Potential impacts to spawning or incubating eggs/embryos are considered negligible due to the distance and the presence of a large settling basin (Sunshine Bay) between the project and this location.
- Project timing occurs when water temperatures are expected to range from 10 – 15°C, reducing the risk to fish associated with moving at cold temperatures when metabolic activity is lowest.

4.4.2.2 Fish/Mussel Salvage

Prior to dredging, the work area will be surveyed for the presence of fish and mussels. If large schools of fish are observed, then work will be delayed until the fish can be encouraged to leave the work area. If mussel beds are observed, a mussel salvage will be conducted.

4.4.2.3 Dredgeate Monitoring

The quantity and composition of the dredgeate will be monitored as it is brought to the surface. If the composition of the dredgeate changes from the coarse material (sands – boulders) anticipated to fine sediments (silts and clays), the fine materials will be assessed and handled separately. On shore disposal of large amounts of fine materials is an option.

4.4.2.4 Turbidity Monitoring

During dredging and disposal operations, turbidity monitoring will be conducted. A qualified environmental professional will determine whether the observed turbidity levels are considered acceptable, or if additional mitigation is required (i.e use of turbidity curtains, temporarily slowing/stopping work).

4.4.2.5 Equipment Management

- Inspect machinery for aquatic invasive species prior to mobilization – decontaminate if required.
- Clean machinery free of leaks or excess oil/grease will be used.
- Re-fuel or service equipment at designated locations away from the water <u>or</u> use of secondary containment if refueling/servicing on the barge is required.
- Inspect machinery for leaks regularly.
- Store fuel in designated locations away from the water <u>or</u> in secondary containment.

4.4.2.6 Spill Response

A detailed spill response plan will be developed by the Contractor prior to the project implementation. Sufficient quantities of materials to deal with a spill will be required on site and readily accessible. Spill response training for all personnel will also be required.

4.5 Residual effects to fish and fish habitat

Residual effects are the effects on fish and fish habitat of a project after all measures and standards to avoid or mitigate effects have been applied. If the residual effects result in serious harm to fish (residual serious harm), the project will require authorization under the *Fisheries Act* (S35 (2)). Serious harm is defined as:

1. the death of fish;
2. a permanent alteration to fish habitat at a spatial scale, duration or intensity that limits or diminishes the ability of fish to use such habitats as spawning grounds, or as nursery, rearing, or food supply areas, or as a migration corridor, or any other area in order to carry out one or more of their life processes;
3. the destruction of fish habitat of a spatial scale, duration, or intensity that fish can no longer rely upon such habitats for use as spawning grounds, or as nursery, rearing, or food supply areas, or as a migration corridor, or any other area in order to carry out one or more of their life processes.

The results of the effects assessment are summarized in Table 5. After implementing the mitigation identified above, the project is anticipated to be able to avoid "serious harm to fish".

Table 5. Summary of residual effects to fish and fish habitat due to the project.

Effect	Mitigation	Probability	Magnitude	Geographic Extent	Duration	Residual Effects
Change in habitat due to removal of substrate	Yes, retain boulders/wood if present	low	low	local	year	None
Change in habitat due to placement of dredgeate	Yes, avoid environmentally sensitive locations	low	low	local	year	None
Change in habitat due to sedimentation	Monitor turbidity	high	mod	reach	short	None
Increased sedimentation during to dredging activities	Monitor turbidity	high	high	reach	short	None
Contamination due to use of industrial equipment (fuel/oil/grease spills)	Clean equipment, spill response	low	mod	local	short	None
Injury/death of a fish during dredging or placement of dredgeate	Project timing, visual survey before work, mussel salvage	low	mod	local	permanent	None
Disturbance of eggs/embryos	Avoid known spawning areas, project timing	low	mod	local	permanent	None

5 CLOSURE

This document is to the best of our knowledge, accurate and correct. If you have any questions or concerns regarding its contents, please contact the undersigned.

