MORRISON COPPER/GOLD PROJECT

Fish Habitat Compensation Plan

M09382A04

Klohn Crippen Berger

March 21, 2011

Pacific Booker Minerals Inc.
#1702 - 1166 Alberni Street
Vancouver, British Columbia
V6E 3Z3

Mr. Erik Tornquist
Executive VP and COO

Dear Mr. Tornquist:

Morrison Copper/Gold Project
Fish Habitat Compensation Plan

This report presents the revised Fish Habitat Compensation Plan (FHCP) for the Morrison Copper/Gold Project. The FHCP was developed on the basis of the project effects on fish habitat and the compensation plan addresses the "harmful alteration, disruption or destruction of fish habitat (HADDs)" associated with the Project and the effects of reduction of productive capacity due to loss of barren fish habitat.

Please contact us if you have any questions or require any further clarification.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Harvey McLeod, P.Eng., P. Geo.
Project Director

HM/MK/JJ/ML:tc

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Pacific Booker Minerals

Fish Habitat Compensation Plan for the Morrison Copper/Gold Project

March 21, 2011

Klohn Crippen Berger

EXECUTIVE SUMMARY

Pacific Booker Minerals (PBM) is proposing to develop the Morrison Copper/Gold Project (the Project) on the east side of Morrison Lake, north of Babine Lake, in north-central British Columbia (BC) (Figure 1.0). The Project will require construction of a Tailings Storage Facility (TSF), including tailings and seepage control dams, and other mine operations infrastructure that will cause harmful alteration, disruption or destruction (HADD) of fish habitat in the Morrison Lake watershed. Specifically, the Project will result in the loss of an estimated 1,251.5 m^2 of fish habitat in several ephemeral tributary streams on the east side of Morrison Lake. In addition, there is a reduction of the productive capacity due to a loss of an estimated 27.5 ha (275,000 m^2) of non-fish bearing aquatic habitat that provides, to some limited extent, water, food, and nutrients to Morrison Lake fish stocks. Both fish-bearing and non fish-bearing habitat has "productive capacity" to produce fish and/or fish food.

Morrison Lake and Morrison River support numerous species of salmonids including rainbow trout, lake trout, and coho and sockeye salmon, as well as numerous non-sport fish species. Morrison Lake first and second order tributary streams support small populations of juvenile rainbow trout, coho salmon, and redside shiner at certain times of year, and sockeye have been observed in the lower reach of Stream 44800. These small tributaries reach peak flow during spring freshet and become intermittent during low water periods in late summer and early fall. During low water periods, the streams contain numerous small pools separated by sections with sub-surface flows, providing marginal-value fish habitat. Fish stranded in isolated pools are subject to predation and desiccation.

PBM proposes to compensate for the displacement and/or loss of flows in the Morrison Lake tributaries in accordance with the federal *Fisheries Act* and the Department of

Fisheries and Oceans' (DFO) guiding policy of "No Net Loss" of productive capacity in fish habitat due to human activities.

The guiding principle for the FHCP is to maintain the productive capacity for rainbow trout, coho, and sockeye salmon in the Morrison Lake watershed. The limited distribution of spawning, rearing, and overwintering habitat for salmonids, especially creek-resident rainbow trout, is believed to be one of the main limiting factors to fish production in the Morrison Lake watershed. Therefore, development and improvement of areas providing spawning, rearing, and overwintering habitat are the focus of the FHCP.

The FHCP compensates for:

- Fish bearing habitat including spawning and rearing areas; and
- Non-fish bearing aquatic habitat, which provides productive capacity in the form of water, nutrients and benthic invertebrate drift to Morrison Lake fish.

A number of locations were identified as potential sites to compensate for fish habitat losses. Options were identified and screened against the DFO list of preferences for habitat compensation and the Lake Babine Nation (LBN) preference for rehabilitation and protection of fish habitat in Morrison Lake. Options were evaluated to assess the best potential for success. A shortlist of preferred options was presented to, and discussed with, DFO and LBN. The outcome of working group meetings and discussions was the fish habitat compensation plan (FHCP) outlined herein.

The FHCP includes the following components:

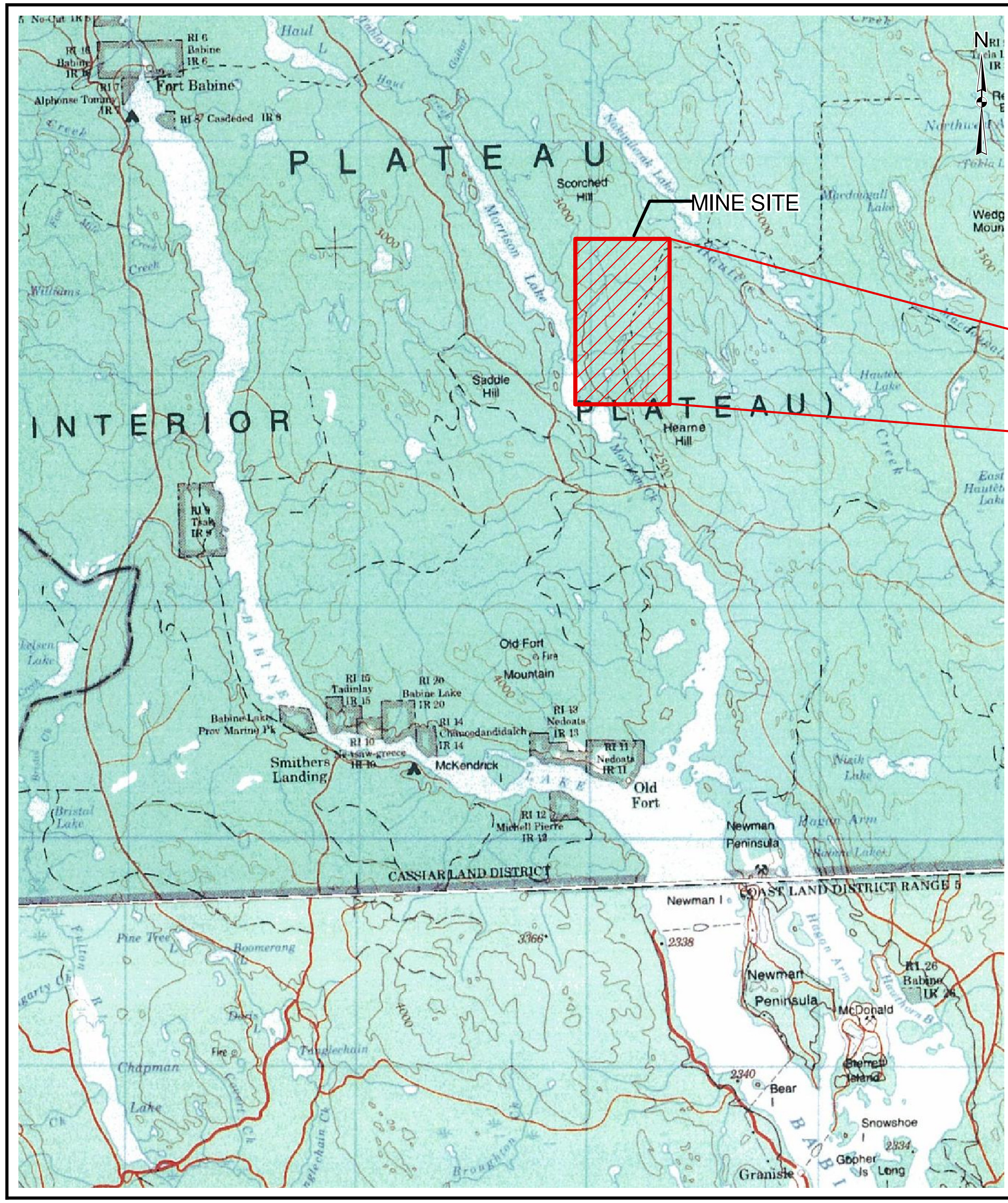
- Creation of salmonid rearing and overwintering habitat on Morrison Lake by constructing two off-lake channels on the southeast shore. This option creates a total of approximately 3,700 m^2 of fish habitat comprised mostly of rearing and overwintering habitat with some spawning habitat; and

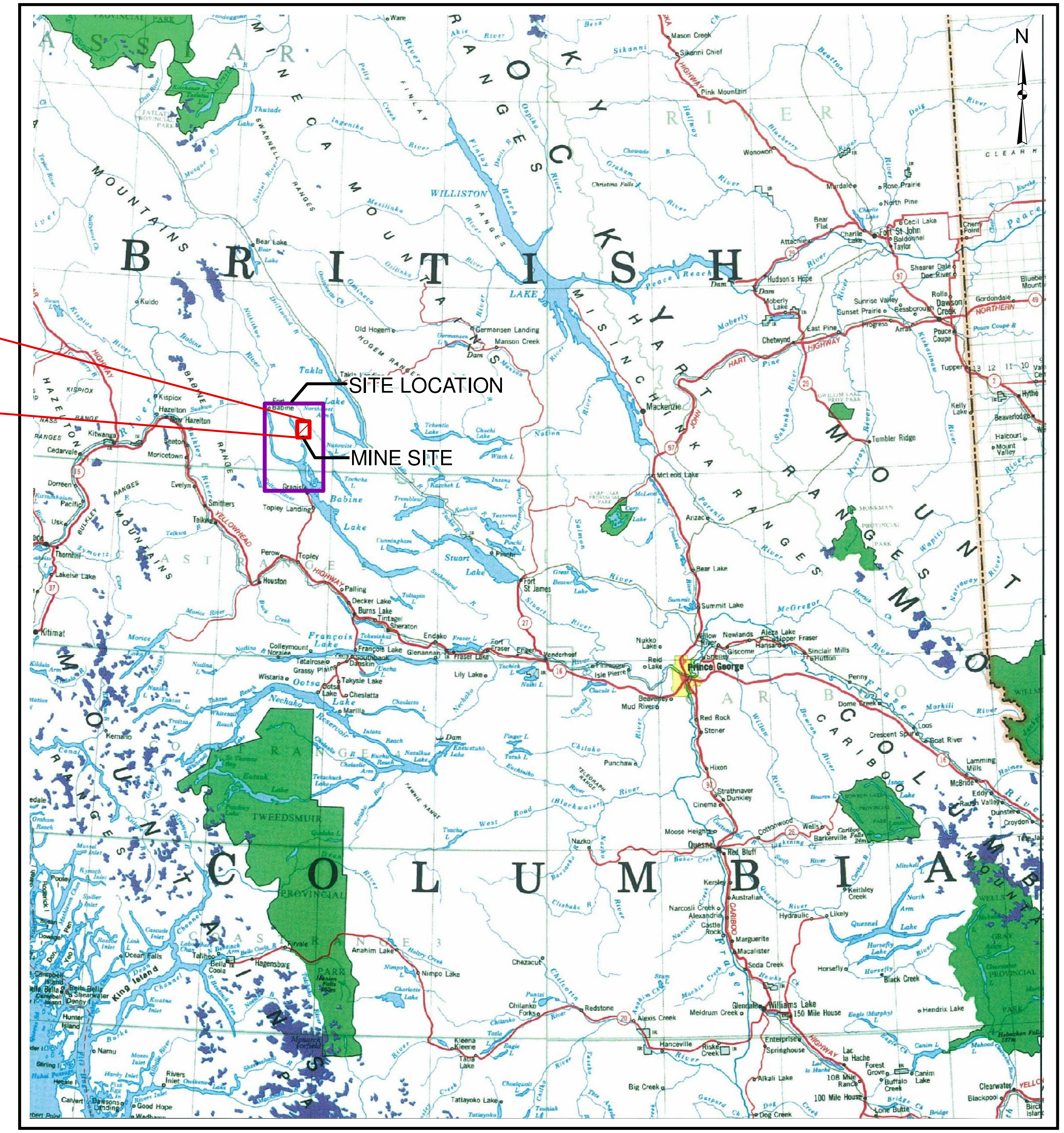
- Enhancement of fish habitat by improving fish access in Olympic Creek (i.e. between Olympic Lake and Morrison Lake) for spawning rainbow trout and, possibly, coho salmon. This option maintains Olympic Lake at a full-pool level, improves fish access, and enhances fish habitat within Olympic Creek, thereby providing direct access for fish to previously inaccessible food and nutrients within Olympic Lake.

Fish Habitat Loss / Gain Summary

Fish Habitat	Area
Fish Bearing Area Losses (HADDs) in Morrison Lake Tributaries	1,251.5 m^2
Fish Bearing Area Gain from Morrison Lake off-channel FHCP	3,700 m^2
Fish Bearing Gain/Loss Ratio	3:1
Riparian Area Loss (Gain)	13,500 m^2 (54,000 m^2)
Non-Fish Bearing Productive Capacity Habitat Losses in Morrison Lake Tributaries	12,000,000 organisms/year
Increased Productive Capacity via Habitat Gain in Olympic Lake system	Access to ~51 million organisms

The long term success of the FHCP will be ensured by using multiple compensation sites and fish habitat enhancement strategies. An Adaptive Management Plan has been developed, which will evaluate the success of compensation and to identify opportunities for improvement, if necessary. For example, the Adaptive Management Plan includes several alternatives, including: 1) habitat enhancements in Morrison River between Lake Babine and Morrison Lake to improve over-wintering and spawning habitat for salmonids; and 2) beaver management program at regional sites. These alternatives, or others, could be considered if the proposed compensation plan does not meet the intended targets.





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CLIENT	pbm
	Klohn Crippen Berger
PROJECT	MORRISON COPPER/GOLD PROJECT
TITLE	MORRISON PROJECT REGIONAL LOCATION MAP
PROJECT No.	M09382A04
FIG No.	1.0

Notes:
1. Topography courtesy of Softmap

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APPENDICES

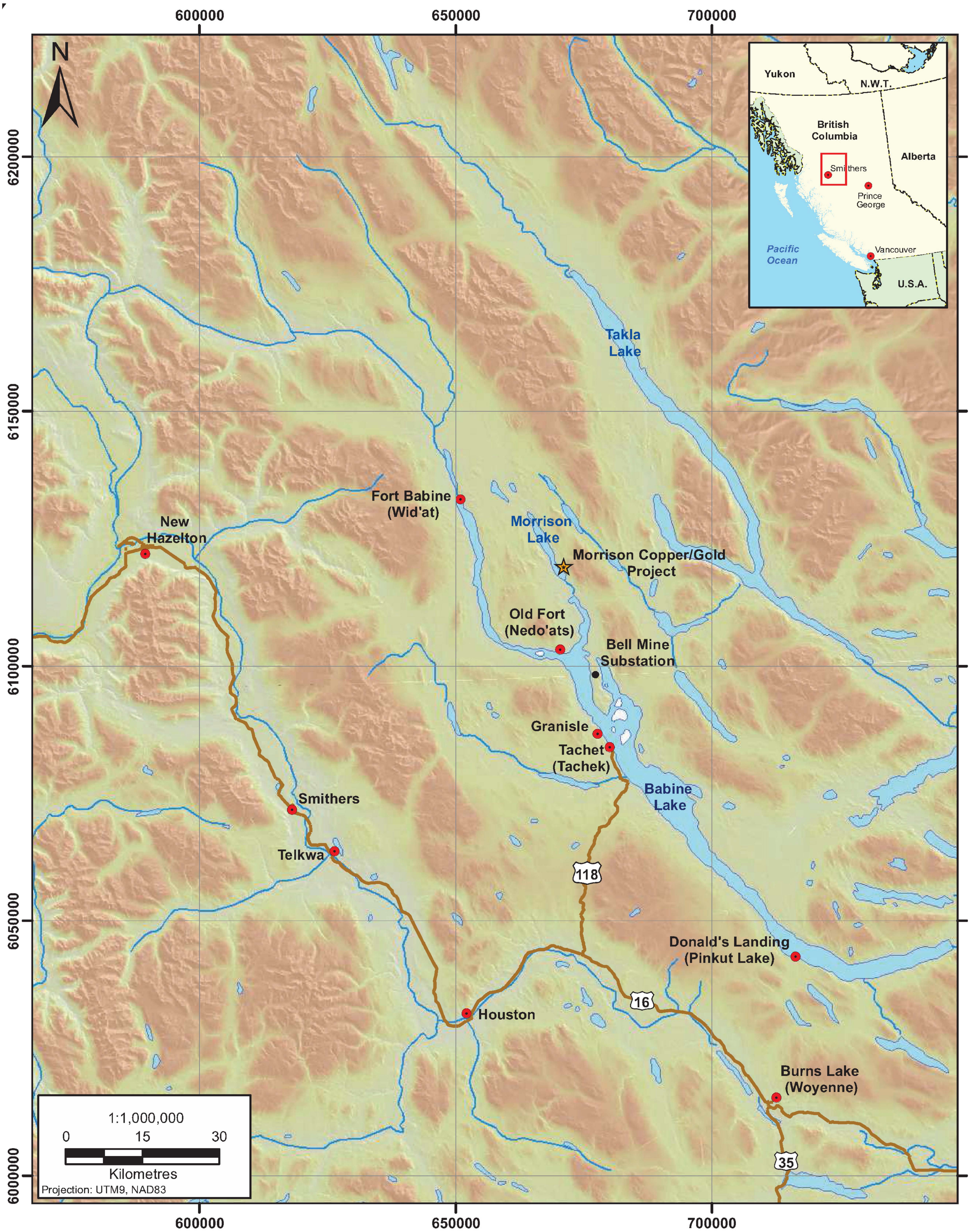
1. INTRODUCTION

1.1 Background

Pacific Booker Minerals (PBM) is proposing to develop the Morrison Copper/Gold Project (the Project) in north-central British Columbia (BC). The Project is situated on the east side of Morrison Lake approximately 65 km northeast of Smithers and 35 km north of Granisle, BC, within the traditional territory of the LBN (Figure 1.1). The Project includes an open pit, a processing plant, a waste rock dump, low grade ore stockpiles, a tailings storage facility (TSF), a run-off collection system, mine effluent treatment plant, and associated mine infrastructure (Figure 1.2). During maximum production, the mine will process 30,000 tonnes of ore per day. Mine life with known mineable reserve is 21 years.

The Project will result in the harmful alteration, disruption, or destruction (HADD) of fish habitat in the Morrison Lake watershed due to the footprint of the project facilities and reduced flows in some of the streams. Additionally, some non-fish bearing habitat will be affected resulting in loss of productive capacity. Although mitigation measures have been incorporated into the Project, some residual impacts to fish habitat in the Morrison Lake watershed are unavoidable. Although the federal *Fisheries Act* prohibits the HADD of fish habitat, Section 35(2) of the *Fisheries Act* allows authorization for the HADD of fish habitat, which generally requires "no net loss of productive capacity" of fish habitat.

The FHCP was developed concurrently with the Environmental Assessment Certification Application (EACA) and in consultation with representatives from the British Columbia Environmental Assessment Office (BC EAO), Department of Fisheries and Oceans (DFO), British Columbia Ministry of Environment (MOE), Environment Canada (EC), and members of the LBN.



Notes:
1. UTM Zone 9N, NAD83
2. Map altered from Rescan Job. 0793-001-15

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PROJECT	MORRISON COPPER/GOLD PROJECT
TITLE	MORRISON PROJECT LOCATION MAP
PROJECT No.	M09382A04
FIG No.	1.1

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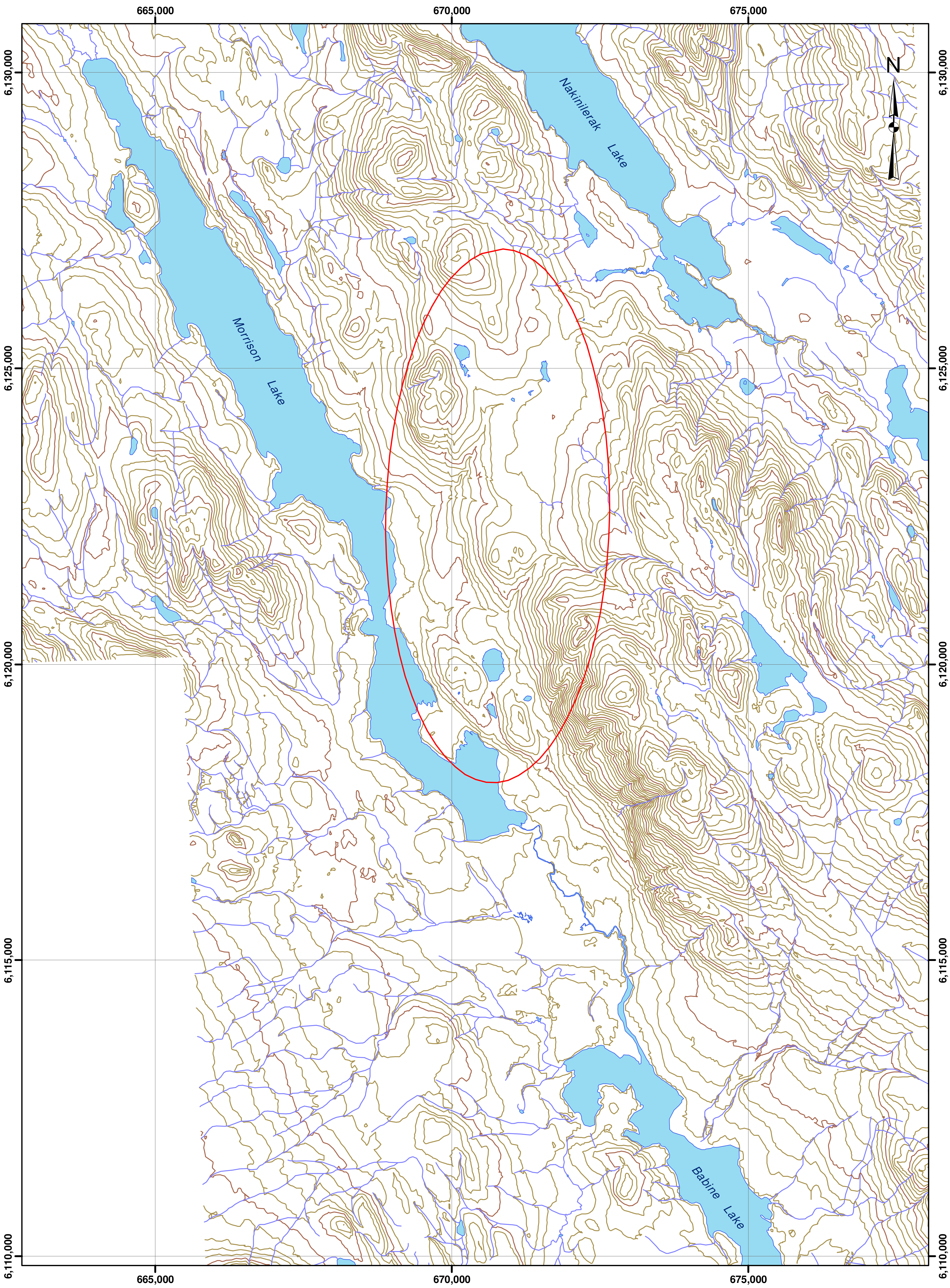

Major Contours
Minor Contours
Approximate Mine Site
Rivers and Streams
Lakes and Ponds

Notes:
1. UTM Zone 9N, NAD83
2. Contour interval is 20m.

0 2,500 m

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pbm

Klohn Crippen Berger

PROJECT
MORRISON COPPER/GOLD PROJECT

TITLE
LOCATION MAP

PROJECT No. M09382A04

FIG No. 1.2

Table 1.1 Project Fact Sheet

PROJECT	Morrison Copper/Gold Project	
OPERATOR	Pacific Booker Minerals Inc. #1702 – 1166 Alberni Street Vancouver, BC V6E 3Z3 Telephone: 604-681-8556 Fax: 604-687-5995	
	Contacts: Erik Tornquist, Executive Director, Executive VP, and Chief Operational Officer Email: e.tornquist@pacificbooker.com Don Betton, Project Manager Email: d.betton@pacificbooker.com	
MINING PROPERTY OWNERSHIP	PBM has owned the Morrison property since September 8, 2006.	
MINERAL TENURE	PBM's mineral tenure consists of 45 contiguous mineral claims totalling 12,027 ha; all claims are within the Omineca Mining Division. Tenure includes the Morrison property (20 units in 1 claim: ERIN 1) and the Hearne Hill property (378 units in 27 claims).	
SITE LOCATION	The Project site is located on the east side of Morrison Lake, in north-central BC. . The Project site is located on Crown land, 65 km northeast of Smithers and 35 km north of Granisle, on the east side of Morrison Lake Project site coordinates are lat 55º11'24" N and long 126º19'7" W.	
ACCESS	**Vehicle –** Travel along Highway 16 to Topley, BC, take Highway 118 north to Michelle Bay (11 km south of Granisle) where an all-season barge crosses Babine Lake to Nose Bay. Once at Nose bay, take approximately 49 km of Forest Service Roads to the site.	
	Air - The Project will not require regular air access. An emergency helicopter landing site will be available during construction and operations. Smithers is the closest regional airport.	
	Haul Route –Off-site, haul trucks/trailers will travel route 2C to the Port of Stewart, BC.	
SITE DESCRIPTION	The mine property covers approximately 9,950 ha at elevations ranging from 730 m to 1,020 m.	
PROJECT PLAN	The Project involves developing: an open pit mine; a 30,000 t/day processing plant (mill) for producing copper/gold concentrate; supporting mine facilities (e.g., warehouse, labs, etc.) and supporting infrastructure (e.g., roads, sewage, etc.) at the Project site. Off-site infrastructure includes: a 25 km, 138 kV power transmission line and corridor connecting the Bell Mine substation to the Project site; site access and locals roads; and air access.	

Table 1.1 Project Fact Sheet (cont'd)

MINE DESCRIPTION	Classified as a major mine, the Project will be a 30,000 t/d open pit mine operating 24 hours per day, 365 days per year for the whole of the comminution and processing system. The pit will be developed through four phases. The Phase 1 pit will be in the northwestern deposit area, the Phase 2 pit will be in the southeastern deposit area, and the Phase 3 and 4 pits will be expansions of the pits described above. Copper-gold-molybdenum ore will be processed at a conventional milling plant. The copper/gold concentrate will be transported to the Port of Stewart for shipment to offshore smelters. Molybdenum concentrate will be trucked to a refinery. The mine will receive electrical power from the BC Hydro grid.
GEOLOGY	The Morrison deposit is on the northern edge of the Skeena Arch within the Intermontane Belt of central BC and includes the Stikine volcanic arc terrain. The region is underlain by volcanic, clastic, and epiclastic rocks ranging in age from the Lower Jurassic to Lower Cretaceous. The deposit is a calc-alkaline copper gold porphyry. The primary copper-bearing mineral is chalcopyrite, with minor bornite occurring within the higher grade copper zones. Magnetite and pyrite are present in the low-grade core of the deposit, and molybdenum is present in smaller and somewhat spatially restricted amounts, particularly in the southeast portion of the deposit.
METALS	Copper, Gold
PROCESSING	Ore will be processed on-site using crushing, grinding, and flotation to recover copper, gold, and molybdenum concentrates.
MINEABLE RESERVES	The mineable reserve is estimated to be 224 Mt with an average grade of 0.330% Cu, 0.163 g/t Au and 0.004% Mo reported at a $5.60/t NSR cut-off grade. The Project will produce over 1.37 billion pounds of copper, 658,090 ounces of gold and about 10.05 million pounds of molybdenum over its operating life.
LIFE OF MINE	Mine life with known mineable reserves is 21 years.
ENVIRONMENTAL APPROVALS AND PERMITTING	Provincial and Federal project approvals and permitting is required to allow the Project to proceed. In addition to the British Columbia Environmental Assessment Act (BCEAA) and the Canadian Environmental Assessment Act (CEAA), several other federal and provincial licences, permits and approvals are required.

This revised fish habitat compensation plan has been developed following review of the initial Fish Habitat Compensation Plan (FHCP) for the Morrison Copper/Gold Project (the Project) (December 7, 2010 Klohn Crippen Berger) by Fisheries and Oceans Canada (DFO) and the Canadian Environmental Assessment Agency (CEAA). The context for the development of this revised framework is provided in the January 24, 2011 letter from Jack Smith of DFO to Robyn McLean, of CEAA. This letter indicates that the description of environmental effects of the project on fish habitat can be improved and provides detailed comments on the document as well as general comments for consideration.

In response to these comments received by PBM from DFO and CEAA, this document addresses the deficiencies in fisheries baseline information within the draft FHCP, and implements a more detailed assessment of fish habitat impacts as a result of the Morrison Copper/Gold Project. This revised document describes the FHCP developed to address expected fish habitat and productive capacity losses resulting from the Project. Pacific Booker Minerals is committed to continue working with DFO and CEAA to develop and implement a thoughtful and innovative approach to fish habitat compensation as a component of the Morrison Copper/Gold Project (the Project).

As noted herein, this document updates and supersedes all previously submitted information regarding Fish Habitat Compensation for the Project.

1.2 Lake Babine Nation Consultation

The following provides an overview of the consultation which has occurred between PBM and Lake Babine Nation (LBN) in developing the FHCP for the Morrison Copper/Gold Project.

1.2.1 Early Fisheries Studies

Throughout the Project's history, PBM has consulted LBN with regards to the importance of salmon and other fish to their culture and way of life, and the Project's potential effects on fisheries values in Morrison Lake and streams in the project area. PBM has sought LBN's input and participation in the development of the Project's Terms of Reference, fish and aquatic baseline studies, Traditional Knowledge and Traditional Use studies, fish habitat compensation and environmental monitoring. This has included site visits incorporating both ground based and aerial site tours, open house discussions, employment of individual LBN as field assistants and contracting of LBN which combined have provided the opportunity for consultation. Additionally, LBN has been active as Environmental Assessment Working Group members providing comments on the EAC Application as well as participating in Working Group Meetings. LBN has also been a participant in meetings PBM has held with DFO regarding fisheries and has provided verbal and written comments to PBM on the proposed FHCP.

1.2.2 Conceptual Fish Habitat Compensation Plan

Conceptual plans for the FHCP were part of the EAC Application submitted to EAO in September 9, 2009, a copy of which was submitted to LBN on September 24, 2009. On July 16, 2010 LBN provided PBM their review of PBM's Application. LBN recommended avoidance of salmon habitat loss by improving project design and mitigation, and taking inventory of lake, shoreline and stream habitat for salmon. LBN also recommended that any mine effluent be released into deep waters well removed from salmon spawning areas. PBM addressed LBN's concerns in the following months by committing to placing the overburden stockpile location farther from Morrison Lake, conducting additional fisheries field work, funding LBN's salmon spawning study and designing the underwater discharge pipeline to release mine effluent in the deepest part of Morrison Lake, over 1 km from the spawning areas of interest.

1.2.3 Fish Habitat Compensation Options

PBM prepared a poster illustrating several compensation options for the FHCP. In July and September 2010, the poster was displayed at EAO Open Houses in Granisle, Burns Lake and Smithers. The Open Houses provided opportunities for PBM to informally discuss with LBN members and their environmental consultants issues of concern surrounding fisheries, and to introduce the FHCP. At the July 26, 2010 Open House in Granisle, LBN requested funding to undertake a salmon spawning survey on Morrison Lake. PBM agreed to provide $20,000 in financial support to LBN to complete this study. PBM provided to LBN a copy of the compensation options poster so it could be taken back to LBN communities for discussion and presented at an LBN meeting that was held on July 27, 2010.

On August 10, 2010, PBM provided the draft document "Fish Habitat Compensation Options" to LBN for their review and comment. The document outlined options considered to compensate for potential lost fish habitat due to the Project. The purpose of the report was to provide a framework for discussion with LBN, DFO and other regulatory agencies regarding optimization of fish habitat compensation works to best meet the needs and objectives of reducing potential harmful effects and increasing/enhancing fish habitat in the area.

1.2.3.1 Compensation Options Field Tour

On August 16 - 18, 2010 PBM organized a field tour to examine options for the FHCP, which was attended by six LBN members, including a Hereditary Chief, and representatives from EAO, MOE and PBM consultants. The field trip consisted of a ground tour and two helicopter fly-overs of Morrison Lake, tributary streams and proposed compensation sites, all of which afforded participants the opportunity to discuss the proposed options and related considerations. During the field trip, PBM was advised by our consultants that LBN responded favourably to the concept of replacing the beaver dams on Olympic Lake with a concrete dam and fish ladder. LBN discussed how they (LBN) had previously placed gravels in the shallows of Morrison Lake near the previously proposed rock reef site, which is consistent in manner and location with PBM's rock reef option described in the "Fish Habitat Compensation Options" document. LBN also discussed the former fish ladder that LBN had constructed in Morrison River. In summary, PBM understands that LBN responded positively to the compensation options considered for the FHCP, although they did not indicate which options were preferred.

1.2.4 Salmon Spawning Inventory

On August 23, 2010 LBN's Ned'u'ten Fisheries Commission provided a proposal to PBM for the Spawning Inventory that was discussed at the July 26, 2010 Open House in Granisle and for which PBM committed $20,000. The LBN Spawning Inventory was completed in the fall of 2010 and the resulting report was provided to PBM on January 24, 2011. The report contains information that will be used to inform the FHCP.

1.2.5 Environmental Assessment Application Review

On September 30, 2010 LBN provided review comments on the EAC Application and Addendum that was accepted into the EA review process on July 12, 2010. In their comments LBN suggested constructing fish habitat compensation measures in Babine Lake instead of Morrison Lake. Regarding compensation measures for lost fish habitat, DFO prefers like-for-like compensation in the same drainage area as the original disturbance; therefore, PBM was unable to follow LBN's suggestion of compensation measures within Babine Lake. In addition, LBN reiterated the need for a salmon spawning survey and suggested that Booker Lake be considered fish-bearing. PBM addressed these concerns by funding the aforementioned Salmon Spawning Survey and re-examining Booker Lake for evidence of fish presence.

1.2.6 Fish Habitat Compensation Plan (December 2010)

On December 7, 2010 PBM submitted to the EAO the report entitled "Fish Habitat Compensation Plan for the Morrison Copper/Gold Project". On December 9, 2010 PBM sent a copy of the report to LBN for their review and comments. Specific written comments have not yet been received from LBN on this document.

On January 26, 2011 PBM met with DFO, EAO and MOE to discuss the December 7, 2010 FHCP report. LBN representative Verna Power and First Nations representative David Latremouille from Skeena Fisheries Commission were also present at the meeting. LBN expressed a concern that any reduction in stream flow, habitat modification or HADD due to the Project should be viewed as major issues so as not to downplay the value of fisheries to LBN. LBN were also concerned about any degree of reduced flow in Morrison River that may potentially jeopardize the salmon.

1.3 Purpose and Objectives

The purpose of the FHCP is to compensate for any harmful alteration, disruption or destruction (HADD) of fish habitat resulting from the Project and the reduction of productive capacity due to loss of aquatic habitat. The specific objectives of the FHCP are to:

- Characterize and quantify HADDs of fish habitat due to Project development;
- Characterize reduction of productive capacity due to loss of barren aquatic habitat;

- Describe the quantity and quality of the habitat created and/or enhanced by the proposed compensatory works;
- Describe the rationale and objectives of the FHCP and the anticipated benefits for fish:
    - Characterization of the habitat gains expected from the compensation works (i.e., the type and amount of habitat to be created, the species that will benefit, the habitat function or capacity that will be created, improved or enhanced, and how such gains will offset the HADD and achieve no net loss in the productive capacity of fish habitat);
- Construction:
    - A detailed description of the compensation sites and planned compensation works including photographs, sketches/drawings depicting the approximate location (geographic coordinates), area, number and dimensions of compensation works and structures;
    - Detail the technical feasibility of the proposed compensation works;
    - Details of construction such as machine access routes and construction methods;
    - Describe a mitigation plan to reduce or avoid impacts to aquatic or terrestrial resources during construction of the compensatory habitat;
    - Describe a monitoring plan for construction of the proposed compensatory work to ensure the work is conducted in accordance with relevant regulatory requirements; and
    - Confirmation of land tenure, legal right of access, and management authority for compensation works (i.e., evidence to support the ability of the Proponent to construct and maintain the compensation works).
- Environmental monitoring commitments (i.e., a description of compliance and effectiveness monitoring that will take place in relation to the compensation works).

1.4 Regulatory Framework and Policy

This FHCP was developed to meet the DFO policy for fish habitat compensation to achieve no net loss, and to comply with the companion *Policy for the Management of Fish Habitat* (Fisheries and Oceans Canada, 2001). Fish habitat compensation is considered an option only when a HADD is both unavoidable and deemed acceptable. DFO's guiding principle of "no net loss of productive capacity" of fish habitat has been applied to offset unavoidable (residual) habitat losses with habitat replacement for the Project. The term productive capacity is defined by DFO as the "maximum natural capability of habitats to produce healthy fish, safe for human consumption, or to support or produce aquatic organisms upon which fish depend". DFO's hierarchy of fish habitat protection or enhancement measures provided guidance in the development of this FHCP. DFO's policy also provides guidance on implementation procedures and preferences when compensation is required. This hierarchy of preferences is as follows:

- Create or increase the productive capacity of **like-for-like** habitat in the same ecological unit;
- Create or increase the productive capacity of **unlike** habitat in the same ecological unit;
- Create or increase the productive capacity of habitat in a **different** ecological unit; and
- As a last resort, use artificial production techniques to maintain a stock of fish, deferred compensation or restoration of chemically contaminated sites.

1.5 Approach to Fish Habitat Compensation Planning

The main goal of the FHCP is to compensate for the loss of rearing and spawning habitat within tributary streams on the east side of Morrison Lake. Consequently, the FHCP focused on identifying areas to increase rainbow trout (*Oncorhynchus mykiss*), and coho salmon (*Oncorhynchus kisutch*), rearing, spawning and foraging habitat. The creation of off-lake channels and access improvements to existing spawning, rearing and overwintering habitats, while providing "no net loss of productive capacity" is one approach of the FHCP.

Compensation planning was developed following guidance from DFO's hierarchy of preferences, and through the BC EAO Environmental Assessment process. PBM also worked with DFO, MOE, BC EAO and the LBN to provide a forum for discussion and evaluation of proposed compensation options. Collaboration with these stakeholders has guided the development and design of technically feasible and desirable compensation options.

Compensation planning has focused on "on-site" options within the Morrison Lake watershed and was guided by intensive fisheries and aquatic ecosystem studies within the Morrison Lake watershed from 2004 to 2010.

The value of existing fish habitats as "high value", "moderate", or "marginal", were also considered in the design of the FHCP using DFO's Habitat Conservation and Protection Guidelines (DFO 1998) and professional judgement. The quality of fish habitats was determined by comparing the stream morphology, substrate composition, and cover attributes of impacted stream reaches to the habitat preferences of each salmonid life stage (mainly rainbow trout and coho salmon as they are the fish species most affected by the Project) and estimating a suitability score between 1 (marginal) and 3 (high-value). In addition, the seasonality of the streams was considered, as many of the streams in the Project area are ephemeral. Table 1.2 outlines habitat value criteria used for assessing fish habitat in the Project area.

Table 1.2 Habitat Value Criteria

HABITAT CLASSIFICATION VALUE	FISH HABITAT CRITERIA
High Value	The presence of abundant spawning or rearing habitat (e.g., locations with abundance of suitably sized gravels, deep pools, undercut banks, or stable debris.
Moderate	Important migration corridor. Presence of suitable spawning habitat, but not in abundance. Habitat with some rearing potential for the fish species present.
Marginal	The absence of suitable spawning habitat, and habitat with low rearing potential (e.g., locations with distinct absence of deep pools, undercut banks, or stable debris, and with little or no suitably sized spawning gravels for the fish species present).

2. ENVIRONMENTAL SETTING

To apply DFO's "no-net-loss principle" it is important to understand the fish species composition and existing productive capacity of the Morison Lake watershed. Field work and analysis conducted within the Morrison Lake watershed from 2004 to 2009 is documented in PBM's EAC Application. Supplemental fisheries and aquatic baseline data for Morrison Lake, Nakinilerak Lake, and associated tributaries was collected by Klohn Crippen Berger (KCB) from 2009 to 2010 and is ongoing. These studies provide the information required to assess the potential effects of the Project on fish habitat and productive capacity.

Interactions between the physical, chemical, and biological environment within the Morrison Lake watershed, as discussed in the following sub-sections, determine the capacity of the system to produce fish.

2.1 Physical Setting

The receiving waters for the Project are Morrison Lake which forms part of the Babine Lake drainage, and Nakinilerak Lake, part of the Stuart River watershed. The Project is located within the sub-boreal spruce bio-geoclimatic zone at lower elevations, and within the Engelman spruce subalpine fir bio-geoclimatic zone at higher elevations. The Morrison Lake watershed is characterized by mature and secondary growth forest dominated by white and black spruce, trembling aspen, balsam poplar and white birch. The Morrison Lake watershed near the Project has been significantly impacted by past logging activities.

The Project site encompasses approximately 1,800 ha, ranging in elevation from 730 m to 1,020 m. The topography of the Project site comprises undulating plateaus adjacent to Morrison Lake rising easterly to a ridge dominated by Hearne Hill at an elevation of

1,350 m. Morrison Lake drains to Morrison River, which enters the north side of Babine Lake. Morrison Lake has several small tributaries along its eastern flank near the Project site. Most of these are small, ephemeral first and second order streams.

Tributary streams near the Project site rise steeply from outlets at Morrison Lake eastward (upstream) towards their headwaters. This topography results in streams with deeply incised channels consisting of run-pool habitat complexes dominating much of their length. Stream gradients average 1.8%. Habitat in the lower gradient reaches of these tributaries includes riffle-pool habitats dominated by gravel (33%) and cobble (56%) substrates. Cover for fish in the form of large overwintering pools with accompanying large woody debris (LWD) is uncommon.

The hydrology of the Morrison Lake watershed is typical of central-interior watersheds in BC with peak discharge during spring freshet followed by periods of low flow in late summer and fall (Table 2.1). Many of the tributaries on the east side of Morrison Lake are ephemeral, resulting in sub-surface flow and small isolated pools during low water periods. Tributary flows increase in late fall/early winter due to increased rain events followed by a winter low flow period from late December to March. Morrison Lake is accessible to migrating fish, anadromous and freshwater, from Babine Lake during spring freshet and late fall rains. At low flows, Morrison River is often intermittent, with short sections running sub-surface such that fish cannot pass until the water rises, in the spring and fall.

Table 2.1 Base Flows as a Percentage of Mean Annual Discharge in Morrison Lake Tributaries

STREAM GAUGE SITE	MEAN ANNUAL AVERAGE DISCHARGE (m^3/sec)	7-DAY LOW FLOW AVERAGE, JUNE TO SEP (m^3/sec)	BASE FLOW AS % OF MEAN ANNUAL DISCHARGE
Morrison River	8.40	0.79	9.3
MCS-1	0.077	0.0008	1.0
MCS-4	0.0188	0.0026	14.6
MCS-5	0.016	0.0045	27
MCS-6	0.27	0.017	6.4
MCS-7	0.113	0.0065	5.7
MCS-8	0.024	0.0010	4.4
MCS-10	0.0069	0	-

2.2 Chemical Setting

Phosphorus, nitrogen, and total organic carbon are important nutrients for the primary production of the plankton and periphyton communities that support Morrison Lake fish. The concentration and uptake of these nutrients into the Morrison Lake food chain are highly variable, both spatially and seasonally. In general, the concentration of phosphorus, nitrogen, and total organic carbon in water and sediments of the Morrison Lake watershed is relatively low. This is likely due to naturally low nutrient levels in the oligotrophic lake and creek system and rapid uptake of these nutrients into the food web.

Total suspended solids (TSS) and dissolved oxygen (DO) concentrations also vary spatially and seasonally within the Morrison Lake watershed. DO and TSS concentrations are typically higher during spring freshet and fall rains. DO concentrations within Morrison Lake tributaries are at or near saturation during most of the year, while Morrison Lake and Nakinilerak Lake concentrations vary significantly by depth and season.

2.3 Biological Setting

Periphyton are algae attached to the streambed that function as the base of the stream environment food web. The periphyton community in the Morrison Lake watershed is dominated by Crysophyta, Cyanophyta, Bacillariophycae, and diatoms. Average periphyton biomass is spatially and seasonally variable but shows a similar structure within upper and lower tributaries with Simpson's Diversity values in the range of 0.45 to 0.70.

Benthic invertebrates are an important food source for Morrison Lake fish species. Benthic invertebrate communities within Morrison Lake tributaries are generally dominated by Diptera (mostly chironomids), Plecoptera, and Ephemeroptera. Proportions of each are generally similar within upper and lower tributary reaches. Benthic invertebrate density within the Morrison Lake watershed ranges from 2.3 organisms/m^2 to 7.2 organisms/m^2 with biomass ranging between 0.00025 mg/m^2 and 0.0016 mg/m^2 (Rescan 2009).

Morrison Lake supports numerous fish species including rainbow trout, lake trout (*Salvelinus namaycush*), coho salmon, sockeye salmon, lake whitefish (*Coregonus clupeaformis*), burbot (*Lota lota*) and several non-sport fish species including large-scale sucker (*Catostomus macrocheilus*), long-nose sucker (*Catostomus catostomus)*, northern pikeminnow (*Ptychocheilus oregonensis*), prickly sculpin (*Cottus asper*), and redside shiner (*Richardsonius balteatus*). Large piscivorous (fish-eating) lake trout are the most abundant salmonid species in Morrison Lake, feeding primarily on juvenile fish, including rainbow trout and coho salmon. Rainbow trout, followed by coho salmon have the largest distribution in Morrison Lake tributaries (Rescan 2009).

Rainbow trout and coho salmon spawn within the lower reaches of several Morrison Lake tributaries. Based on densities of young-of-the-year (YOY) rainbow trout and coho salmon captured between 2006 and 2009, Streams 5, 7 and 8 are the three principle spawning streams affected by the Project.

2.4 Species Habitat Preferences

Fish species and their habitats that will be most affected by the Project include rainbow trout and coho salmon spawning, foraging and rearing habitats in tributary streams on the east side of Morrison Lake and, to a lesser extent, sockeye salmon spawning habitat near the proposed freshwater and diffuser pipelines. For this reason, the life history and habitat preferences of rainbow trout and coho salmon are the primary focus of the FHCP. Other fish species known to occur within the Morrison Lake watershed were not specifically included within the assessment of habitat preferences; however, they occupy similar habitat to rainbow trout, coho salmon, or are restricted to reaches within the watershed that will not be affected by the Project.

2.4.1 Rainbow Trout

Rainbow trout occur throughout Morrison Lake and are a primary food source for larger predatory lake trout. Adults feed in the foreshore areas of Morrison Lake in the summer months and on salmon eggs in tributary streams during the fall. In the spring, rainbow trout access the lower reaches (100 m to 700 m, depending on gradient) of Morrison Lake tributaries, preferring deep pools (<1 m) with cover immediately below riffles.

Within Morrison Lake and tributaries, rainbow trout spawn between April and June in inlet and outlet riffle and pool habitats. Young-of-the-year rainbow emerge from the gravel in summer and move to the stream margins, to deeper pools, or to Morrison Lake shallows and vegetated shoals. As they grow, they seek more cover in deeper water.

In general, overwintering pools with cover are important habitat preference for adult and juvenile rainbow trout. Juveniles are also known to overwinter within gravel substrates and in rock crevices below winter ice. In-stream cover including large woody debris (LWD), boulder clusters, undercut banks, and pools greater than 1.0 m in depth provide rainbow trout with protection from predators, overwintering habitat, refuge and cover. Overhead vegetation provides a source of allochthonous nutrients in the form of terrestrial invertebrates, as well as shade to help regulate water temperature.

2.4.2 Lake Trout

A top predator in Morrison Lake, lake trout occur throughout Morrison Lake at various depths and remain dispersed throughout the year. Lake trout spawn in Morrison Lake between September and November over boulder or cobble bottoms at depths between 1 m and 12 m. Although the biology of juvenile lake trout in Morrison Lake is not well known, it is thought that juveniles seek deeper water shortly after hatching.

2.4.3 Coho and Sockeye Salmon

Coho and sockeye salmon school at the mouth of Morrison River until fall rains increase river flow. Sockeye and coho salmon spawn in Morrison River in late September and early October, respectively. Coho salmon typically spawn in swift, shallow gravelly areas of Morrison River and Tahlo Creek and, to a lesser extent, within smaller Morrison Lake tributaries. Coho and sockeye salmon utilize the rocky reefs and gravel-cobble substrates within shoal habitats of Morrison Lake and Morrison River. Seventeen shoreline redds were identified and mapped along the Morrison Lake shoreline in the area of the proposed mine by Lake Babine First Nations in October 2010. Groundwater was observed to contribute to the clean gravels at these sites. Young-of-the-year coho and sockeye emerge from the gravel in spring and summer and take up residence in nearby shallow, gravelly areas along stream banks, or Morrison Lake shallows and vegetated shoals. Smoltification and ocean migration usually occurs in March or April after 1 to 3 years.

2.5 Limitations to Productive Capacity

Interspecific competition between rainbow trout and lake trout, as well as predation by non-salmonids, is likely a factor limiting production of Morrison Lake salmonids. Trout are territorial in streams and lakes and compete for territories that provide the best combination of spawning gravels, refuge, cover from predators, and access to prey. Lake trout are opportunistic piscivorous predators and feed on juvenile rainbow trout, coho and sockeye salmon, as well as other fish species. Inter-specific competition between Morrison Lake salmonid stocks is likely exacerbated by the following physical habitat limitations:

- Limited deep-water side-channels and overwintering pool habitats, except the lake itself, in which the predators also over-winter;
- Limited spawning substrates with groundwater upwelling within Morrison Lake;
- Limited riffle-pool habitats in tributaries with available LWD for rearing and spawning salmonids;
- Lack of cover and refugia for juvenile salmonids; and
- Lack of base-flow discharge in first and second order tributary streams which provide spawning habitat for rainbow trout and to a lesser degree, coho salmon.

The lack of significant deep-water side-channels and overwintering habitat for juvenile rainbow trout, lake trout, and young salmon is thought to limit the production and recruitment of adult salmonids in Morrison Lake and tributaries. A recent fish habitat assessment of Morrison Lake conducted by KCB in September 2010 documented little to no high-value off-channel habitats within Morrison Lake or the ephemeral tributary streams flowing into Morrison Lake. Pool depths in Morrison Lake tributaries are typically less than 0.5 m and most pools and many shallows in this part of the watershed freeze to the bottom in winter.

Rock reefs with potential groundwater upwelling in Morrison Lake occur in three known locations within Morrison Lake. As discussed previously, these areas are known to serve as spawning and overwintering habitat for sockeye and to a lesser extent coho salmon. These areas are considered as "high-value" habitats and are relatively uncommon within Morrison Lake. Due to their scarcity, juvenile salmonids within Morrison Lake likely share these higher value spawning and overwintering habitats with large predatory lake trout, pikeminnow and burbot.

Limited riffle-pool sequences in Morrison Lake tributaries limit rainbow trout and coho salmon production within the Morrison Lake watershed. Some of the tributary streams within the watershed are beaver-dominated, undefined wetland-fen channels with mud substrates in their lower reaches, and bed-load choked thalwegs with occasional marginal value pool habitats in upper sections.

Lack of significant cover and refugia for juvenile salmonids limits rainbow trout production in Morrison Lake and its tributaries. Cover in the form of LWD is limited along the Morrison Lake shoreline. LWD that does exist within tributaries lacks significant depth to adequately support juvenile salmonids. Lack of in-stream LWD forces juveniles to more exposed areas with a greater risk of predation.