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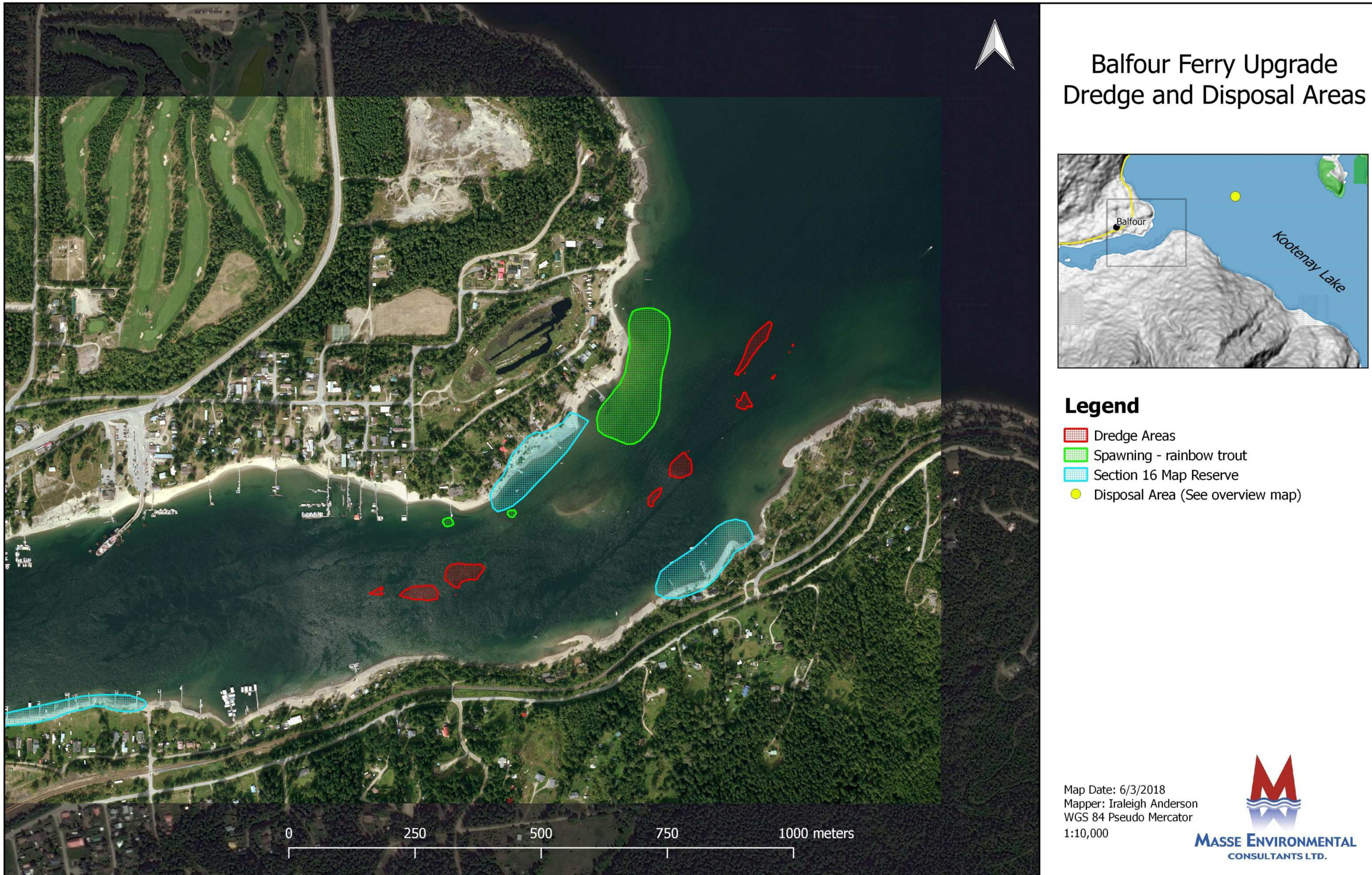
APPENDIX 1

MAP SHOWING LOCATION OF PROJECT COMPONENTS



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