A final limiting factor to the productive capacity of the Morrison Lake watershed is likely the lack of base-flow discharge in first and second order tributary streams. Many Morrison Lake tributaries flow sub-surface during part of the year, limiting their ability to support fish. These tributaries begin to flow sub-surface in late summer and fall, forming small isolated pools (average ~0.35 m deep) between dry riffles and runs with no surface base flow. Juvenile salmonids inhabiting these isolated pools risk predation by terrestrial mammals including fisher, marten, and racoon, or desiccation if the pools dry completely.

3. PROJECT EFFECTS

3.1 Revised HADD Areas

The following section details the habitat calculation of the HADD areas for compensation planning. The fish bearing status and habitat quality for each of the effected streams in the Project area was considered. The methodology used to calculate the fish bearing HADD areas in the Project area is described, and the overall habitat loss summarized in Section 3.3.

3.1.1 Watershed Reduction

To determine the residual HADD effect of the Project on local streams, it was necessary to determine the potential changes in the catchment areas from the direct mine footprint and water diversions. The overall reduction in watershed areas including diversions was calculated and illustrated in Figure 3.1. The largest reduction in watershed area is seen in Catchment 7 and Catchment 5 (Table 3.1; Figure 3.1), these area reductions will be described in detail, per stream, in the following sections. The direct habitat loss from infrastructure is shown in Figure 3.2.

Table 3.1 Reduction in Watershed Areas from Project

CATCHMENT (STREAM NUMBER)	TOTAL AREA (km^2)	REDUCED AREA (km^2)	% REDUCTION
4 (25500)	3.27	1.1	**34**
5 (29000)	2.3	1.88	**82 (100)**
6 (44800)	13.25	0.47	**3.5**
7 (53400)	13.49	7.24	**54**
8	4.72	0.23	**5**
10 (6070)	3.63	0.61	**17**

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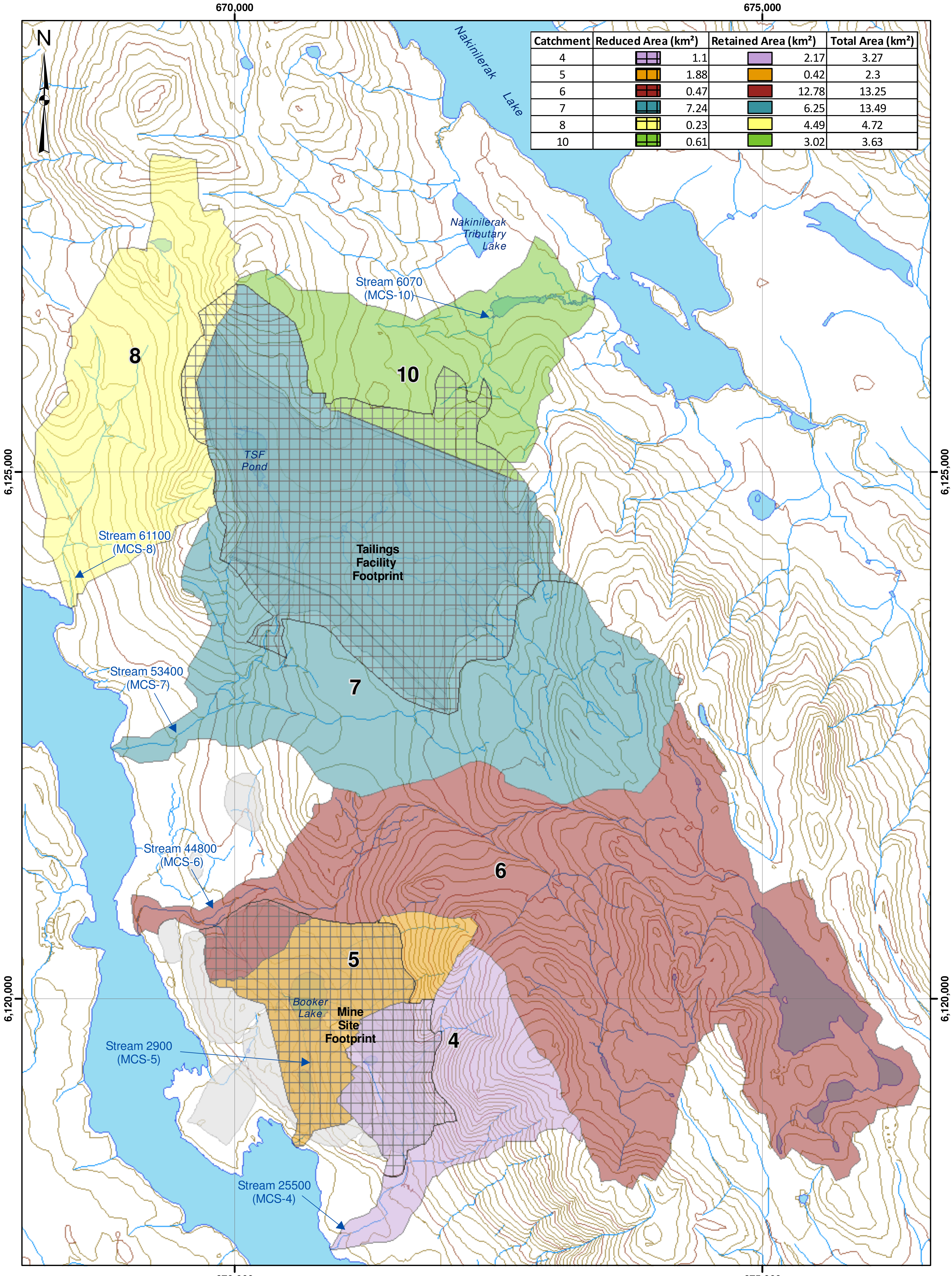
Catchment	Reduced Area (km²)	Retained Area (km²)	Total Area (km²)
4	1.1	2.17	3.27
5	1.88	0.42	2.3
6	0.47	12.78	13.25
7	7.24	6.25	13.49
8	0.23	4.49	4.72
10	0.61	3.02	3.63



LEGEND

- Major Contours
- Minor Contours
- Rivers and Streams
- Lakes and Ponds
- Mine Footprint

0 2,000 m

Notes:
1. UTM Zone 9N, NAD83
2. Contour interval is 20m.
3. Map data is BC TRIM (1:20,000)

TO BE READ WITH KLOHN-CRIPPEN REPORT DATED ______________

CLIENT

pbm

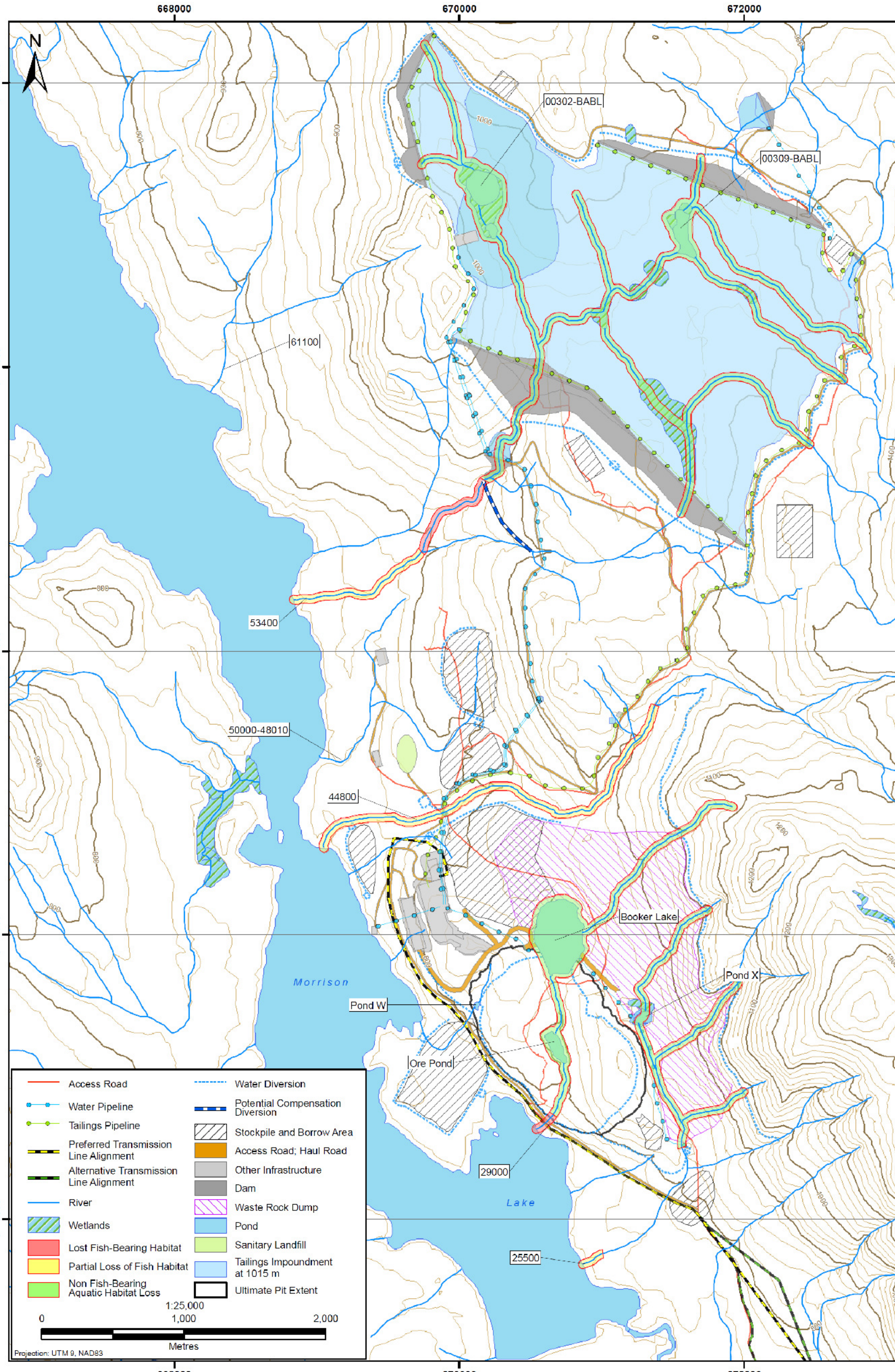
Klohn Crippen Berger

PROJECT
MORRISON COPPER/GOLD PROJECT
FEASIBILITY DESIGN

TITLE
AFFECTED AND RETAINED CATCHMENT AREAS

PROJECT No. M09382A04

FIG No. 3.1



TO BE READ WITH KLOHN-CRIPPEN REPORT DATED ____________

From Rescan Environmental Assessment Application dated Septermber, 2009

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT

pbm

Klohn Crippen Berger

PROJECT

MORRISON COPPER/GOLD PROJECT

TITLE

WATERBODIES TO BE LOST TO INFRASTRUCTURE OF THE MORRISON COPPER/GOLD PROJECT

PROJECT No. M09382A04

FIG No. 3.2

3.2 Fish Bearing Habitat Losses (HADDs)

A detailed quantitative and qualitative assessment of the habitat and productive capacity values within the proposed Project site is important in achieving no net loss, and requires an evaluation of the quantity and quality of all habitat types lost and gained. To determine the amount of fish habitat to be displaced by the Morrison Project, the habitat losses and gains have been subdivided into: 1) Fish bearing; and 2) Non-fish bearing; this section describes in detail the expected habitat loss to fish bearing habitat in the Project area.

All fish habitat affected by the proposed Project for the purposes of fish habitat compensation planning was evaluated for each of the following salmonid life stage characteristics:

- Spawning adults;
- Foraging adults;
- Incubating eggs;
- Rearing juveniles;
- Overwintering of all life stages; and
- Productive capacity.

Habitat quality ratings of “high value”, “moderate”, and “marginal”, were identified for various habitat types utilized by juvenile rainbow trout and coho salmon, the fish species most affected by the Project. The quantification of habitat area loss is included, which includes the methodology and rationale where applicable.

Fish-occupied habitats affected by the Project include Stream 25500, Stream 29000, Stream 44800, Stream 53400, Stream 6070 (tributary to Nakinilerak Lake), and the

Morrison Lake foreshore at the proposed freshwater and treated effluent pipeline locations (Figure 3.2). Habitats and potential impacts to the production of rainbow trout and coho salmon in these systems are discussed below.

3.2.1 Stream 25500 (also known as (aka) Stream 4)

3.2.1.1 Baseline Condition

Stream 25500 is affected by the waste rock dump, which will occupy a portion of its watershed. Surface water will be diverted around the waste rock. Fish habitat in Stream 25500 has moderate to marginal value for rainbow trout and coho salmon. Average depth of Stream 25500 during high flow events is 0.2 m. Substrates in Stream 25500 are dominated by fines interspersed with gravels with abundant LWD throughout. A series of bedrock waterfalls approximately 1,000 m upstream of Morrison Lake serve as permanent fish barriers. Pockets of suitable spawning gravels are present below the barrier down to Morrison Lake and are included in the habitat areas for the FHCP.

Beaver activity is common in the lower reaches of Stream 25500, resulting in the accumulation and build-up of thick organics and undefined channels. Although juvenile coho salmon are known to utilize the lower ~100 m of the stream, the restricted access due to accumulated beaver materials in the lowermost reaches limits the number and extent of salmonids entering Stream 25500 under natural conditions. Table 3.2 summarizes the baseline habitat characteristics of Stream 25500; these values were derived from Bustard (2004).

Table 3.2 Summary of Key Habitat Characteristics of Stream 25500

REACH	LENGTH (m)	SLOPE %	AVERAGE CHANNEL WIDTH (m)	AVERAGE WETTED WIDTH (m)	AVG AREA (m^2)
1	~30	1.5	1.78	1.6	48
2	~100	6	2.12	1.5	150
3	~100	3	1.50	1.3	130
TOTAL					**328**

Stream 25500 has a very small watershed area (3.27 km^2) (Figure 3.1) and drains the ridge to the east of Morrison Lake. Encroachment of the waste rock dump into Stream 25500 will reduce the catchment by approximately 35% (Table 3.1). The lower reaches of this stream are considered in this assessment, as this was the extent of fish access due to the bedrock chute and extensive beaver dams in the creek. Reach 1 is characterized by a series of beaver dams with small ponds and short glide sections; the substrate in this area consists of 100% sands (Rescan, 2010). Fish habitat improves upstream of Reach 1 with several riffle sections associated with glides, pools and step-pools present. Bustard (2004) captured only three coho fry approximately 100 m upstream from Morrison Lake. No fish were captured upstream of the beaver dams and downstream of the permanent barrier (Bustard, 2004).

The average discharge in Stream 25500 was 17.8 L/s in 2008 and average runoff depths are also low ranging from 3.9 mm to 91 mm. A rating curve was developed for Stream 25500 (Rescan, 2009: Appendix 22, Figure 3.2-2), and was based on manual flow measurements. A discharge hydrograph was also developed for 2008 (Rescan, 2009: Appendix 22, Figure 3.2-8), which shows the same distribution of flow typical for the watershed, with high flows occurring during spring freshet with discharge tapering to <10 L/s for the remainder of the year.

3.2.1.2 Habitat Loss

Based on the hydrograph for Stream 25500 fish use in this stream is limited to a few months of the year, and fish population studies supports limited use (Bustard, 2004). To quantify the potential fish habitat loss the historic baseline hydrology data was compiled and used to calculate the mean monthly flows. This calculation incorporated the catchment area, annual precipitation, the runoff coefficient, and the average monthly runoff as a percent of the annual flow. These calculations resulted in a theoretical flow volume and average monthly runoff for Stream 25500, along with the corresponding flow volume and depth from the predicted 35% reduction of the watershed (Figure 3.3).

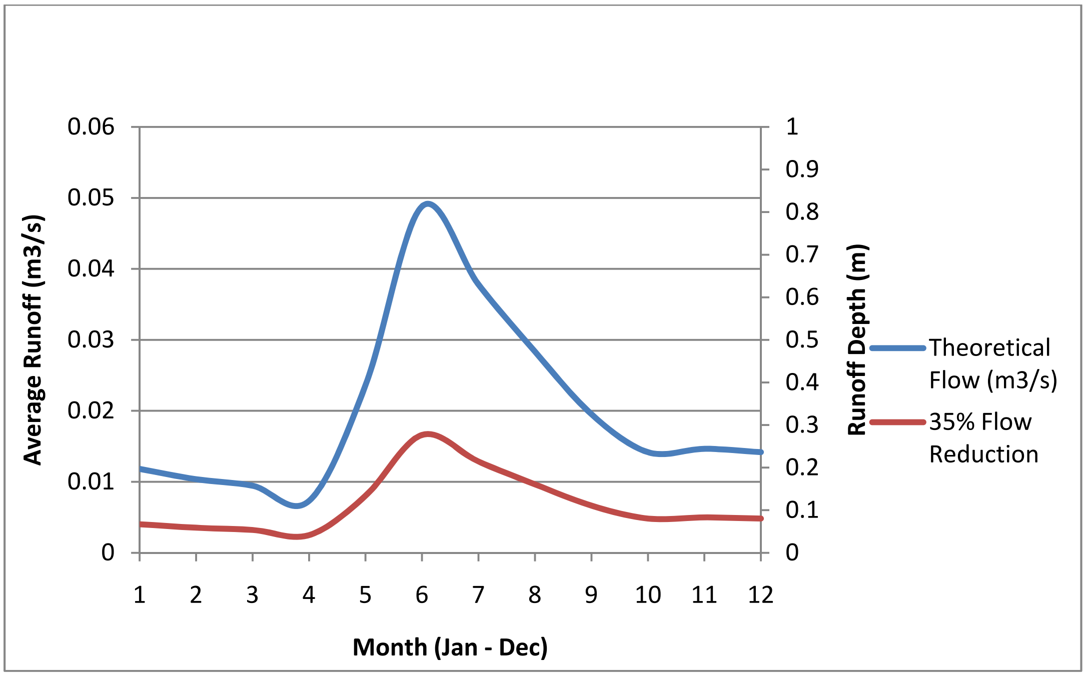


Figure 3.3 Theoretical Flow and Flow Reduction, Stream 25500

The Manning Equation was applied to determine what the reduced flow and corresponding depth equated to in terms of fish habitat loss. Section 3.7.4 describes the Manning Equation in more detail. The output of the Manning Equation is shown in Table 3.3 which demonstrates the expected change to the habitat characteristics from the 35% reduction in flow. Due to the naturally limited flow and depth in this stream the decrease in flow results in a negligible decrease in habitat, and the expected reduction of wetted width is 0.05 m (Table 3.3).

Table 3.3 Changes in Habitat Characteristics with 35% Flow Reduction

HABITAT CHARACTERISTIC	AVERAGE MONTHLY DISCHARGE	35% FLOW REDUCTION	CHANGE
Normal Depth (m)	0.11	0.08	-0.03
Velocity (m/s)	0.13	0.11	-0.02
Flow Area (m^2)	0.14	0.11	-0.03
Top Width (m)	1.41	1.36	-0.05

When applying this change to fish habitat, the reduced wetted width of 0.05 m results in the expected fish habitat loss of 11.5 m^2 (Table 3.4).

Table 3.4 Fish Bearing Habitat Loss in Stream 25500 from 35% Flow Reduction

STREAM 25500	BASELINE AREA (m^2)	TOTAL AREA AFTER 35% FLOW REDUCTION (m^2)	LOST FISH HABITAT AFTER 35% FLOW REDUCTION (m^2)
	230 x ~1.5 = 345	230 x 1.45 = 333.5	11.5

3.2.2 Stream 29000 (aka Stream 5)

3.2.2.1 Baseline Condition

Stream 29000 drains the main mine area, including Booker Lake and Ore Pond and the majority of the watershed will be covered by the project facilities. Fish habitat in Stream 29000 has only marginal value for rainbow trout. A 10 m high waterfall exists approximately 100 m upstream from the confluence with Morrison Lake precluding upstream migration of fish, potentially to Ore Pond and Booker Lake, which are both fishless. The plunge pool at the base of the falls is used by rainbow trout and coho salmon. There is some limited spawning and rearing habitat in the form of gravel riffles within the lower 100 m of the stream below the falls. During high flow conditions, this 100 m section is approximately 1 m – 2 m wide and 0.2 m deep, with a mix of gravel and cobble bed material. Total wetted area in the lower accessible reach ranges from 90 m^2 during lower flows to 200 m^2 at high flow conditions (Table 3.5). Due to limited flows in

Stream 29000, rainbow trout likely move out of this system due to space and depth limitations as water levels drop in summer.

3.2.2.2 Habitat Loss

Stream 29000 will be completely displaced by the mine activities, the entire fish bearing portion of this stream is considered a HADD which amounts to an upper bound loss of 200 m^2 of wetted habitat, which includes the highest flow period. This loss includes 4 m^2 of spawning habitat. Table 3.5 summarizes the habitat characteristics of Stream 29000, these values were derived from Bustard (2004).

Table 3.5 Summary of Key Habitat Characteristics of Stream 29000

REACH	LENGTH (m)	SLOPE %	CHANNEL WIDTH (m)	WETTED WIDTH (m)		AREA (m^2)		SPAWNING AREA (m^2)
				Low Flow	High Flow	Low Flow	High Flow	
75 m below barrier to Morrison Lake	100	7.5	1.5	0.9	2.0	90	200	4
TOTAL						**200**		**4**

3.2.3 Stream 44800 (aka Stream 6)

3.2.3.1 Baseline Condition

Stream 44800 is a major stream which runs along the north side of the mine area. The lower 3 km of Stream 44800 provides high value habitat for rainbow trout and coho salmon and consists of two reaches. The upper reach of Stream 44800 flows through a steep walled bedrock canyon, with step-pool morphology and a 7% average slope. Pockets of potential spawning gravels have accumulated behind log steps within the canyon. Several 2 m high waterfalls are present within the upper reach of stream 44800 the lowest of which is located 2,000 m upstream from Morrison Lake forming the uppermost point of fish passage from the lake.

The lower reach of Stream 44800 breaks out of the canyon and widens to 5 m with a 3.7% slope over a 1,500 m section. The channel is characterized by riffle-run, run-pool, and step-pool habitat with cover in the form of heavy overhanging riparian vegetation and large woody debris within the channel. A gravel fan section occurs in the lowermost section of the creek where it enters Morrison Lake. An estimated 60 m^2 of high value spawning sites for rainbow trout and coho salmon occur within the lower reach. High value spawning sites also occur on the creek fan where it enters the lake and along the lake shoreline to the south in the area influenced by the creek fan. Table 3.6 provides the habitat characteristics of Stream 44800, these values are derived from Bustard (2004).

Table 3.6 Summary of Key Habitat Characteristics of Stream 44800

REACH	LENGTH (m)	SLOPE %	CHANNEL WIDTH (m)	WETTED WIDTH (m)		AREA (m^2)		SPAWNING AREA (m^2)
				Low Flow	High Flow	Low Flow	High Flow	
LOWER	1500	3.7	5.0	3.4	4.7	5100	7013	15
UPPER	2200	7.2	4.6	3.4	4.3	7375	9470	60
TOTAL						**12475**	**16483**	**77**

3.2.3.2 Habitat Loss

The catchment area for Stream 44800 is the second largest (13.25 km^2) in the Project area (Table 3.1). The encroachment of the waste dump will reduce the catchment area by 3.5% (Figure 3.1), which is considered a negligible decrease in a watershed of this size and in a stream with channel widths of 5.0 m. Additionally, a diversion above the WRD will compensate in part or full for any loss of catchment. Any resulting small change in this watershed is not significant in any habitat loss calculations and as a result there is no expected fish habitat loss in Stream 44800.

3.2.4 Stream 53400 (aka Stream 7)

3.2.4.1 Baseline Condition

Habitat

Stream 53400 has the largest catchment (13.49 km^2) in the Project area and from the development of the tailings storage facility (TSF) it will have the greatest reduction in habitat area of streams in the Project area. The two lower reaches of Stream 53400 is the focus for habitat loss as these areas constitute the fish bearing portion of the watershed. Stream 53400 has a total length of approximately 4 km where it arises from two small headwater ponds. At approximately 1.8 km upstream from Morrison Lake, a 16-m high cascade is located in a canyon section of the stream and denotes the upper extent of fish access from Morrison Lake (Bustard 2004). No fish have been captured above this cascade (Bustard 2004) and none were observed in July 2010 during a two-person snorkel survey by KCB biologists of the largest beaver pond upstream of the canyon.

The lower 1.8 km section of Stream 53400 provides mostly rearing habitat, with limited spawning habitat for stream resident rainbow trout, while the lowermost 175 m provides moderate rearing habitat for coho salmon.

The lower 1.8 km of stream consists of two fish bearing reaches:

> Reach 1 is confined and moves from a pool-riffle morphology to Reach 2 which is defined by a cascade-pool morphology dominated by cobbles. Channel widths in Reach 1 (950 m in length) have an average wetted width of 3.4 m which range between 3.5 m during high flows and 2.8 m during low flow periods. Large woody debris and riparian vegetation are relatively abundant. Substrates are composed of large gravel and cobble with an estimated 36 m^2 of suitable spawning habitat (Bustard 2004).
>
> Reach 2 (850 m in length) (directly below canyon) is predominantly riffle habitat with some cascade-pool features. The mean channel width is 5 m

and the wetted width ranges from a mean of 3.6 m during higher flows to 2.3 m during lower flow periods. As with Reach 1, LWD and riparian vegetation are also abundant. Substrates are dominated by cobble with an estimate of 23 m^2 of high value spawning habitat (Bustard 2004).

The relatively small discharge in Stream 53400 and excess outwash cobbles blocking the main channel (elevated substrate) limits upstream access to these habitats. Observations by Bustard (2004) indicate that Stream 53400 is often dry between August and October and is likely too small to attract coho spawners in the fall. With the combination of low flows and winter icing coho spawning is likely precluded.

Table 3.7 summarizes the key habitat characteristics of Stream 53400. These values were derived from Bustard (2004).

Table 3.7 Summary of Key Habitat Characteristics of Stream 53400

REACH	LENGTH (m)	SLOPE %	CHANNEL WIDTH (m)	AVERAGE WETTED WIDTH (m)		AVERAGE AREA (m^2)	SPAWNING AREA (m^2)
				Low flow	High Flow		
Reach 1	950	4.6	4.9	2.8	3.5	2995	36
Reach 2	850	7.7	5.3	2.3	3.6	2600	23
TOTAL						**5595**	**59**

Fish Use

Detailed fish habitat data for Stream 53400 is presented in Rescan (2009; 2010) and Bustard (2004). Rainbow fry and parr are present throughout the mainstem sites below the barrier (16 m cascade), whereas coho are only present in the lowermost section of the creek, close to the Morrison Lake confluence. Rainbow fry densities (28 fry/100 m^2) were highest in upper Reach 1 as were parr densities (14 parr/100 m^2) (Table 3.8 and Bustard 2004).

Table 3.8 Fish Densities Lower Stream 53400 (Bustard, 2004)

REACH	DISTANCE FROM LAKE (m)	FISH/100m²		
		Coho	Rainbow	
			Fry	Parr
1	175	9.0	8.3	3.0
1	273	0	4.9	3.7
1	683	0	27.7	14.3
2	1000	0	1.4	13.5
2	Trib @ 950 m	0	0	0

Population estimates in Stream 53400 showed 437 rainbow fry, 171 rainbow parr and 73 juvenile coho in Reach 1, and 30 rainbow fry and 296 rainbow parr in Reach 2 (Bustard, 2004).

Bustard (2004) found the majority of rainbow were age 1+ and 2+, and maturing males were as small as 125 mm. A spawning male was captured with a fork length of 210 mm and was aged at 3+ (Bustard 2004). Due to the small size of the maturing rainbow and colouration, Bustard (2004) concluded these fish are stream residents. Reach 1 fish may also be stream residents due to their small size (less than 200 mm for spawners). The largest spawning area was observed in the upper portion of Reach 1, where redds and higher fry densities were observed. Bustard (2004) notes that spawning rainbow in Stream 44800 (Stream 6) were in the 350 mm - 400 mm range, which is more comparable with the size of Morrison Lake rainbow trout and further supports the conclusion that Stream 53400 trout are likely stream residents.

Coho observed in Stream 53400 consisted of juveniles (70 mm or smaller) and likely use the lower section of the stream for rearing. No coho adults have been observed nor any indication of spawning activity (Bustard 2004).

Hydrology

The natural flow in Stream 53400 is typical of all streams in the watershed, which can be characterized by a snow melt freshet in mid April to mid May, with low flows extending from mid to late summer and throughout winter, with some rainfall events increasing flows in the fall (Figure 3.4). Rescan (2009) describe in detail the hydrology for Stream 53400 (Rescan 2009: Appendix 22; Figures 3.2-2, 3.2-5; Tables 3.2-1, 3.2-2, 3.2-3). The average annual discharge in Stream 53400 was 112 L/s in 2007 and 114 L/s in 2008, with a maximum discharge of 676.04 L/s on May 25, 2007 and 778.71 L/s on May 18, 2008. It should be noted that not a full year of data was collected in 2007, and may not represent the true range of peak flow for that year. The average monthly runoff depth totals in Stream 53400 range from 5.1 mm to 46.7 mm (September and June, respectively; exclusive of January to May) in 2007 and from 0.5 mm to 106.7 mm in 2008 (July and May, respectively) (Rescan, 2009: Appendix 22, Table 3.2-2). Figure 3.4 illustrates the measured mean daily flow for Stream 53400 from 2008 and highlights how “flashy” the natural flows can be in these systems. It should be noted, 2008 did have an above average snowpack with an associated higher spring freshet than historically observed (Rescan, 2009).

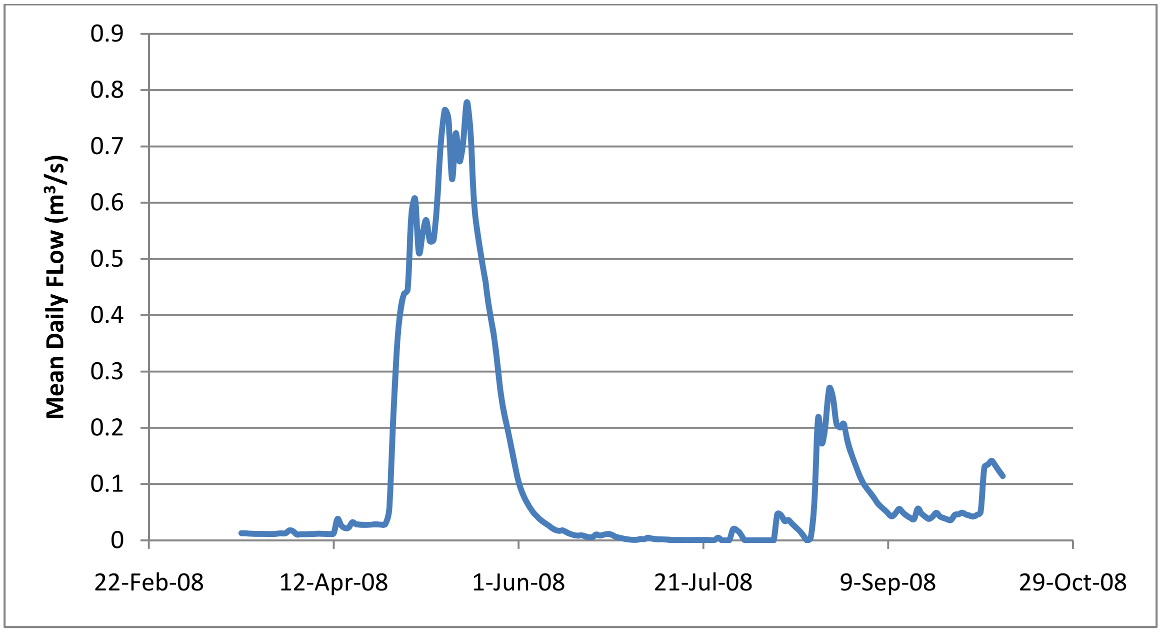


Figure 3.4 Measured Mean Daily Flow, Stream 53400, 2008

Stage discharge curves have been established for both lower and upper Stream 53400. The stage-discharge curve is an empirical relationship between water depth (stage) and discharge. The stage-discharge curve for lower Stream 53400 appears to have a change in slope of the stage-discharge relationship for lower flows (stage <0.20 m) and larger flows (stage >0.20 m). The stage-discharge relationship for upper Stream 53400 was developed using data from low-flow periods and, although robust rating equations were not developed, a rating curve was developed using the available data and best-fit (Rescan, 2009: Appendix 22, Figure 3.2-2).

3.2.4.2 Habitat Loss

The TSF effects on flows in Stream 53400 have been revised from the EAC Application to account for the modifications to the diversions during operations, the short closure period, and the revised groundwater seepage rates. The surface areas for Stream 53400, and the reductions at various stages of mine life, are summarized in Table 3.9.

Table 3.9 Summary of Area Reductions for Stream 53400 due to TSF

COMPONENT	Ha OF CATCHMENT FOR TIME (YEAR OF OPERATION)					
	Baseline	0-5	5-10	10-15	15-25	Closure
TSF	510	300	385	440	510	510
Seepage Ponds and Dams	205	205	205	205	205	205
TSF Diversion - primary	320	320	320	320	320	320
TSF Diversion – secondary		210	125	70	0	0
Downstream of TSF	315	315	315	315	315	315
Total area contributing	1350	950	755	700	360	1350
% of baseline flow	100	70	56	52	47	100

The % reduction in stream flow has been assumed to be 50% recognizing that the secondary diversions during operations may not be fully implemented, depending on the actual water balance for the project.

To quantify the habitat loss in the fish bearing portion of Stream 53400 the historic hydrology data was used to calculate summary statistics of baseline flows and depths which could then be compared with predicted flow reductions. Mean monthly flows were calculated using baseline conditions including catchment area, annual precipitation, runoff coefficient, and average monthly runoff as a percent of the annual flow. This resulted in a theoretical flow volume and average monthly runoff for Stream 53400 and the corresponding flow volume and depth from the Project-related 50% flow reduction (based on area reduction from Table 3.9). Figure 3.5 illustrates the natural conditions of Stream 53400 and show the abrupt increase of flow during freshet, reducing to no flow over summer with increases in the fall.

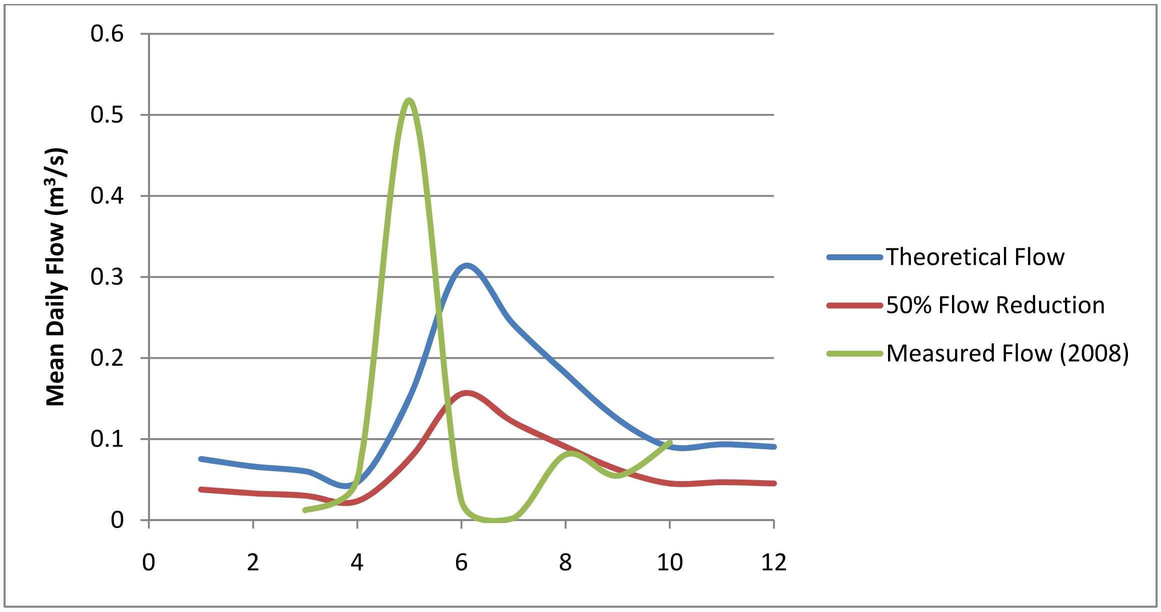


Figure 3.5 Measured Flow, Theoretical Flow and 50% Flow Reduction, Stream 53400

To determine what the reduced flow and corresponding depth equated to in terms of fish habitat area lost, the "Manning Equation" was applied. The Manning Equation is an empirical formula and is a function of the channel velocity, flow area and channel slope. The Manning Equation includes:

$$Q = VA = \left(\frac{1.00}{n}\right) A R_3^2 \sqrt{S}$$

Where: Q = Flow Rate (m^3/s);
V = Velocity (m/s);
A = Flow Area (m^2);
n = Manning's Roughness Coefficient;
R = Hydraulic Radium (m); and
S = Channel Slope (m/m).

Table 3.10 illustrates the output of the Manning Equation, which demonstrates the stream characteristics at differing discharges. For example, at a discharge of 125 L/s (approximately the average annual discharge for Stream 53400) the normal depth is 0.31 m, when the 50% reduction in flow is applied, the habitat will change to those characteristics applicable at a discharge of 50 L/s - 75 L/s, which reduces the depth to between 0.18 m and 0.23 m. When applying this to the width, a reduction of between 0.17 m and 0.26 m wetted width is observed.

Table 3.10 Rating Table from Manning's Equation for Stream 53400

DISCHARGE (L/s)	NORMAL DEPTH (m)	VELOCITY (m/s)	FLOW AREA (m^2)	WETTED PERIMETER (m)	TOP WIDTH (m)
25	0.12	0.07	0.37	3.33	3.23
50	**0.18**	**0.09**	**0.57**	**3.5**	**3.36**
75	**0.23**	**0.1**	**0.73**	**3.64**	**3.45**
100	0.27	0.11	0.88	3.76	3.54
125	0.31	0.12	1.02	3.87	3.62
150	0.34	0.13	1.15	3.97	3.69
175	0.38	0.14	1.27	4.07	3.75
200	0.41	0.14	1.39	4.15	3.82

In terms of relating this to fish habitat loss, the average wetted width will reduce from 3.6 m to 3.3 m (Table 3.11). The resulting loss to fish habitat is therefore approximately 540 m^2 or 5 m^2 of spawning habitat and 535 m^2 of rearing habitat (Table 3.11).

Table 3.11 Fish Bearing Habitat Loss Stream 53400 from 50% Flow Reduction

STREAM 53400	BASELINE AREA (m^2)	TOTAL AREA AFTER 50% FLOW REDUCTION (m^2)	LOST FISH HABITAT AFTER 50% FLOW REDUCTION (m^2)
	1800 x 3.6 = 6,480	**1800 x 3.3 = 5,940**	**540**
Fish-Bearing Habitat Loss (50% Flow Reduction)	Spawning (m^2)	Rearing (m^2)	Total Habitat (m^2)
	5	535	540

As the majority of habitat is utilized for rearing, with limited spawning, the habitat suitability for rainbow trout fry and juvenile rearing is considered. Rescan (2009) compiled Habitat Suitability Indices (HSI) for rainbow trout in the Project area (Rescan 2009: Volume III, Table 13.6-5), although the HSI is site specific and limited data could be applied. No preferred depths were provided in the HSI for rearing juveniles; however, a suitable thalweg depth for adults was provided which rated habitat between 0.25 m to 0.30 m as average, and depths ranging from 0.35 m to 0.45 m as excellent habitat. In central British Columbia, juvenile rainbow trout are reported to occupy runs with depths of <0.25 m with average water velocities of 0.2 m/s to 0.4 m/s (McPhail, 2007). It is considered that the resulting depths from the reduced flow into Stream 53400 will not preclude fish from accessing this habitat. If at the average annual flow, the depths reduce to between 0.18 m and 0.23 m it is within the range of preferred depth for rainbow trout of <0.25 m. Furthermore, these depths do not consider the smaller relative size of the rainbow trout encountered in this stream. It is, however, recognized that the reduced flow and lower depths will potentially alter the timing of the low flow events to occur sooner than under natural conditions.

In summary, construction of the TSF will result in the dewatering of an expected 540 m^2 of wetted fish habitat in Stream 53400 during mine operations, including 5 m^2 of spawning habitat. Fish access is not expected to be obstructed; however, the low flow periods may occur sooner than the natural hydrograph. The full extent of this loss will occur toward the end of mine life (Year 15-25; Table 3.9) when the TSF reaches capacity; however, the full extent of habitat loss is included in the overall habitat balance. Following mine closure, the catchment flow will be returned to Stream 53400.

3.2.5 Stream 6070 (aka Stream 10)

3.2.5.1 Baseline Condition

Stream 6070 is a tributary to Nakinilerak Lake and drains a small part of the proposed footprint of the north dam of the proposed TSF. Stream 6070 provides moderate value habitat for rainbow trout. Rescan (2010) sampled the lower reach of Stream 6070, which consisted of a series of wetlands below a beaver dam. Redside shiner's were the only fish captured and no fish were captured above the beaver dam in over 750 m of stream. It is however expected that the lowermost reach (~100 m) of the stream below the beaver pond and adjacent to Nakinilerak Lake provides suitable rearing habitat for juvenile rainbow trout (Table 3.12).

No fish have been captured upstream of the beaver pond likely due to the ephemeral nature of Stream 6070 during most months, with episodic flows only during spring freshet. The high gradient and relatively small discharge above the beaver ponds limit the suitability for juvenile trout rearing habitat and adult foraging habitat. Thick layers of organic material have accumulated behind the beaver dams in the upper sections of the stream. Table 3.12 summarizes the habitat characteristics of Stream 6070.

Table 3.12 Summary of Key Habitat Characteristics of Stream 6070

REACH	LENGTH (m)	SLOPE %	AVERAGECHANNEL WIDTH (m)	AREA (m^2)
1	~100	-	1.5	150
TOTAL				**150**

3.2.5.2 Habitat Loss

Stream 6070 drains a very small watershed that lies east of the Babine Lake drainage divide, the catchment area is 3.63 m^2 (Figure 3.1) and is one of the smaller catchments in the Project area, there is little water storage in this upland watershed (Rescan, 2010). The hydrograph for Stream 6070 (Rescan, 2009; Appendix 22; Figure 3.2-8) is similar to the other streams in the watershed, however the flows are only present during the freshet months. Similarly the observed monthly runoff depths in Stream 6070 show a peak in May (223 mm) which reduces substantially in June (20 mm) and the remainder of the year sees little to no flow (Rescan, 2009; Appendix 22; Table 3.2-2). Stream 6070 also has the lowest average annual discharge (10.6 L/s) of all streams in the Project area. As this stream only experiences freshet flows, Manning's Equation to calculate habitat reductions was not applicable. The beaver dams impound the water in the lower sections of the creek and the small reduction in catchment is not expected to affect the water levels in the beaver impoundments.

Construction of the TSF north dam and proposed seepage control (reclaim) dam will, however, displace a portion of the headwaters of Stream 6070 and potentially reduce the catchment area by up to 17%. This is recognized as having the potential to reduce fish habitat in the lower section of Stream 6070, and therefore the lower 150 m^2 is included in the habitat loss.

3.2.6 Morrison Lake Shoreline at the Diffuser and Water Supply Pipelines

The Morrison Lake shoreline at the proposed diffuser and freshwater supply pipeline provides high-value spawning habitat for coho and sockeye salmon, as well as suitable rearing habitat for juvenile fish. The shoreline consists of a shallow vegetated beach consisting of primarily gravel substrates (80%). During low water there is approximately 2 m (horizontal) of shoreline exposed which is comprised predominantly of rounded cobble and course gravel.

The freshwater and treated effluent pipelines will impact an estimated 350 m^2 (0.035 ha) of lake shore and shoal habitat on the east shoreline of Morrison Lake. The area of shoal habitat was calculated based on the area of lake shore and shoal habitat below the high water mark that will be overlain by the freshwater and treated effluent pipelines. No spawning habitat was observed at the diffuser and water supply pipeline location, this is confirmed by Bustard (2004) where sockeye beach spawning occurred along the lake shoreline immediately south of Creek 44800, which was the only location along the Morrison Lake shoreline where spawning was observed.

3.3 Fish Bearing Habitat Loss

Fish bearing habitat areas affected by the Project were assessed from historic data collected as part of the EAC Application and Addendum and additional field data collected during habitat assessments in 2009 and 2010. HADD's were calculated for the fish bearing sections of the streams that were directly affected by the Project footprint, or by reduced stream flows as previously described. Table 3.13 summarizes the fish habitat displaced by Project infrastructure and/or partial/full dewatering.

The total fish bearing loss from Project effects amounts to 1,251.5 m^2, including 9 m^2 of spawning habitat.

Table 3.13 Fish Bearing Habitat Displaced by Project Infrastructure or Partial/Full Dewatering

STREAM	LENGTH AFFECTED (m)	WIDTH LOST (m)	FISH HABITAT AREA LOST (m^2)	SPAWNING HABITAT LOSS (m^2)	FISH SPECIES	HABITAT TYPE	HABITAT QUALITY
Complete loss of fish-occupied habitat							
2900 (Mine area: MCS-5)	100	2.0	200	4	RB, CO	Rearing	Marginal
Partial loss of fish-occupied habitat							
25500 (mine area)	230	0.05	11.5	-	RB, CO	Rearing	Marginal
44800 (Mine area: MCS-6)	3,700	-	-	-	RB, CO	Rearing, spawning	Moderate
53400 (TSF: MCS-7)	1,800	0.4	540	5	RB	Rearing	Moderate
6070 (TSF: MCS-10)	100	-	150	-	RB, RSS	Rearing	Marginal
Diffuser pipeline & water supply pipeline			350	-	SO, CO, RB, OS	Lake bottom	High
Total							
Total Lost Habitat			**1,251.5**	**9**			

3.4 Non-Fish Bearing Habitat

Loss of "productive capacity" addresses the contribution of water, nutrients, and benthic invertebrates from first and second order tributaries into Morrison Lake and Nakinilerak Lake. The non-fish bearing habitat contributes to the productive capacity by transporting nutrients and benthic invertebrates with the stream flows. The contribution of nutrients will be reduced in proportion to the reduction in stream flows and based on a representative mass of nutrients per cubic meter of stream flow.

Nutrient Supply

> The 2009 Fish and Fish Habitat and Aquatic Resources Report (EAC Application Addendum Appendix AE) documents drift invertebrates in Stream 53400 in July 2009, and found that most drift items came from terrestrial origins (e.g. adult craneflies, blackflies, mosquitoes, midges and caterpillars), along with stream-origin (autochthonous) taxa such as mayfly and stonefly nymphs. There was little difference in the numbers or proportions of species in the drift samples from upper to lower sections of Stream 53400. The drift samplers were set in groups of three in the upper, middle and lower sections of the creek for about 3 to 3.5 hours and the nine (9) nets filtered from 20.2 m^3 to 110.6 m^3 of water during the sampling time.
>
> Average drift density (# organisms/m^3) was greater at the upper and middle sites than at the lower site. Densities ranged from 2.3 to 7.2 organisms/m^3 and the biomass ranged from 0.00025 to 0.0016 mg/m^3. For present assessment purposes, and in keeping with the results of the July 2009 field work, the higher figures will be used (i.e. 7.2 organisms/m^3 and 0.002 mg/m^3) to represent the numbers and biomass of nutrient materials entering the upper end of the fish-bearing reaches of Stream 53400.
>
> Drift invertebrate species richness ranged from 14 taxa at the lower site to 17 taxa at the mid and upper stations. In almost all samples, adult craneflies (Tipulidae) of terrestrial origin dominated the catch, followed by other dipteran chironomids (e.g. midges, mosquitoes, blackflies) and mayflies (Ephemeroptera). The terrestrial portion of the drift samples comprised 68 to 78% of the taxa caught in the nets, particularly adult

> craneflies and caterpillars. There was a gradual increase in the numbers of stoneflies, dipterans and mayflies from the upper to lower sections of the creek.
>
> Fish stomach content (diet) analysis in July 2009 showed few adult craneflies. Diptera (2-winged flies) and Lepidoptera (caterpillars / butterflies) and were the most abundant prey items of rainbow trout in Stream 53400. By weight, 65% of the stomach contents of rainbow trout (N=8) consisted of lepidopterans, while ephemeropterans showed 16% and unidentified insect parts 10%. Comparison of the stomach and drift samples showed some overlap in represented invertebrate groups, including ephemeroptera, lepidoptera, coleoptera (beetles) and dipterans; however, the large numbers of craneflies found in the drift samples were not reflected in the fish stomach samples.

In summary, the average productive capacity, measured as amounts of drift organisms produced, for the headwater tributaries and ponds in the Morrison Lake watershed is up to 7 organisms per cubic meter of stream flow. Based on the reduced flow in Stream 53400 and benthic drift data, the following assumptions were made; with the average annual flow of 114 L/s with a 50% reduction this results in (0.5x0.114 m^3/s x 7 organisms/m^3 of stream flow) a loss in the order of 12 million organisms per year into Morrison Lake from Stream 53400. It is considered that Stream 53400 provides the majority of benthic invertebrate input when compared with the other tributaries affected in the Project area (exclusive of Stream 44800).

3.5 Riparian Habitat

The loss of riparian habitat was calculated for stream habitat directly displaced by the Project. Stream 29000 is the only stream that will be completely disrupted by Project development, while the other streams are not considered to lose their riparian function due to reduced flows. Stream 53400 will have a minimum riparian flow of 50% of the baseline flows maintained throughout operations. A 30 m riparian buffer is standard forestry practice and was therefore applied (Ministry of Forests, 1998). Riparian habitat was therefore calculated using a riparian buffer of 30 m inland from each bank for the estimated length (450 m) of Stream 29000 to be lost. The approximate riparian loss is therefore estimated at 13,500 m^2.

3.6 Habitat Loss Summary

The total fish bearing habitat loss from Project effects amounts to 1,251.5 m^2 (0.12 ha), with a riparian loss of 13,500 m^2 (Table 3.14). The non-fish bearing habitat loss is considered here in terms productive capacity, which is quantified as the amount of drift organisms produced. It is estimated that the reduced contribution of benthic invertebrates to Morrison Lake will amount to a loss in the order of 12 million organisms per year. The habitat loss is summarized in Table 3.14 and the fish habitat compensation options are introduced in the following sections.

Table 3.14 Habitat Loss from Morrison Copper/Gold Project

<table>
<tr><th>FISH HABITAT</th><th colspan="2">LOSS</th></tr>
<tr><td rowspan="2">Fish Bearing Area Losses (HADDs) in Morrison Lake Tributaries</td><td colspan="2">1,251.5 m^2</td></tr>
<tr><td>9 m^2 Spawning</td><td>1,242.5 m^2 Rearing</td></tr>
<tr><td>Non-fish bearing Productive Capacity Loss in Morrison Lake Tributaries</td><td colspan="2">12 million organisms</td></tr>
<tr><td>Riparian Area Losses – fish bearing</td><td colspan="2">13,500 m^2</td></tr>
</table>

4. FISH HABITAT COMPENSATION PLAN

The FHCP for fish-bearing habitat was developed to replace the loss of 1,251.5 m^2 of rainbow trout and coho salmon rearing and spawning habitat at a 3:1 ratio and provide a "no net loss of productive capacity" within Morrison Lake and its tributaries.

The FHCP for barren (non-fish bearing) habitat was developed to replace the loss of productive capacity provided by the nutrient loads from the non-fish bearing streams and lakes in the Project area to Morrison Lake. The FHCP is based on increasing fish biomass by enhancing fish access to food-production habitat and to high quality spawning, rearing, and overwintering habitat in presently inaccessible aquatic habitat in Olympic Creek and Olympic Lake.

The FHCP meets the goal of compensating for lost fish-bearing habitat and barren habitat while minimizing the risk through long-term adaptive management, which is discussed in the below.

4.1 Compensation Options

Several options were screened to provide the best combination of engineering feasibility, compatibility with regulatory objectives, LBN preferences, and biological relevance. Two of the five options (presented in Figure 4.1) were selected as compensation for the HADD of fish habitat and productive capacity:

- Fish Bearing Habitat - Creation of two off-lake spawning and rearing channels adjacent to Morrison Lake to compensate for HADDs; and
- Non-fish Bearing Habitat - Enhancement of rainbow trout and coho salmon spawning and rearing habitats in Olympic Creek and access improvements between Olympic Lake and Morrison Lake to compensate for reduction in productive capacity due to loss of aquatic habitat.

MORRISON COPPER-GOLD PROJECT

FISH HABITAT COMPENSATION OPTIONS

Habitat	Habitat Area
Fish Bearing Impacts	1,251 m^2
Non-Fish Bearing Impacts	27.5 ha

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FIG 4.1

The general locations of the compensation sites are shown in Figure 4.2.

4.2 Fish Bearing Habitat Compensation

To compensate for the unavoidable HADDs of fish-bearing habitat, PBM has chosen to create two off-lake spawning, rearing and overwintering channels at the southeast end of Morrison Lake. Construction of the off-lake channels will include the following activities:

- Excavating 4 m to 6 m wide by 2 m to 5 m deep, meandering channels with trapezoidal cross-sections adjacent to Morrison Lake. Each channel will extend for approximately 600 m in length and be fed by lake water and surface water flows from nearby tributaries. The channels will connect to Morrison Lake by openings at the north and south ends.

- Lining the newly-created channels with a 25 cm layer of clay, rock fabric, and heavy duty pond liner to prevent excess silt and sedimentation from the walls of the new channels, and percolation of surface water into underlying substrates.

- Placing a 10 cm to 20 cm layer of spawning substrate within the new alignments. Spawning substrate will be composed of rounded, screened and washed, non-crushed gravel and cobble ranging in size from 1.0 cm to 8.0 cm in diameter.

- Excavating 2 to 3 pools up to 5 m deep in each channel at channel meanders to provide rearing and overwintering habitat for juvenile fish.

- Placing 60 large woody debris (LWD) and root-wad structures, and 30 boulder clusters within each newly constructed channel.

- Plantings live-cuttings of willow stakes and riparian vegetation salvaged from the Project footprint along the newly created channels to provide nutrient input and regulate summer water temperatures. This will serve to contribute to lost riparian habitat from Project development.

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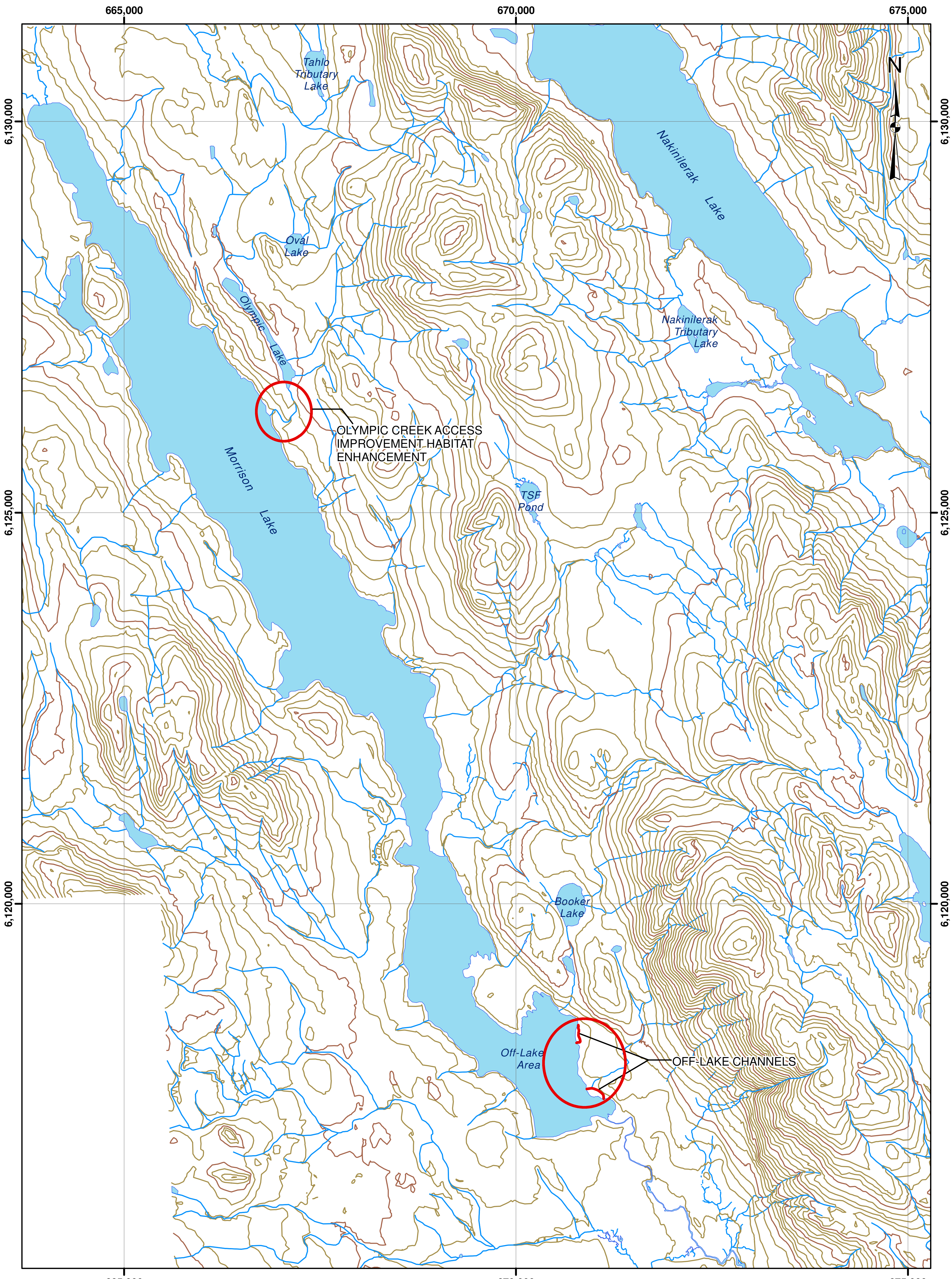

Major Contours

Minor Contours

Rivers and Streams

Lakes and Ponds

Notes:
1. UTM Zone 9N, NAD83
2. Contour interval is 20m.
3. Map data is BC TRIM (1:20,000)

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PROJECT
MORRISON COPPER/GOLD PROJECT

TITLE
FISH HABITAT COMPENSATION PLAN MAP

PROJECT No. M09382A04

FIG No. 4.2

4.2.1 Rationale

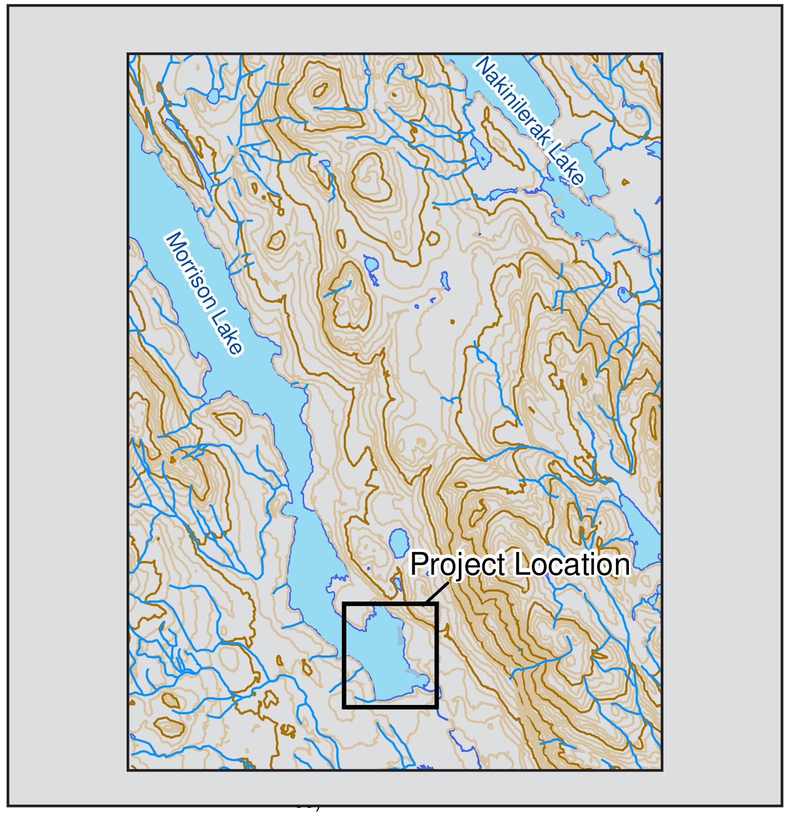
The off-lake channel compensation increases rearing and overwintering habitat and provides spawning habitat at the inlet and outlet of the channels for rainbow trout and other salmonids in the Project area. The low topography and extended flood plain on the southeast end of Morrison Lake provides an ideal opportunity to create off-channel rearing channels.

The channels will be used primarily as high value rearing, foraging and overwintering habitat by juvenile rainbow trout, and will be used by other life stages of other salmonids in Morrison Lake. The channels will also provide spawning habitat for rainbow trout and potentially other Morrison Lake salmonids. Pools will be excavated and boulder clusters constructed of clean, large diameter material, thus introducing large interstices between rocks to function as additional refugia for small fish. Boulder clusters combined with LWD will improve rearing habitats by adding cover and physical diversity (morphologic and hydraulic) to the off-channel habitat. Spawning gravels will be placed at the inlet and outlet of the off-channel habitat with additional pockets added at select locations within the channel.

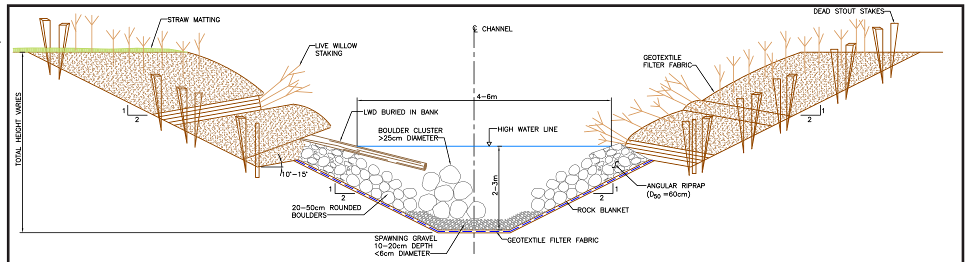
Replanting of riparian vegetation along the new channels is expected to provide riparian cover and shade for juvenile salmonids in addition to reducing potential for bank erosion. Riparian plantings will also introduce an additional source of food and nutrients to the Morrison Lake ecosystem, and serve to replace lost riparian habitat from the displacement of Stream 29000.

The compensation design for the off-lake channels at Morrison Lake is shown on Figure 4.3, Figure 4.4 and Figure 4.5. The total expected increase in high value, perennial rearing habitat in the Morrison Lake off-channel habitat will be up to 3,700 m^2, with the replacement of at least 30 m^2 of spawning habitat. The current design shown in Figure 4.4 includes in the order of 200 m^2 of spawning gravels at the inlet and outlet, which is an over estimate of the amount of spawning habitat to be created in these channels.

The off-lake channel fish habitat compensation features described above will not affect navigation on Morrison Lake.



Notes:
1. UTM Zone 9N, WGS84
2. Imagery from Google Earth
3. Waterbodies from NTS (1:50,000)



TYPICAL SPAWNING AND REARING CHANNEL CROSS SECTION
N.T.S

CLIENT	PROJECT
pbm	MORRISON COPPER/GOLD PROJECT
Klohn Crippen Berger	TITLE: OFF-LAKE CHANNEL LOCATIONS
	PROJECT No. M09382A04 — FIG No. 4.3

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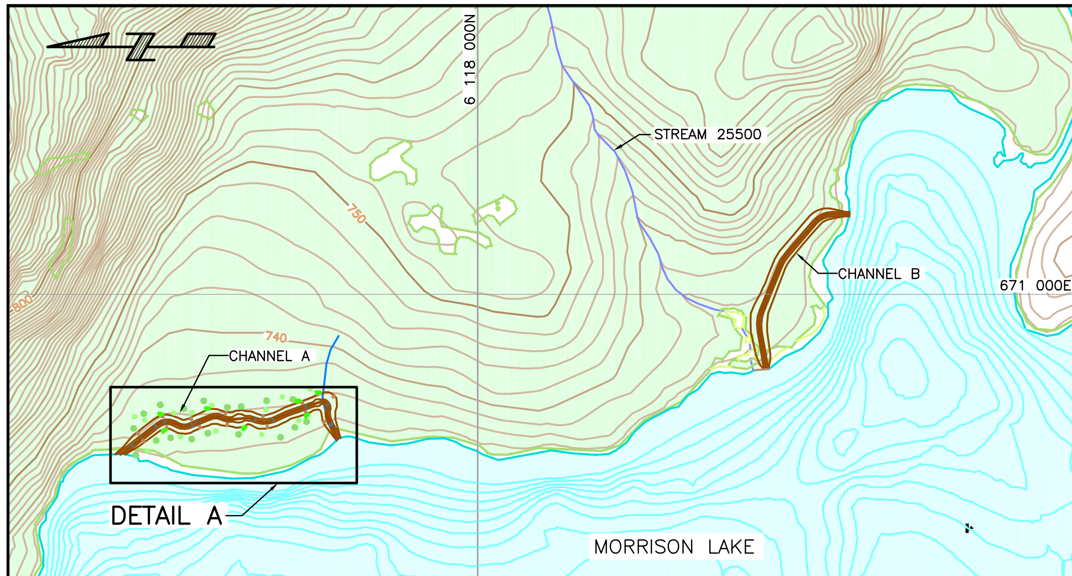
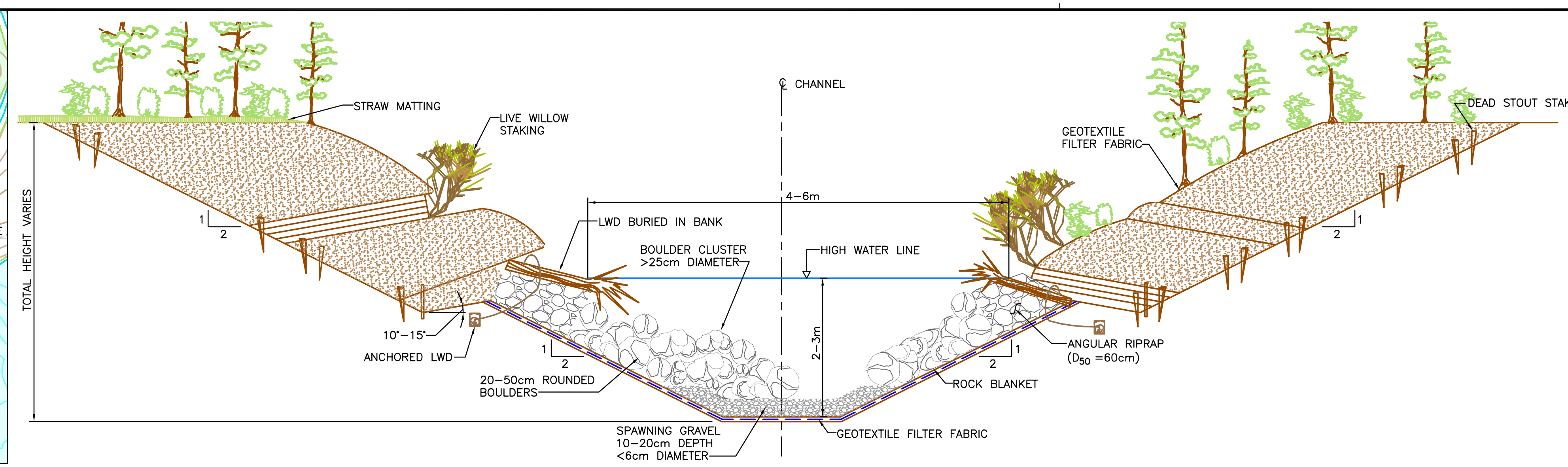


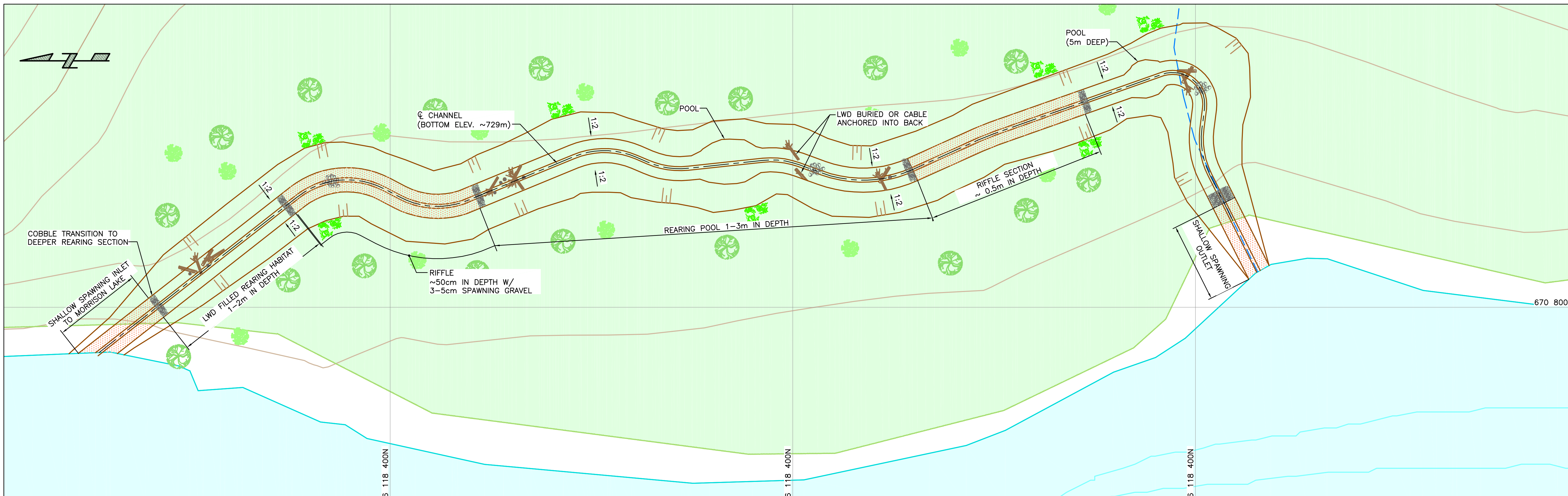
LOCATION PLAN OF OFF LAKE CHANNELS

0 200 m



TYPICAL SPAWNING AND REARING CHANNEL CROSS SECTION

N.T.S



DETAIL A

PLAN VIEW OF OFF–LAKE CHANNEL A

0 20 m

NOT FOR CONSTRUCTION

NOTES:

1. SURFICIAL TEST PITS PERFORMED IN CHANNEL AREA INDICATES CLAY TO A DEPTH OF 0.45m.

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SCALE AS SHOWN

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MORRISON COPPER/GOLD PROJECT
FISH HABITAT COMPENSATION PLAN

TITLE

DETAIL OF OFF–LAKE CHANNEL

PROJECT No. M09382A04

FIG. No. 4.4

KCR-DM

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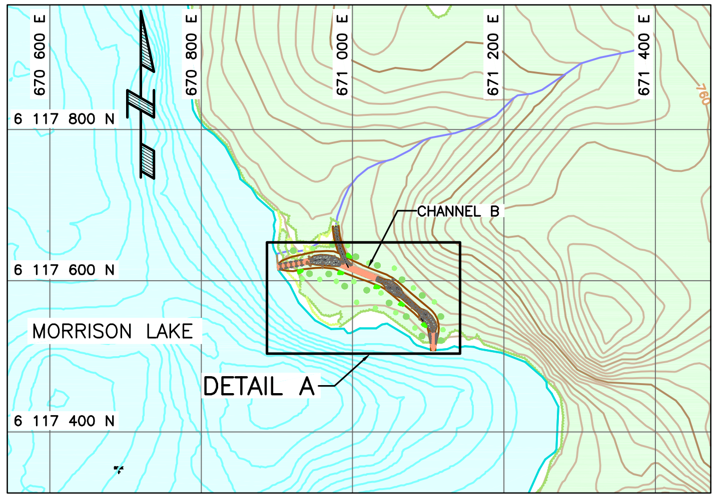
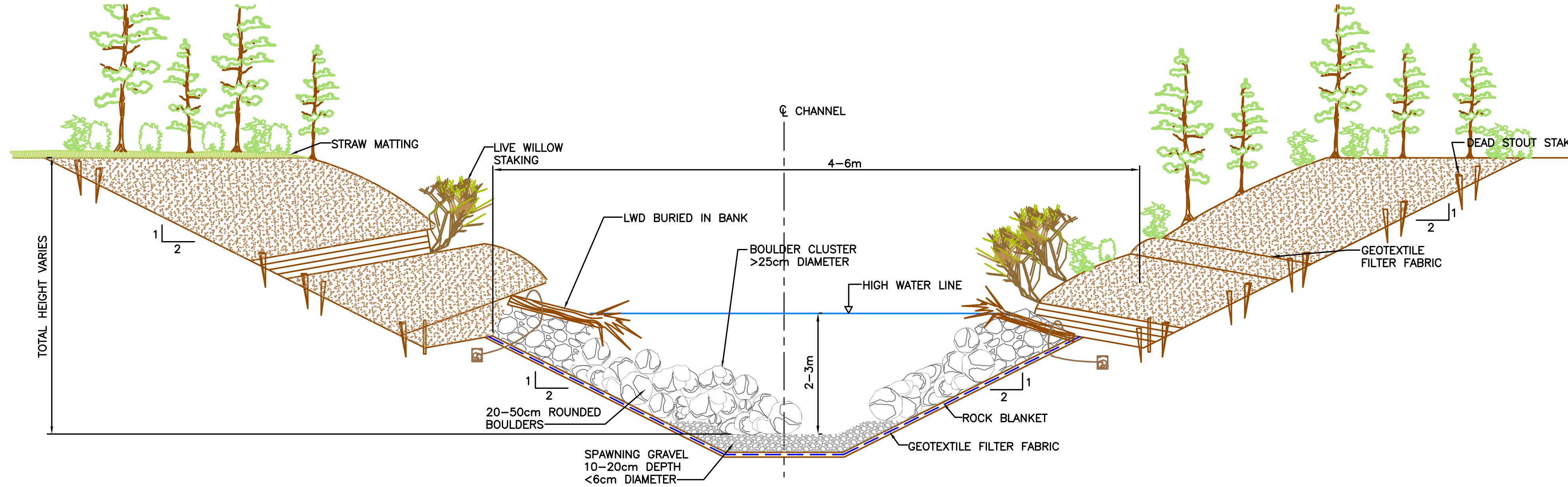
Date: 3/21/2011
Scale: 1=10(PS)
Drawing File: M:\VCR\M09382A04 – Morrison EAC Support\400 Drawings\FIG 4.4.dwg
Xrefs: BM–Morrison Copper–Jan10

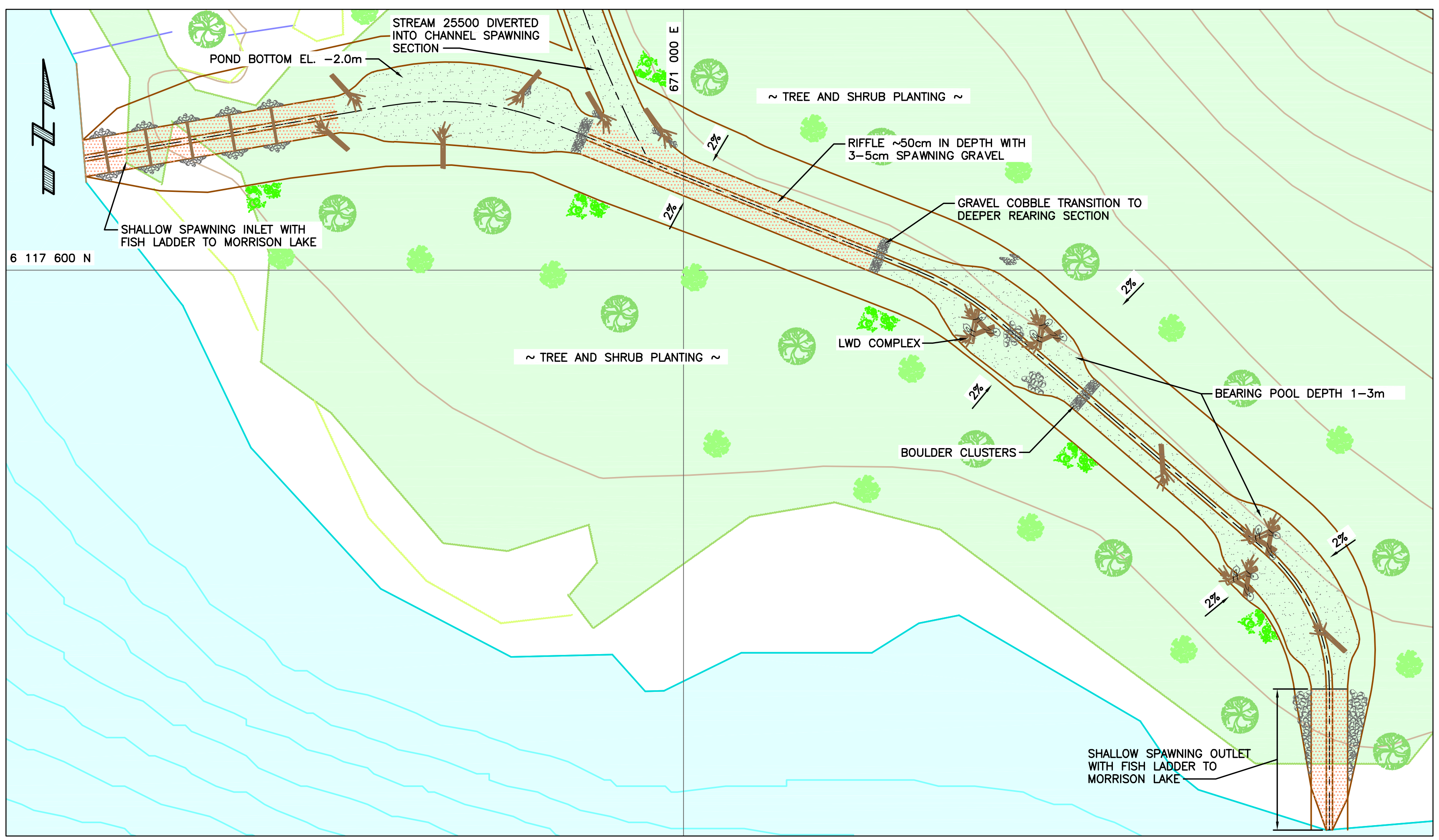


LOCATION PLAN OF OFF LAKE CHANNELS



TYPICAL SPAWNING AND REARING CHANNEL CROSS SECTION

N.T.S



DETAIL A

PLAN VIEW OF OFF–LAKE CHANNEL B

0 20 m

NOTES:

1. SURFICIAL TEST PITS PERFORMED IN CHANNEL AREA INDICATES CLAY TO A DEPTH OF 0.45m.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN REPORT DATED ____________

SCALE AS SHOWN

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT: pbm

Klohn Crippen Berger

PROJECT: MORRISON COPPER/GOLD PROJECT FISH HABITAT COMPENSATION PLAN

TITLE: DETAIL OF OFF–LAKE CHANNEL

PROJECT No. M09382A04

FIG. No. 4.5

KCR-DM

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Date: 3/21/2011
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Drawing File: M:\VCR\M09382A04 – Morrison EAC Support\400 Drawings\FIG 4.5.dwg
Xrefs: FISH HABITAT PLAN, BM-Morrison Copper-Jan10

4.2.2 Existing Conditions in the Off-Lake Channel Area

The proposed off-lake channel area consists of predominantly mature forest of sub-alpine fir (*Abies lasiocarpa*), white birch (*Betula papyrifera*) and white spruce (*Picea Glauca*) up to 30 cm in diameter. Understory vegetation consists of Devil's club (*Oplopanax horridus*), sword fern (*Polystichum* munitum), bracken fern (*Pteridium aquilinum*), bunchberry (*Cornus Canadensis*), and a variety of mosses and lichens.

Site topography is relatively flat between the shoreline and the 50 m riparian offset. The general slope of the area trends towards the lake from 5% to more than 10%. Test pits completed with a hand auger to 1.5 m in depth indicate a top 30 cm to 50 cm of organic soil underlain by firm clay down to 1 m. Soils at 1.0 m to 1.5 m were composed predominantly of gravelly till with some groundwater infiltration. Two small tributaries near the proposed off-lake channels are aligned east-west and enter Morrison Lake through undefined wetland-fen channels.

The shoreline and littoral zone of Morrison Lake at the inlet/outlet of the proposed off-lake channels is comprised of cobble and large boulders. Shoreline vegetation provides rearing habitat for smaller fish species.

4.2.3 Design Details

The rearing channels will be excavated parallel to the lake shore 50 m inland (except where they enter Morrison Lake) in an effort to maintain the riparian vegetation along Morrison Lake. The channels will be excavated in a meandering pattern to allow for maximum channel length in the available area. Surface water flows from nearby tributaries will be tied in to the newly constructed channels to provide a constant influx of freshwater. Spawning riffles will be created at the inlet and outlet of the channels with additional riffles within the channels if the flows prove to be adequate.

Channel excavation will be completed using one or more excavators (an EX 270 LC, EX 150 or equivalent) to dig a sinusoidal channel 50 m inland and parallel to the Morrison Lake shoreline. The excavated channel will be trapezoidal in cross-section at a 2:1 slope. The channels will be excavated at varying depths to include shallow spawning areas and deeper pool habitats. Construction of a temporary access road along the east side of the proposed channels will be required to facilitate channel construction and placement of habitat features.

The channels will be subject to variations in water levels associated with freshet and low flow conditions in the lake and in the creeks, and the new channels will be engineered to accommodate these flow regimes. Due to natural fluctuations in water levels of Morrison Lake, a fish ladder constructed at the entrance of the channel inlets and outlets will allow fish passage into the channel during spawning.

The constructed fish habitats will be designed to emulate natural structures and habitat features in Morrison Lake, Morrison River, and other tributaries. The majority of the channel excavation will be conducted outside of the 50 m riparian buffer of Morrison Lake except where the inlets and outlets of the new channels enter the lake.

Soil stockpiles, trees and shrubs removed from the newly excavated channels will be retained at the site for re-vegetation of the newly constructed channel banks. All vegetation areas disturbed by fish habitat compensation construction activities will be re-vegetated with native vegetation salvaged from the excavated channels and other Project areas.

Upon completion of channel excavation and vegetation salvage, the channels will be lined with a combination of clay, geotextile filter, rock fabric, and pond liner to reduce the likelihood of excess silt and sedimentation as well as sub-surface flow within the constructed channels). Clean spawning gravels will then be placed at a depth of 10 cm to 20 cm to serve as spawning habitat in the system.

From the access road, an excavator with a long-arm can then position LWD complexes and boulder clusters evenly within the channels. LWD complexes will be comprised of 2 to 3 logs positioned in a triangular fashion and buried or securely anchored into the spawning channel berm. Deeper pool habitats within the channels will be complexed with single logs and rootwads entrenched within the channel berm. All LWD complexes will extend into the wetted perimeter of the channel to serve as refugia for juvenile fish.

Upon completion of the channels soil will be carefully placed above the high water line on the edge of the channels, entrenched and secured with geo-textile fabric or coco-matting, and angular boulders (if necessary). Lastly, the channel banks and access road will be re-vegetated with willow staking and plants salvaged from site. The site will then be covered with straw matting as a temporary erosion and sediment control measure.

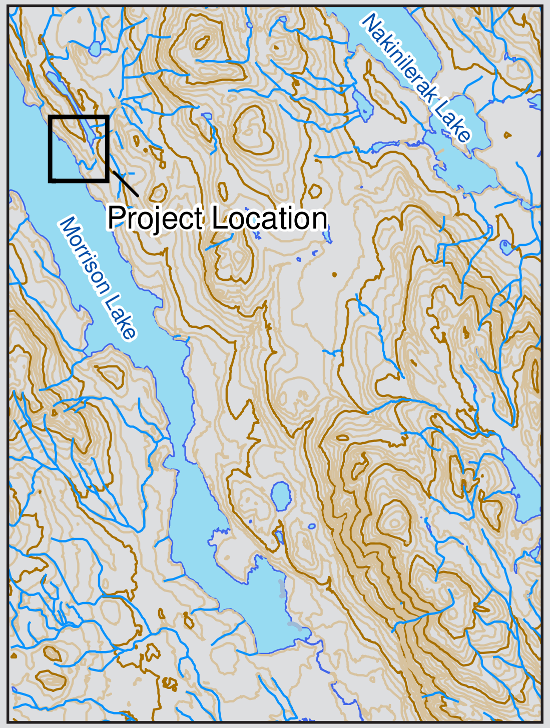
Once the fish habitat features of the channels are in place, the channels can be permanently flooded with lake water by carefully removing the earthen plugs and/or sand bags at the inlet and outlet of both channels. Morrison Lake tributaries tied into the new channels, as well as groundwater, will provide flow-through while the water depth in the channels will be mainly controlled by the water levels in Morrison Lake.

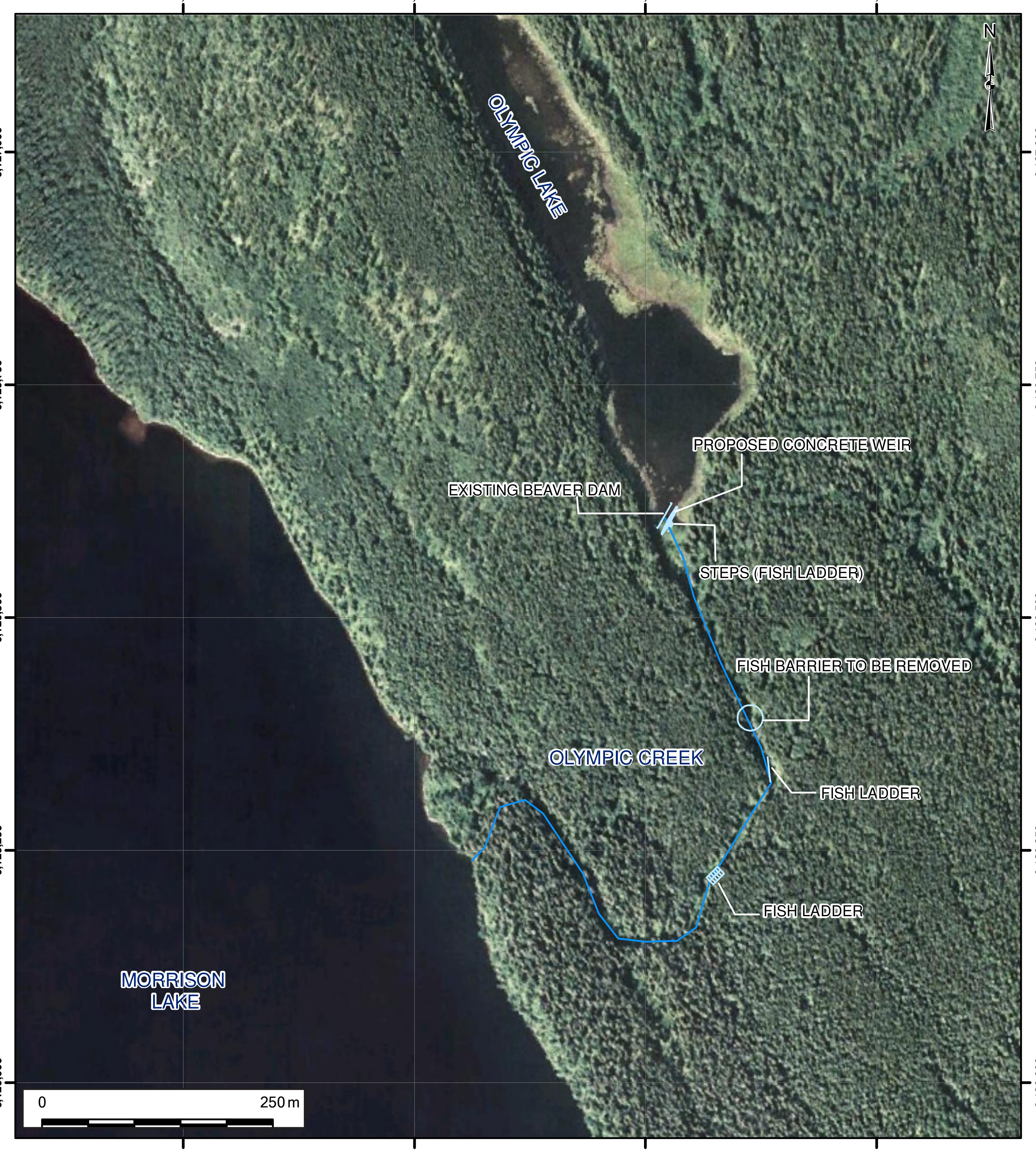
4.3 Productive Capacity Compensation for (Non-fish Bearing Habitat)

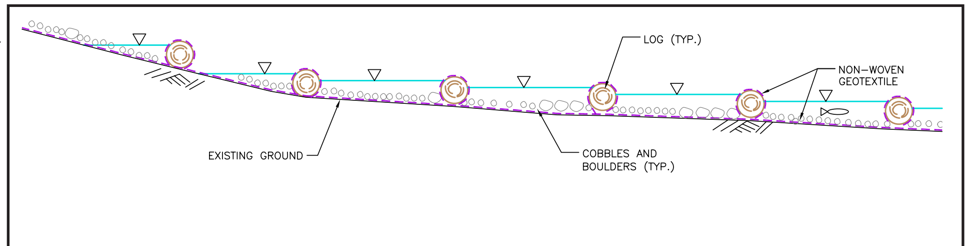
The compensation plan for the loss of productive capacity of the non fish-bearing habitats to be displaced is to enhance fish access between Morrison Lake and Olympic Lake by improving fish habitat and fish access in Olympic Creek and to construct a fish ladder and control weir on Olympic Lake.

The works are shown on Figure 4.6 and includes the following:

- Removal of existing beaver dams, flood-deposited boulders, cobbles, gravels, and LWD that currently preclude, or greatly impede, upstream fish migration from Morrison Lake to Olympic Lake, as well as the recruitment of trout downstream to Morrison Lake;
- Re-alignment and lining of the Olympic Creek channel at specific sites to improve base-flow conditions and enhance year-round fish access;
- Construction of pool-riffle sequences, installation of LWD and boulder clusters, and augmentation of the gravel substrate to improve in-stream fish habitat, upstream access, channel stability, energy dissipation, and reduce movement of sediment bedload;
- Installation of 2 to 3, ~2 m high fish ladders at existing waterfall fish barriers within Olympic Creek to improve fish access; and
- Construction of a 1.5 m high weir and accompanying fish ladder at the outlet of Olympic Lake to maintain lake levels, control stream discharge, maintain base flows within Olympic Creek, and improve conditions for fish migration between the lakes.







TYPICAL FISH LADDER DESIGN
NTS

Notes:
1. UTM Zone 9N, WGS84
2. Imagery from Google Earth
3. Waterbodies from NTS (1:50,000)

CLIENT

pbm

Klohn Crippen Berger

PROJECT	MORRISON COPPER/GOLD PROJECT
TITLE	OLYMPIC CREEK FISH ACCESS ENHANCEMENT MAP
PROJECT No. M09382A03	FIG No. 4.6

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4.3.1 Existing Conditions in Olympic Lake and Olympic Creek

Currently, the majority of habitat in Olympic Creek is comprised of run-pool habitat and small plunge-pools within a deeply incised low gradient channel. Channel morphology in Olympic Creek between Morrison Lake and Olympic Lake is characterized by a "V-shaped" channel profile, with an excess of flood-deposited boulder/cobble substrates and LWD blocking the main channel. Most of the available habitat in Olympic Creek lacks important pool-riffle sequences preferred by rainbow trout. Olympic Creek flows sub-surface during summer and fall months, limiting access to upstream habitat. Moreover, fish migration between Olympic Creek and Olympic Lake is precluded by multiple beaver dams across the main channel at the outlet of the lake.

Olympic Lake is a 17.1 hectare beaver controlled lake that currently supports a small isolated population of rainbow trout. Substrates are composed of silt and organics within a flooded forest wetland fen habitat.

4.3.2 Rationale

The aim of the FHCP, for the impacts to non-fish bearing streams and lakes, is to increase the productive capacity of the Morrison Lake watershed. Enhancements to Olympic Creek by removing excess bedload, creating pool-riffle sequences, placing LWD and boulder clusters, and installing weirs and fish ladders at potential fish barriers will provide greater access to Olympic Lake and Olympic Creek. Specifically, this will include enhanced access to 171,000 m^2 + 1,265 m^2 = 172,265 m^2 of productive fish habitat that is presently a highly productive and under-utilized source of food and nutrients in the Morrison Lake system.

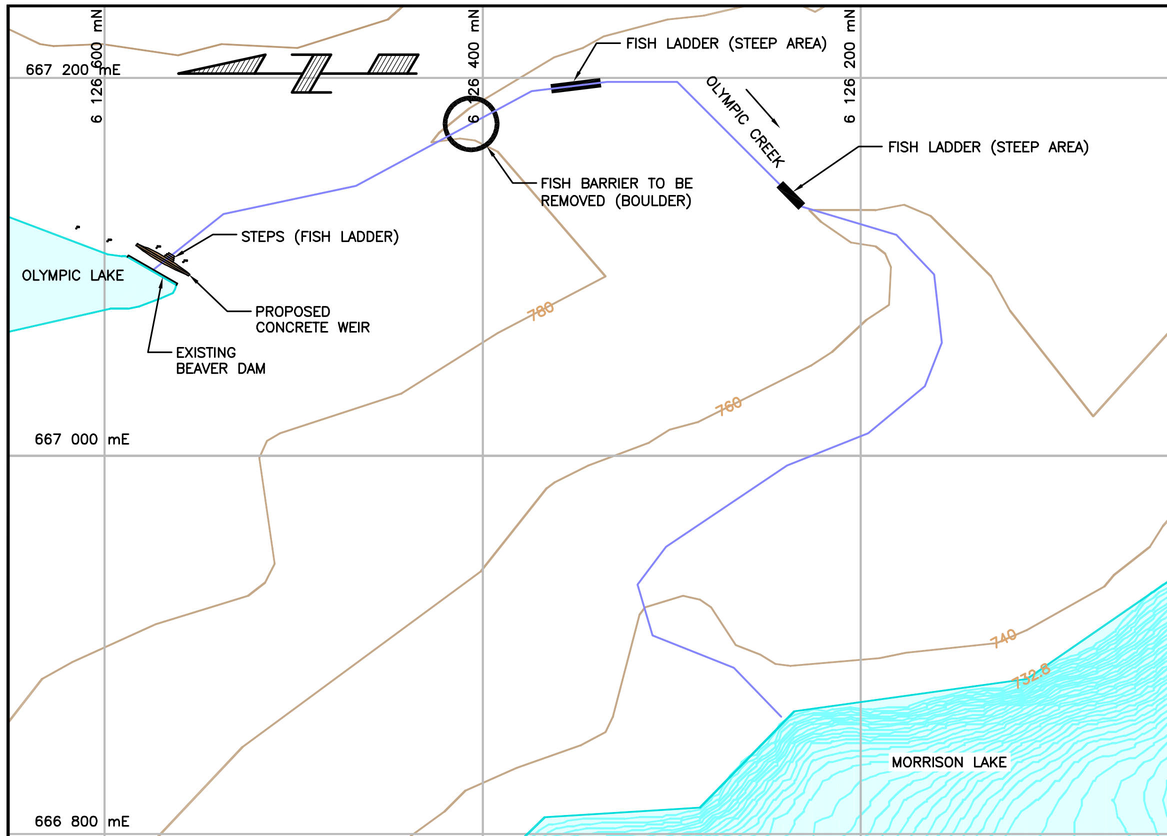
Placement of boulder clusters and LWD structures in Olympic Creek will increase the abundance of juvenile rainbow trout by providing higher value spawning and rearing habitat than that which currently exists. Boulder clusters and LWD structures will provide a greater diversity in water depths and velocity and provide cover and refuge areas for fish. Pool-riffle sequences within Olympic Creek will increase the density and depth of pools and cover available, and greatly improve access to higher value overwintering habitat in Olympic Lake. The proposed fish weir at the outlet of Olympic Lake will provide a more stable and permanent lake level with better access for fish. Fish ladders at natural fish barriers in Olympic Creek will encourage fish migration to high-value habitats upstream.

The Olympic Creek compensation will provide access to productive lake habitat that is currently underutilized while enhancing the stream habitat. Opportunities exist for increased fish access to habitats upstream of Olympic Lake, which could be a consideration in future planning, if needed. Improving access to Olympic Lake and enhancing the habitat in Olympic Creek is designed to greatly increase the productive capacity of this system and thus improve fish production in the entire Olympic Lake system.

Figure 4.6 to Figure 4.8 illustrate the proposed fish habitat enhancements to Olympic Creek and the Olympic Lake outlet.

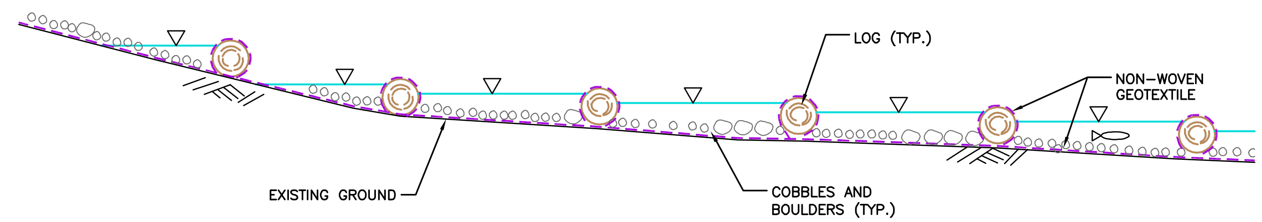
4.3.3 Design Details

The Olympic Creek and Olympic Lake fish weir and ladders will involve construction of a weir to replace the beaver dam controlling the lake level and thereby maintain the lake level / volume, while allowing fish access via a built-in fish-way of several steps (Figure 4.7). The weir will maintain a relatively constant full-pool volume and permanent lake environment.



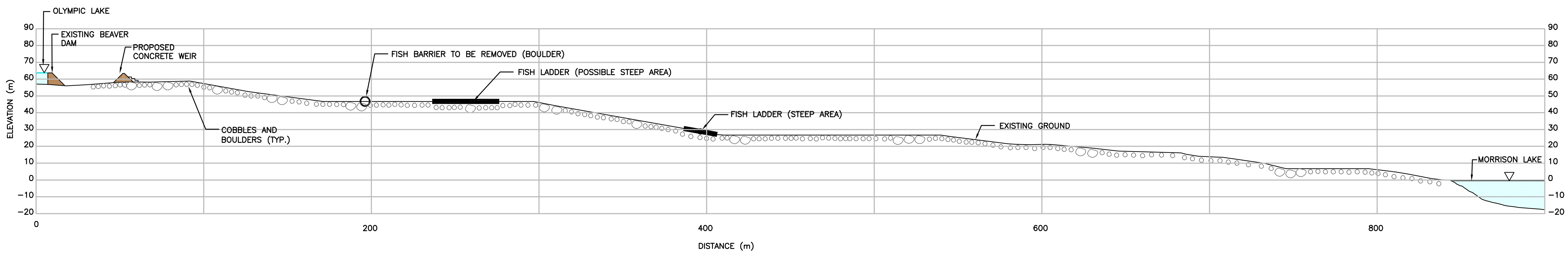
PLAN

SCALE A



TYPICAL FISH LADDER DESIGN

NTS



PROFILE OF OLYMPIC CREEK

SCALE B

NOTES:

1. ALL TOPOGRAPHY IS BASED 20 m CONTOUR INTERVAL, PRODUCED FROM AERIAL PHOTOGRAPHY FLOWN IN SEP, 2003 AND COMPILED BY EAGLE MAPPING LTD.
2. DATUM IN UTM NAD83, ZONE 9.
3. COORDINATES AND ELEVATIONS SUBJECT TO CHANGE AFTER SURVEYING.
4. FISH LADDERS WILL BE CONSTRUCTED AS REQUIRED TO REDUCE CHANNEL SLOPES TO LESS THAN 20 %.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED ________

SCALE B 0 62.5 m

SCALE A 0 100 m

CLIENT

pbm

Klohn Crippen Berger

PROJECT

MORRISON COPPER/GOLD PROJECT

TITLE

FISH OLYMPIC CREEK ACCESS WORKS

PROJECT No. M09382 A04

FIG. No. 4.7

KCB-R-MLD

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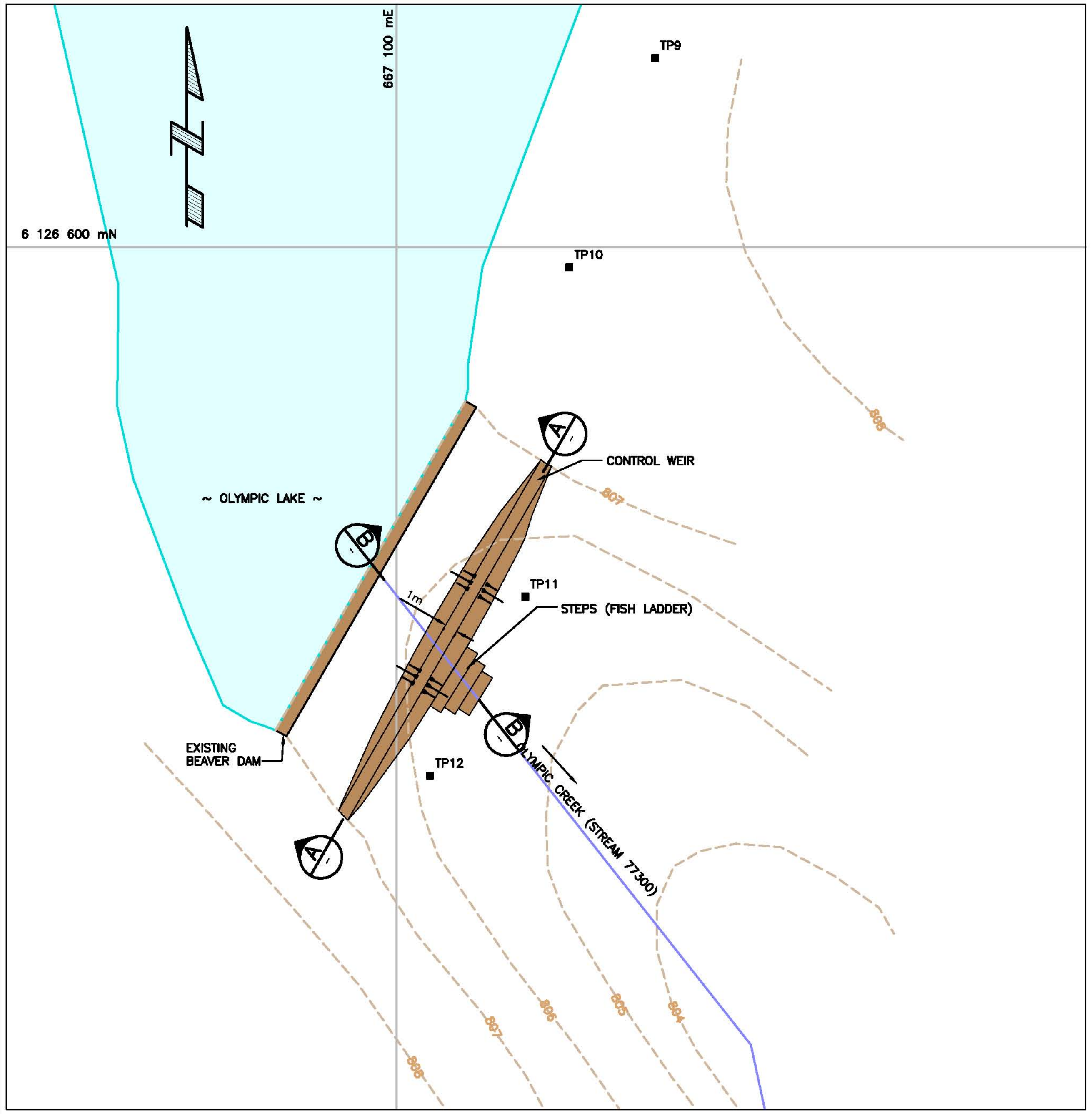
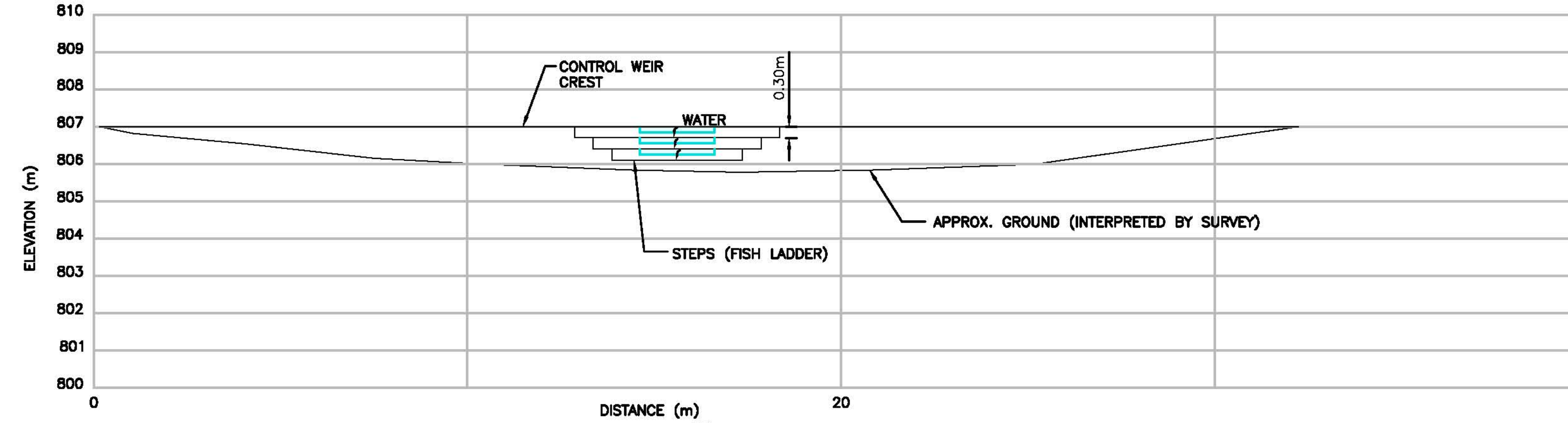
Date: 3/21/2011
Scale: 1=1(PS)
Drawing File: M:\VCR\M09382A04 - Morrison EAC Support\400 Drawings\FIG 4.7.dwg (jrg)
Xrefs: BM-Morrison Copper-Jan10



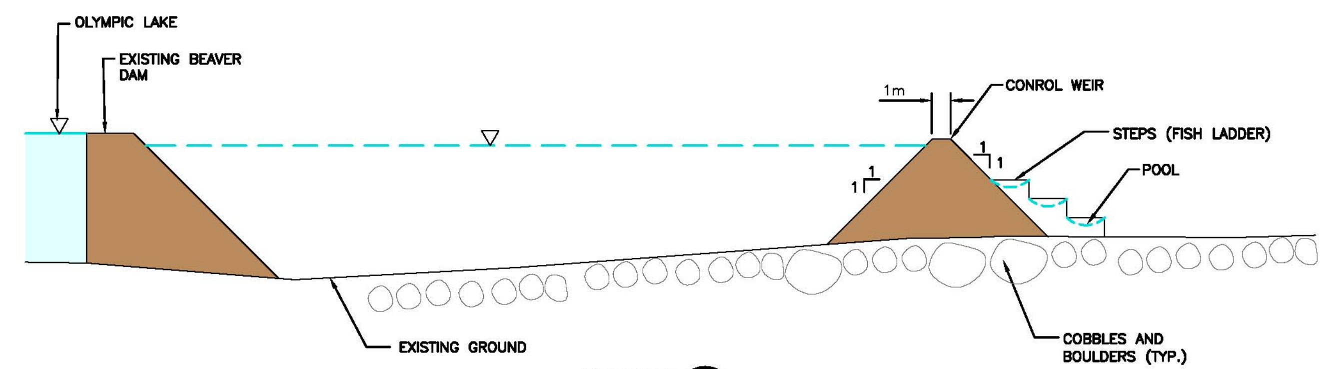
PLAN

SCALE A



SECTION A

SCALE B



SECTION B

NTS

LEGEND

TP9 2010 TEST PIT (APPROXIMATE LOCATION)

NOTES:

1. CONTOUR IS INTERPRETED FROM FIELD MAPPING POINTS BY KCB, SEPT, 2010.
2. DATUM IN UTM NAD83, ZONE 9.
3. ELEVATION ARE APPROXIMATED FROM TRIM DATA.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED ________

SCALE B 0 — 5 m

SCALE A 0 — 12.5 m

CLIENT: pbm

Klohn Crippen Berger

PROJECT: MORRISON COPPER/GOLD PROJECT

TITLE: OLYMPIC CREEK PROPOSED FISH LADDER AND CONTROL WEIR

PROJECT No.: M09382 A04

FIG. No.: 4.8

KCB-R-MLD

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Date: 3/21/2011
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Drawing File: M:\VCR\M09382A04 - Morrison EAC Support\400 Drawings\FIG 4.8.dwg
Xrefs: BM-Morrison Copper-Jan10

Site specific design features for the Olympic Creek LWD additions include:

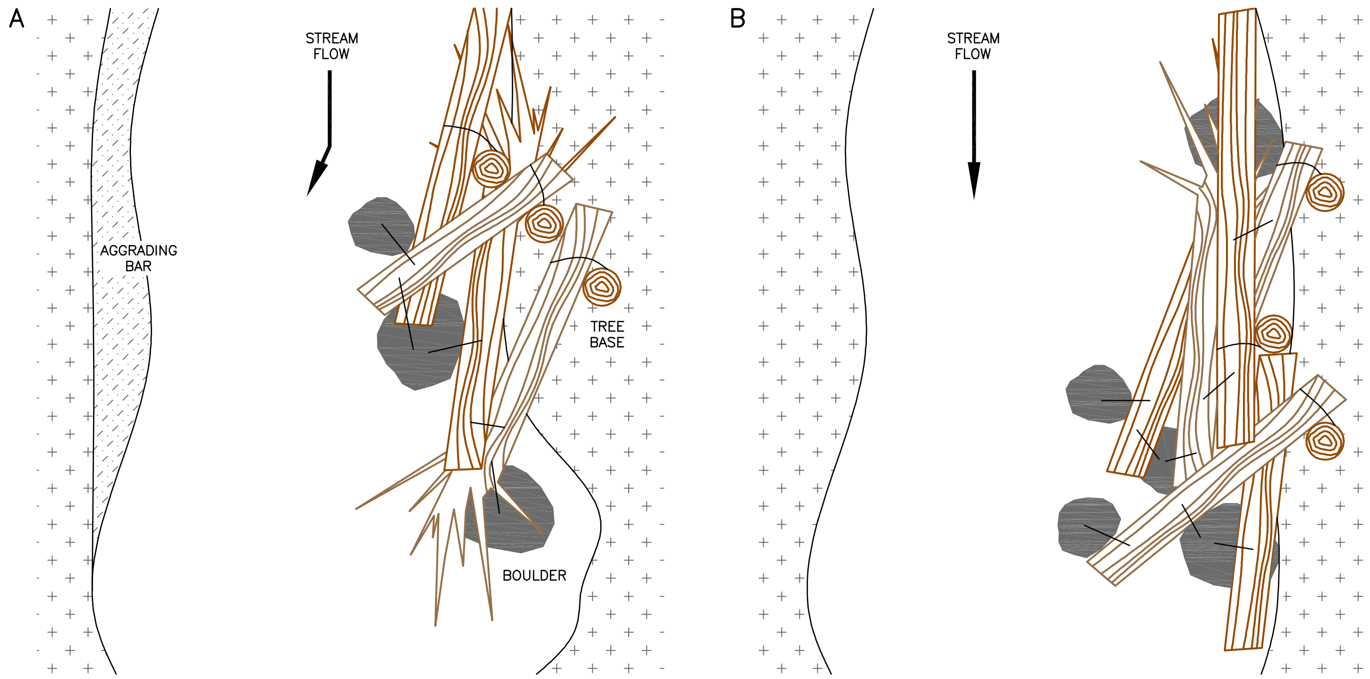
- Using suitable dead native trees (*e.g.* white spruce) including rootwads, branches, and trunks for LWD ballasting (Figure 4.9).
- Placing trees singly or in triangular arrangement such that trees angle downstream and down slope from the bank to increase stability and cover at various flows.
- Ballasting of LWD structures, as necessary, with the appropriate size, weight, and number of boulders using guidelines outlined in Slaney et al. (1997).

Site specific design features for the Olympic Creek boulder cluster installations include:

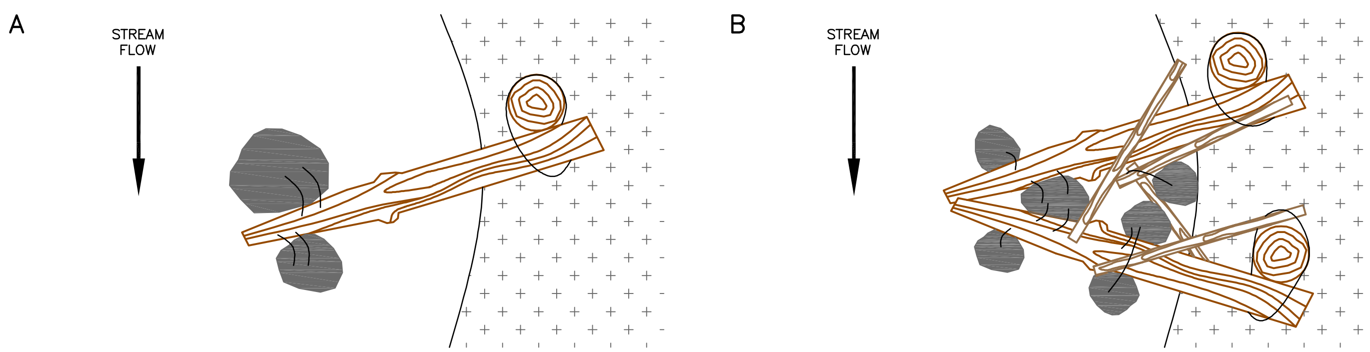
- Using native angular boulders with average diameters of 400 mm to 700 mm.
- Embedding boulder clusters in native substrates and arranging them in diamond-shaped upstream and downstream “V” arrangements, to occupy <1/3 of channel width (Figure 4.10).

Site specific design features for the construction of Olympic Creek riffle-pool sequences include:

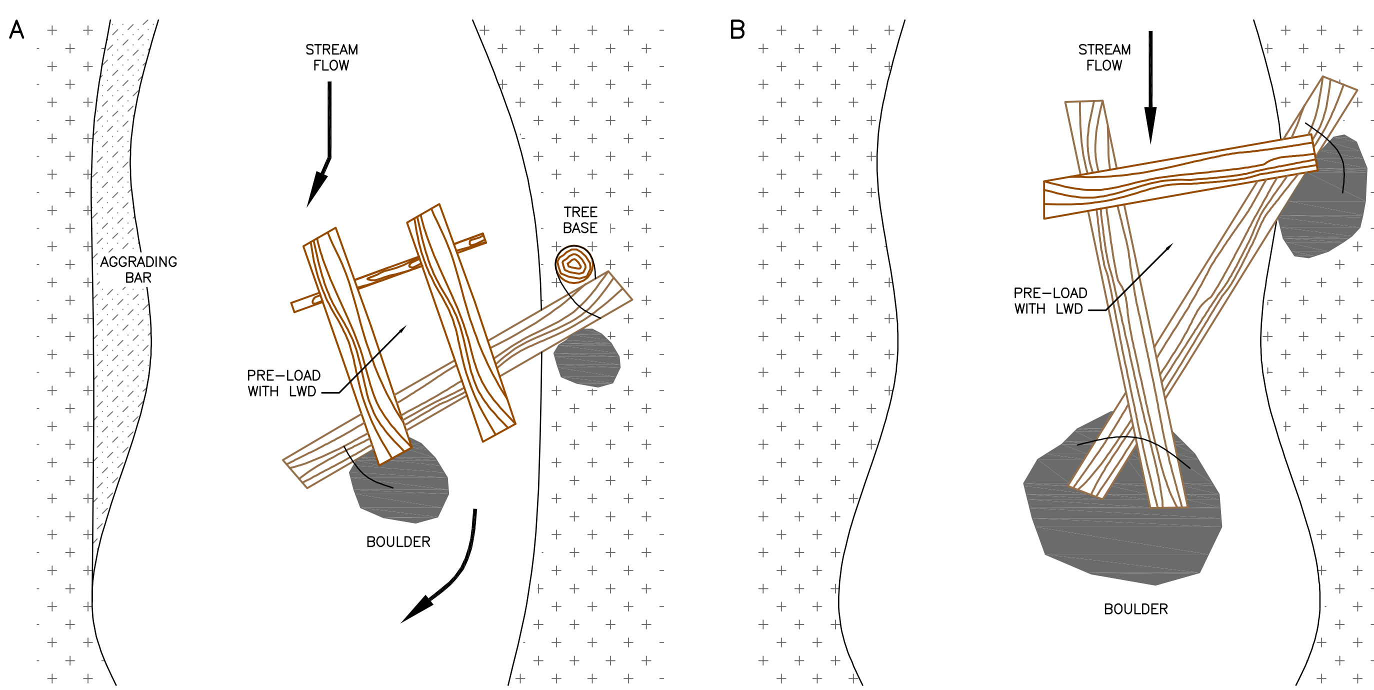
- Using a spider backhoe/walking excavator to side-cast excess boulder and cobble bedload from the Olympic Creek thalweg.
- Re-aligning the channel bed form to create self-regulating step-pool and pool-riffle sequences. Using existing channel restrictions and expansions to determine the exact location and spacing of pool-riffle sequences.
- Augmenting riffle-sequence with gravel substrates.



LATERAL LOG JAMS SECURED TO LARGE BOULDERS, ALIGNED WITH STREAM BANKS AND ATTACHED TO TREE BASES (FROM SLANEY ET AL., 1997). AMOUNT OF JAM WITHIN THE CHANNEL IS REDUCED WHERE THE CHANNEL IS CONFINED BY STEEPER BANKS (B).



CONCEPTUAL DESIGN OF LATERAL LOG JAMS. (A) SINGLE LOG. (B) TRIANGULAR. (FROM SLANEY ET AL., 1997)



CONCEPTUAL DESIGN OF BOULDER-WOODY DEBRIS CATHERS. TRAPPING LOGS ARE A RAMP SPANNING FROM BOULDER ATTACHMENTS TO THE STREAM BOTTOM. (FROM SLANEY ET AL., 1997)

DESIGN GUIDELINES

A. USE NATIVE PINE OR SPRUCE TREES WITH BRANCHES AND ROOT WADS, WHEN PRACTICAL.

B. TREES CAN BE PLACED SINGLY OR IN MULTIPLE ARRANGEMENTS (E.G., LOOSE BUNDLES, PARRALLEL LOGS, LATERAL LOG JAMS, TRIANGULAR LOG JAMS) WITH OR WITHOUT BOULDERS DEPENDING ON SITE SPECIFIC CONDITIONS AND INTENDED FUNCTION (I.E., ADULT TROUT FORAGING TERRITORIES OR FRY AND JUVENILE COVER).

C. LWD PIECES OR MULTIPLE TREE STRUCTURES EXTENDING FROM BANKS SHOULD BE ANGLED DOWNSTREAM AND ANGLED DOWN FROM THE TOP OF BANK TO INCREASE STABILITY AND TO VARY COVER ABUNDANCE AT DIFFERENT FLOWS.

D. LWD PIECES CAN BE POSITIONED/ANCHORED IN MID-CHANNEL AROUND BOULDER CLUSTERS IF TOTAL CROSS-SECTIONAL AREA CAN BE LESS THAN $\frac{1}{3}$ OF CHANNEL WIDTH.

E. LIMIT THE LWD PROJECTION WIDTH TO $\frac{1}{3}$ OF THE CHANNEL WIDTH; FULL CHANNEL-SPANNING LWD STRUCTURES SHOULD BE LIMITED TO REACHES WITH GRADIENTS LESS THAN 2%.

F. LOCATIONS FOR LWD PIECES AS COVER FOR FISH INCLUDE LOW VELOCITY AREAS SUCH AS POOLS BELOW RIFFLES, RUNS, SIDE CHANNELS, CHANNEL MARGINS, AND BACK EDDIES.

G. FULL-SPANNING LWD USED TO CREATE POOLS AND TRAP GRAVEL SHOULD BE LOCATED IN THE DEEPEST PASRT OF THALWEG.

CONSTRUCTION GUIDELINES

A. FASTEN LWD PIECES TO BANK BY ANCHORING TO EXISTING STUMPS, USING "DEAD-MAN" ANCHORS, OR BURYING ROOT-WADS IN STREAM BANK AND BALLASTING WITH ROCK.

B. BALLAST ROCKS CAN BE CABLED TO TREE TO OFF-SET BUOYANCY.

C. IF USING DEAD-MAN ANCHORS INSTEAD OF LIVE TREES OR STUMPS, POSITION ANCHORS TO ENSURE LWD DOESN'T SHIFT DOWNSTREAM.

D. CABLE STRENGTH OF ANCHORS MUST BE GREATER THAN ROTATIONAL FORCE ON TREE CAUSED BY THE FORCE OF FLOW (Tcable = Fx(d1)/d2) WHERE d1 AND d2 ARE MID-POINT DISTANCES OF THE TREE EXTENDING INTO THE FLOW AT 90° AND 45° ANGLES, RESPECTIVELY.

E. IF USING BALLAST ROCKS, LEAVE CABLE ANCHORS SLACK SO THAT ROCK ANCHORS SCOUR INTO STREAM.

F. SIZE OF ROCKS USED AS BALLAST DEPENDS ON PREDICTED MAXIMUM STREAM VELOCITY AND SIZE OF TREES (SEE SLANEY ET AL., 1997 TO DETERMINE BALLAST REQUIREMENTS).

G. FEWER BALLAST ROCKS ARE NECESSARY IF TOPS OF LOGS ARE BURIED IN STREAM BANK.

H. LARGEST BALLAST ROCK PLACED ON UPSTREAM SIDE OF SINGLE TREE STRUCTURES.

I. MAIN TWO LOGS OF TRIANGULAR JAMS CABLED TO COMMON ANCHOR BOULDER IN THE STREAM.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN REPORT DATED

SCALE N.T.S.

CLIENT
pbm

Klohn Crippen Berger

PROJECT
MORRISON COPPER/GOLD PROJECT
FISH HABITAT COMPENSATION PLAN

TITLE
CONCEPTUAL DESIGN OF
LARGE WOODY DEBRIS STRUCTURES

PROJECT No. M09382A04

FIG. No. 4.9

KCR-DM

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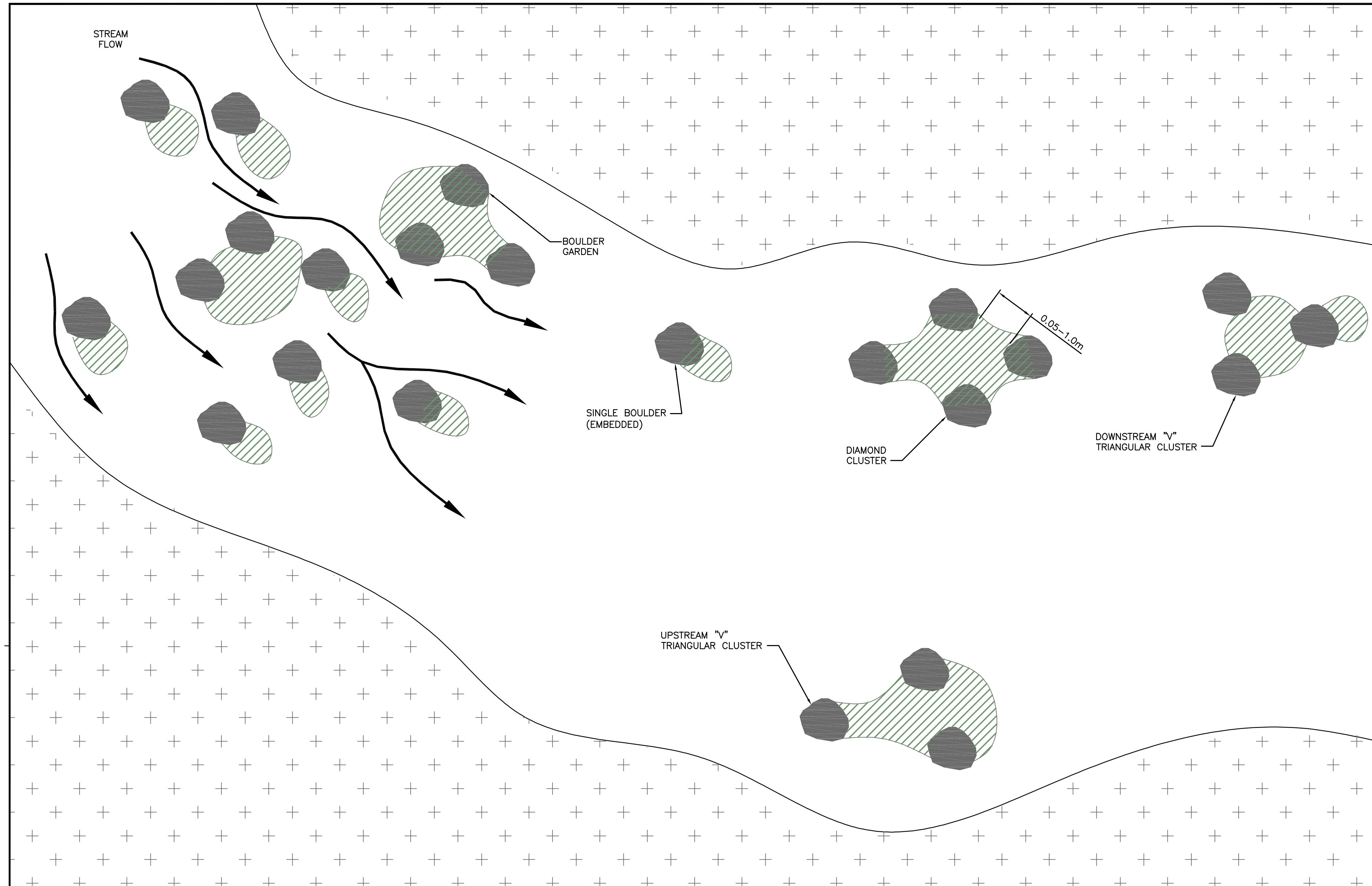
Date: 3/21/2011
Scale: 1=10(PS)
Drawing File: M:\VCR\M09382A04 – Morrison EAC Support\400 Drawings\FIG 4.9.dwg



BOULDER CLUSTERS TYPICAL DETAIL

DESIGN GUIDELINES

A. USE ANGULAR BOULDERS NATIVE TO SITE.
B. BOULDERS CAN BE PLACED IN SEVERAL ARRANGEMENTS (E.G., SINGLE, DIAMOND CLUSTER, UPSTREAM 'V', DOWNSTREAM 'V', BOULDER GARDEN) DEPENDING ON SITE SPECIFIC CONDITIONS AND INTENDED FUNCTION (I.E., ADULT FORAGING COVER OR FRY AND JUVENILE SHELTER).
C. 2–7 BOULDERS PER CLUSTER DEPENDING ON STREAM WIDTH AND SLOPE, BOULDER DIAMETER, AND ARRANGEMENT.
D. BOULDERS AT LEAST 0.3 METRES IN DIAMETER; MINIMUM BOULDER SIZE DETERMINED BY TRACTIVE FORCE EQUATION (T=1000 x DEPTH x SLOPE) AT BANKFULL DISCHARGE MULTIPLED BY 1.5 SAFETY FACTOR (NEWBURY AND GABOURY, 1993).
E. TOTAL BOULDERS CROSS–SECTION SHOULD OCCUPY LESS THAN $\frac{1}{3}$ OF CHANNEL WIDTH AFTER PARTIAL EMBEDMENT.
F. SPACING OF BOULDERS APPROXIMATELY 0.5 TO 1.0 MTRES APART, INCREASING WITH STREAM SIZE (WARD 1997).
G. SPACING OF BOULDER CLUSTERS SHOULD BE AT LEAST $\frac{1}{3}$ OF CHANNEL WIDTH.
H. BOULDERS TO BE PLACED IN AN ARRANGEMENT THAT GUIDES THE FLOW IN ITS NATURAL BEND AND EACH BOULDER CLUSTER GUIDES THE FLOW IN TO THE NEXT DOWNSTREAM CLUSTER (WARD 1997).
I. BOULDERS TO BE PLACED IN AREAS WITH SUB–CRITICAL FLOW, IDEALLY AT BOTTOM OF RIFFLES AND FASTER, DEEPER RUNS.
J. BOULDERS TO SPAN CHANNEL IN AN ARRANGEMENT THAT GUIDES THE FLOW IN ITS NATURAL CHANNEL BUT AWAY FROM UNPROTECTED BANKS.

CONSTRUCTION GUIDELINES

A. BOULDERS TO BE PUSHED INTO THE BOTTOM SUBSTRATES BY EXCAVATOR OR PLACED INTO PRE–EXCAVATED HOLES IF SEDIMENTS ARE ARMOURED AND POTENTIAL FOR ELEVATED TURBIDITY DURING INSTALLATION IS LOW.
B. BOULDERS TO BE PLACED AT OR BELOW, BUT NOT TO EXCEED 0.3 METRES ABOVE WATER LEVEL AT TIME OF INSTALLATION (ALBERTA eNVIRONMENTAL PROTECTION 1996).
C. ALL BOULDERS BACK–FILLED WITH SMALLER ROCK DOWNSTREAM SO THAT BOULDERS ARE EMBEDDED IN CHANNEL BOTTOM.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN REPORT DATED ________

SCALE N.T.S.

CLIENT: pbm

Klohn Crippen Berger

PROJECT: MORRISON COPPER/GOLD PROJECT
FISH HABITAT COMPENSATION PLAN

TITLE: CONCEPTUAL DESIGN OF
BOULDER CLUSTERS

PROJECT No. M09382A04

FIG. No. 4.10

KCR-DM

Time: 16:3:20
Date: 3/21/2011
Scale: 1=10(PS)
Drawing File: M:\VCR\M09382A04 – Morrison EAC Support\400 Drawings\FIG 4.10.dwg

Final design drawings for the off-lake and in-channel compensation will be prepared based on specific site conditions prior to construction and the Contractors proposed methodology and equipment. "Issued for construction" drawings will be provided to DFO and MoE for final review at least 60 days prior to construction.

4.3.4 Non-fish Bearing Habitat Gain

Habitat enhancement in the Olympic Lake system will result in Morrison Lake fish gaining access to the underutilized food source in Olympic Lake. The access improvements will provide an additional 1,265 m^2 of underutilized stream habitat and 171,000 m^2 of underutilized lake habitat. Invertebrate density in Olympic Lake was observed as abundant during snorkel surveys with an estimated 100 organisms/m^3. Based on the area of Olympic Lake of 171,000 m^3 and an average depth of 3 m, the volume of Olympic Lake is approximately 513,000 m^3. The volume, multiplied by the estimated density of organisms (100 m^3) amounts to approximately 50 million organisms which are currently an under-utilized food source in Olympic Lake. The FHCP will therefore provide Morrison Lake fish with access to additional productive lake habitat in the Morrison Lake watershed.

Based on previous studies of estimates of production benefits for salmonids from stream restoration efforts, the proposed enhancements and improved access should translate to a 3-fold increase in rainbow trout density in the Olympic system. The gains from the Olympic Creek compensation option includes the sustained production of benthic invertebrates in the system, with gains realized from Morrison Lake fish having access to a previously unavailable food source. Habitat enhancements including the stabilization of flow, addition of boulders, LWD and cobble/gravel substrate will improve the habitat conditions which will become evident through increased benthic production. Additional benthic data collection will occur in Olympic Lake and Olympic Creek to support the observations. Phytoplankton tows will be conducted in Olympic Lake and invertebrate drift sampling will occur in Olympic Creek in summer 2011. Ongoing follow-up monitoring and adaptive management strategies will monitor changes in productivity in the system, including benthic invertebrate drift and fish habitat use.

4.4 Habitat Balance

The habitat balance has been prepared to summarize habitat losses from the Project and habitat gains from the FHCP. The objective was to compensate for the total fish bearing habitat losses of 1,251.5 m^2 (0.124 ha), and for the loss of non-fish bearing habitat (replacing productive capacity). The FHCP achieves the replacement of marginal rearing habitat with high value, perennial rearing habitat at a ratio of 3:1 or 3,700 m^2. The non-fish bearing habitat loss is replaced by Morrison Lake fish gaining access to in the order of 51 million organisms in Olympic Lake. The gain in riparian area includes a 30 m buffer on each side of and between the off-lake channels, each of which will be approximately 600 m long (i.e. 600 m x 90 m) which amounts to 54,000 m^2 of replaced riparian habitat. Table 4.1 summarizes the habitat balance for the Morrison Copper/Gold Compensation Plan.

Table 4.1 Habitat Balance for Morrison Creek Copper/Gold Project

FISH HABITAT	LOSS	HABITAT GAIN FROM FHCP	HABITAT BALANCE (RATIO GAIN/LOSS)
Fish bearing	1,251.5 m^2	3,700 m^2	**2,448.5 m^2 (3:1)**
Non-fish Bearing	12,000,000 organisms	Improved fish access	**Access to ~ 51,000,000 organisms**
Riparian Area	13,500 m^2	54,000 m^2	**40,500 m^2 (3:1)**

4.5 Constructability, Feasibility, and Risk

4.5.1 Off-Lake Channels

The design and construction of off-lake spawning channels with surface and groundwater infiltration is a proven method for improving a fisheries resource and the productive capacity of a system. The proposed channel design and construction sequence will be guided by proven fish habitat restoration techniques and previous experience in the successful design and implementation of similar spawning channels elsewhere in B.C. Monitoring, maintenance and improvements to the off-lake channels will be provided as needed during mine life and into post-closure to maintain fish access from Morrison Lake and provide for permanence in the main structures.

The risk of failure of the proposed channels is considered low and the duration of time until the new habitat is fully functional will be between 1 year and 3 years. Some fish will likely utilize the compensation habitat within the first year of its creation, which will be early in the Project development stage (see also Section 5.5 below).

4.5.2 Olympic Creek and Olympic Lake Enhancements

The technical and economic feasibility of successfully completing the Olympic Creek and Olympic Lake fish habitat enhancements and access improvements is good, as the work can be done with a small walking excavator and a field crew of 4 to 5 people over a period of 1 to 3 months. Supplies such as geotextile filters, pond liners, spawning gravels, and weir and fish ladder construction materials will be brought to the site via a small barge from the south end of Morrison Lake. Installation of beaver-proof fencing and fish ladders will assist in maintaining fish access between Olympic Lake and Olympic Creek. A long-term beaver management and control plan may be necessary for the Olympic Lake outlet and portions of the Olympic creek system to maintain access.

The risk of failure of the proposed enhancement and access improvements is considered low and the duration of time until the new habitat is fully functional will be about 1 to 2 years. Some fish will likely utilize the compensation habitat within the first year of its creation, which will be early in the Project development stage.

4.6 Timing

Timing is a key consideration in the development of a successful FHCP. In particular, the relationship between the impacts of Project development on the existing habitat and the development of the compensation (*i.e.* when the compensation is actually functioning as fish habitat) is important. These two developments need to occur in a similar time frame to reduce the loss of productive capacity.

Construction of spawning channel(s) along Morrison Lake will be initiated during the first year of mine construction. The excavation should take place during early spring after snow melt but before the ground thaws. This timing will facilitate the movement of heavy equipment over wetted areas and minimize impacts to existing vegetation. Early spring is also generally a low flow time which will reduce potential sedimentation into Morrison Lake and tributaries. This timing will require that re-vegetation take place immediately after construction if planting is to be completed in the spring of the same year.

Fish access improvements and habitat enhancements of Olympic Creek and Olympic Lake will take place during the fall fisheries window in late August and/or September. At this time, fry hatched in the lower portion of the system and adults will both have moved out of the creek into the lake for winter. This time period is also the driest part of the summer which will allow low flows to be easily diverted around the work areas using flumes or dam-and-pump methods. This will also allow for work in the dry and prevent sediments from entering downstream.

The compensatory works should be completed and functioning within the first three years of the Project. Construction will be carried out in early spring (May) and/or late summer (August/September) to minimize disturbance and sediment release. Compensation development will be completed in stages as a sediment control measure and to take advantage of the summer growing season for re-vegetation activities. This will allow planted vegetation to establish itself in the riparian zone along the spawning channels and provide shade, cover, and nutrients for spawning rainbow trout in the spring of the following year.

4.7 Costs

An estimate of the total costs for the FHCP is provided in Table 4.2 below.

Table 4.2 Cost of the Fish Habitat Compensation Plan

MATERIALS	QUANITITIES	COSTS		COMMENTS
		Cost per Unit	Total Cost	
Clean Spawning Gravel	1,000 m^3	$25/m^3$	$25,000	2"minus clean river gravel
Rip-Rap & Boulders	1,600 m^3	$10/m^3$	$16,000	600 mm+ clean angular rock
Trees / Shrubs	6,000	$3 ea.	$18,000	Commercially purchased willow, birch, spruce,
Large Woody Debris	100 pieces	$50	$5,000	Locally obtained
Swamp Pads	20 to 30	$100	$2,000 to $3,000	Locally made from already fallen timber or allowable cut
Silt Curtains	4 x 25 m	$10/ m	$1,000	Stretched across the creeks and Morrison and Olympic Lake at work site
Silt Fencing	1,000 m	$10/m	$10,000	With stakes
Stop-nets	2 x 25 m	$5/m	$250	For fish salvages
Electro-fisher	1	$125/day	$875	Rental for 1 week
Dump truck	1	$1,500/day	$15,000	Rental for 10 days with driver
Back-hoe	1	$1,500/day	$45,000	Rental for 30 days with operator
Front-end Loader	1	$1,500/day	$22,500	Rental for 15 days with operator
Boat	1	$150/day	$13,500	Rental for 90 days;
Sand pump and hose	1	$300/day	$9,000	Rental for 30 days maximum
Helicopter (if needed)	1	$1,500/hr	30,000	20 hrs flying time
Labour	4 to 6	$500 - $1,500/day	$150,000	6 weeks maximum in total
Misc. & Contingency			$80,000	Miscellaneous additional items and / or time
TOTAL COST			**$500,000**	Total maximum cost for initial installation

5. CONSTRUCTION MANAGEMENT PLAN

5.1 General

All construction will follow PBM's Environmental Management System (EMS), which is presented in the EAC Application (Volume III, Section 13). The EMS includes erosion and sediment control, vegetation plans, soils and overburden plans, wildlife logs, spill containment,, waste management, site reclamation, monitoring plans, and the FHCP. The following sections of this document summarize the key aspects related specifically to the FHCP.

Mitigation measures have been incorporated into the FHCP design to minimize or eliminate impacts to fish and fish habitat during construction. These measures include those related to mitigating adverse effects to surface water quality and quantity as well as direct effects to fish and aquatic habitats. PBM (or an authorized representative) will be responsible for the implementation of mitigation measures and construction of each compensation site.

Environmental mitigation practices shall comply with the following Acts, regulations and guidelines, as applicable:

- *Fisheries Act* - Fisheries and Oceans Canada (DFO);
- *Water Act*, Section 9 - Ministry of Environment (MoE);
- Water Regulation, Part 7 (MoE);
- Standards and Best Practices for Instream Works (MoE);
- Land Development Guidelines for the Protection of Aquatic Habitat (1993) (DFO and MoE);
- Worksafe BC Regulations;

- Waste Management Act (MoE);
- Fish Protection Act (MOE); and
- Special Waste Regulation (MoE).

A site plan showing work areas, fuel containment areas and refuelling locations, laydown areas, parking areas, stockpile and disposal areas, topsoil and woody debris stockpile areas will be developed and reviewed by the Environmental Monitor prior to site preparation. In addition, PBM will see that all roadways, culverts, and slopes are sufficiently stable to support vehicle traffic and to minimize the potential to introduce sediment to Morrison Lake and tributaries. Upon completion of the compensatory works, all disturbed areas will be stabilized with permanent reclamation measures to re-establish riparian vegetation and fish habitat.

5.2 Construction Mitigation

5.2.1 Historical and Paleontological Resources

Although no archaeological sites have been reported within the proposed compensation sites archaeological monitoring will occur during the excavation of the off-lake channels.

5.2.2 Construction Materials

Some of the materials to be used onsite are potentially hazardous or toxic to aquatic life (*i.e.,* fuels, solvents etc.). All materials used in, or adjacent to, designated areas of environmental sensitivity will be stored in a designated location that poses no risk of soil contamination and is a minimum 30 m from any watercourse or wetland. The site will be clearly labelled and controlled in accordance with the Workplace Hazardous Material Information System (WHMIS) program. Specific containers will be designated for hazardous waste and will not be used for garbage or construction debris.

PBM, or their representative, will inspect the site on a regular basis to ensure that all construction garbage and debris is placed within designated containers and removed from the site for disposal at an approved landfill site in accordance with the *Water Management Act*. Garbage will be removed on a regular basis. Burning will not be permitted.

All imported ballast and riprap rock will be subjected to testing and rock with a potential to acidify water will not be used.

5.2.3 Water Management

A detailed water management plan including the location of all water exit points and water quality monitoring locations will be developed prior to Project start-up.

To ensure the protection of aquatic life and their habitats, PBM and its Contractors will ensure that water exiting the construction areas and entering a drainage course will meet the criteria for total suspended solids (25 mg/L above background during dry weather; and 75 mg/L above background during storm event).

5.2.4 Erosion and Sediment Control

The proposed FHCP will expose underlying soils that may have the potential to discharge sediments to fish habitat. All work will be undertaken and completed in such a manner as to prevent the release of silt, sediment, or any other deleterious substance into any watercourse. Typical sediment and erosion control measures will include silt fences, drain rock/gravel filters, coco-matting and straw matting, erosion protection (angular rip-rap boulders), vegetative (seeding, hydroseeding, trees and shrubs) and non-vegetative cover (tarps, aggregate cover) to protect exposed soils and stockpiles Erosion control blankets, diversion berms, vegetated filter strips, and temporary sediment/settling ponds to capture and retain sediment-laden runoff at the source will also be used to ensure there is no direct discharge to receiving watercourses.

In addition, the following efforts will be made to control sediment laden runoff:

- Minimizing the duration of soil exposure by implementing an effectively staged construction plan (*i.e.*, expose only that portion of the site required for the immediate work and cover/stabilize immediately upon completion of construction).
- Installing sediment control measures (e.g., straw wattles/matting, coco-matting, silt fences, sediment traps, drain rock check dams, etc.) as required prior to beginning land clearing activities.
- Having filter cloth and clean gravel readily available on-site for use in drainage ditches to filter water laden with silt or sediment.
- Retaining natural drainage patterns wherever possible and using existing ditches and culverts to maintain adequate drainage n construction areas.
- Ensuring that all rock material brought onto site is clean and free of soil and debris. The rock will be stored in a location where it will remain soil/sediment free.
- Where possible, establishing and maintaining riparian setbacks (i.e., “no go” zones) and scheduling site preparation activities to coincide with good (i.e., low precipitation) weather conditions.
- Keeping all stockpiled soil material above the high water mark of any watercourse. Installing straw wattles at the base of stockpiled soil material. Covering all exposed soil material with poly-sheeting to prevent erosion during rain events.
- Monitoring, maintaining and repairing the sediment control components, as necessary, to ensure they are working effectively. If damage is observed PBM will immediately make repairs as required. These components shall be maintained until the work areas are completely stabilized and there is no longer a risk of sediment release to aquatic habitat.

- Halting work during heavy rainfall.

- Placing all soil piles on stable ground to minimize erosion potential. Locating all stockpile sites away from designated areas of environmental sensitivity. Disposing of excavated material to be removed offsite in accordance with all applicable legislation and placing it in such a way that it does not discharge to any watercourse, ravine, or floodplain.

5.2.5 Vegetation

The following recommendations are designed to minimize the impact of the compensation works on existing vegetation resources:

- Ensure the project footprint is kept to a minimum to reduce the amount of vegetation clearing required.

- Store construction materials on previously disturbed areas. If topsoil or other materials must be stored in undisturbed areas, ensure it is on a tarp or other form of ground protection.

5.2.6 Wildlife and Habitat

General protection measures for wildlife that will apply during construction include:

- Conduct land clearing in the fall or winter to avoid impacts to nesting birds in order to ensure compliance with Section 34 of the Provincial *Wildlife Act*. If land clearing is required within the breeding bird nesting window, PBM will contact the MoE to determine and implement an appropriate management plan.

- Complete the works as quickly as possible.

- Dispose of refuse at an approved landfill facility. Store refuse at site in closed containers prior to removal.

5.2.7 Fish and Fish Habitat

When conducting construction activities in and around the Morrison Lake and tributary streams, the following management practices will be applied to protect adjacent fish habitat:

- Plan the project so that the duration and extent of in-water work is kept to a minimum. Minimize duration of in-stream works. Schedule site preparation and construction activities involving work within the wetted environment to periods of reduced risk.
- Work within wetted areas may only be initiated after site inspection and approval by the fisheries biologist or Environmental Monitor.
- Suspend a fabric sediment curtain in Morrison Lake during construction to prevent any turbid water and suspended sediment from passing beyond the construction site and into the lake.
- Select stabilization practices and best management practices (i.e., bank sloping and re-vegetation, tree / rootwad revetments, fencing, etc.) to determine how well the practices stabilize stream banks, maintain proper channel geometry, and re-establish riparian vegetation. Monitoring parameters for these factors include: channel cross-sections, photo points, and surface area of eroding banks.
- Place temporary barriers around work areas (e.g., silt fencing or straw wattles).
- Choose equipment with respect to site sensitivity (i.e., rubber-tired backhoe, walking excavator).
- Isolate environmentally sensitive areas (e.g., Morrison Lake riparian zone and tributary streams) with fencing or flagging tape to prevent accidental intrusion.
- Minimize disturbance and impacts to the surrounding aquatic environment by utilizing proper impact avoidance and mitigation measures as per the guidelines provided in the DFO/MELP publication "*Land Development Guidelines for the Protection of Aquatic Habitat*". The Contractor is expected to adhere to the guidelines in this document.

- Minimize encroachment into fish habitat and retain existing riparian vegetation where possible. Clearly define work area with flagging and fencing where necessary.
- Restore disturbed riparian habitat with appropriate native vegetation.

5.2.8 Fish Salvage

Fish salvage operations will be conducted in Olympic Creek before any dewatering for instream channel work. Stop-nets will be deployed above and below each work section and all fish captured for live transport upstream or downstream of the work sites. Several such fish salvages will likely be required in different sections of the creek, or the entire creek section below Olympic Lake will be fish-salvaged to keep fish out of the creek during the 30 to 45 day period of in-stream work.

A licence to collect fish will be obtained from MoE before the fish salvage is conducted. An authorization under Section 35(2) of the *Fisheries Act* to allow for the disruption of the existing habitat in Olympic Creek will also be obtained before the physical enhancement work is undertaken.

Monitoring of all fish salvages for the proposed compensatory works will be conducted and a report, as outlined in DFO's fish salvage protocol, will be prepared. The report will document all fish species captured, their numbers, sizes, and other details of the fish salvage program. The final fish salvage report will be provided to DFO for review.

5.3 Spill Response

PBM's Environmental Incident Reporting Policy will be adhered to at all times. Prior to the commencement of onsite activities, PBM will develop a spill response plan for approval by the Environmental Monitor. The plan will include a general measure of the probability and severity of an adverse effect to health, property, and/or the environment on the basis of fuel, oil, and other hazardous materials consumed, handled and stored.

Absorbent materials such as pads and booms and other equipment, such as shovels and containers, will be kept on-site at all times. PBM will inspect the spill response equipment regularly to ensure that an adequate supply of absorbent materials is present and the remaining gear is in effective working condition. PBM will require that all contractors' staff be trained in spill response.

In the event of a spill of a deleterious substance into Morrison Lake or a tributary, PBM will immediately install a spill containment boom downstream of the spill and will remove the substance through the use of absorbent pads.

In the event of a spill onto the ground, a spill boom will be placed on the downslope side. All contaminated soil will be treated with absorbent pads. Any contaminated soil that remains in place after the use of the pads will be excavated and placed in an impervious container for offsite disposal at a designated site.

PBM environmental staff and the Environmental Monitor shall be immediately notified of any leaks or spills. All construction machinery will be equipped with spill kits to adequately deal with minor spills and leaks. Any spill of a substance toxic to aquatic life of reportable quantities will be immediately reported to the **Provincial Emergency Program** 24 hour phone line at **1-800-663-3456**. Spills of any hazardous material, or any other material which could be deleterious to fish, will be reported to Environment Canada at 604-666-6100. The incident report shall identify the reporting organization, date, time, location, hazardous materials involved, source, and persons or organizations notified. In addition, the report will describe how the spill or release occurred, remedial action taken or planned, and actions necessary to prevent recurrence.

5.4 Fuelling and Fuel Storage

Fuel storage areas will be protected by an impermeable berm to contain any spills or leaks of substances potentially deleterious to fish or fish habitat. Prior to the commencement of onsite activities, all contractors will submit a signed copy of the Refuelling and Spill Response Procedures to DFO. In addition, the following practices will be implemented:

- Store all fuels and lubricants away from any watercourse or water body.
- Conduct refuelling and changes of oils/lubricant a minimum of 30 m away from any water body. Where appropriate, use a controlled containment structure (*i.e.,* drip tray). Equip refuelling hoses with safety nozzles and automatic shut-off valves.
- Refuel all vehicles on flat surfaces to prevent offsite runoff of spilled fuels.
- Retain a spill kit onsite at all fuelling locations.
- Emergency spill response materials will be carried by all equipment working onsite. The Contractor is to ensure it remains in good working order.
- Ensure personnel are trained in proper spill containment and remediation procedures.
- No smoking will be permitted during refuelling or in proximity to any fuel storage areas.

The names and contact information of all persons responsible for the implementation and control of spill containment shall be made available to all workers onsite.

The Environmental Monitor shall be immediately notified of any leaks or spills.

5.5 General Equipment Cleanliness and Maintenance

All hydraulic, fuel, and lubricating systems will be kept in good repair to avoid leakage of deleterious substances. Leaking equipment will be immediately removed from the vicinity of Morrison Lake or tributary stream, repaired, and inspected before being returned to the work site. Machine maintenance areas will be located 50 m from Morrison Lake and tributary streams and their location approved by the Environmental Monitor. Bio-degradable vegetable based hydraulic fluids will be used in all machinery working within the Morrison Lake floodplain.

5.6 Reclamation

5.6.1 Site Restoration

Any stream bank or riparian area not within the compensatory footprint that is altered during the Project will be restored to its original grade and stabilized. This may include stabilizing exposed areas by scarifying compacted soils, placing topsoil and erosion control blankets as required, hydro-seeding of the impacted area, and re-vegetating with native trees and shrubs.

Soils stockpiles that remain onsite after completion of construction will be seeded to reduce the runoff potential. Stockpiles will be bermed and graded to reduce runoff. Trenched silt fence material will be installed at the base of stockpiles to prevent runoff from entering receiving watercourses.

A post construction monitoring program will be undertaken by PBM to that restoration measures remain in good condition and continue to function as intended.

5.6.2 Re-vegetation

A planting plan will be developed as part of the detailed design and development of each compensation area. This planting plan will include:

- proposed plant species;
- areas to be planted;
- plant source;
- plant spacing;
- details of amount of plants;
- location and installation of woody debris; and
- other habitat complexing details.

In addition to riparian plantings, broadcast seeding with a built in tackifier will be applied to all disturbed surfaces to ensure soil stabilization at impacted sites is effective. Certificate of analysis will be acquired for all native seed mixes. Follow-up monitoring and applications will be conducted as required.

5.6.3 Topsoil Salvage

The proposed off-lake channels and Olympic Creek and Olympic Lake access improvements and habitat enhancements will require topsoil and sediment to be excavated. Excess soils displaced by the excavated channels will be salvaged to a maximum depth of 50 cm to create terraced berms adjacent to the channels. Excess soil will be spread evenly over the work area or stockpiled in a stable dump site at least 50 m away from the nearest watercourse. The placed soil will be compacted and vegetated. Exact quantities of material to be moved and locations of disposed material will be finalized as part of tender drawings and final design.

6. ENVIRONMENTAL MANAGEMENT AND MONITORING

6.1 General

Environmental management and monitoring will occur during construction of the works and with the ongoing assessment of the performance and maintenance of the works.

6.2 Construction Phase

6.2.1 General

On-site monitoring of the construction of the compensatory works is important to ensure the works are built as designed and to discern whether the constructed habitats will perform and function as intended. The Monitor's duties will include:

- Briefing workers on site specific environmental requirements;
- Marking out riparian areas, wildlife trees, wetlands, and other sensitive areas;
- Providing construction guidelines and environmental training;
- Recommending and developing appropriate mitigation measures;
- Liaising with the Contractor, PBM, and government agencies;
- Preparing environmental documentation for PBM and government agencies;
- Routine and random inspections of construction activities and practices;
- Advising construction personnel on environmentally sound approaches and practices;
- Monitoring the effects of construction activities on the environment;
- Assisting in the preparation of the emergency response plan; and

- Stopping construction if the works appear to be, or are deemed to be, detrimental to aquatic life or are being conducted contrary to environmental approvals including:
    - The release of unacceptable amounts of deleterious substances into the environment;
    - Activities which appear to be an infraction of any environmental regulations or requirements;
    - Physical degradation of the environment; or
    - Imminent risk of any such events.

The Environmental Monitor will be viewed as an assistant to the team in protecting environmental quality, implementing effective mitigation, and minimizing liability. If works are suspended, PBM will not resume on-site activities until permitted to do so at the advice of the Environmental Monitor. Monitoring results will be submitted to the appropriate regulatory agencies following project completion.

Details of the compliance and effectiveness monitoring components for the fish habitat compensation works are provided below.

6.3 Compliance Monitoring

During construction of compensatory works a qualified and experienced fisheries biologist will monitor the work and provide direction as to specifications and materials.

The fisheries biologist will compare the design specifications with the constructed habitats by:

- Measuring the created or enhanced habitat areas (m^2);

- Comparing the habitats constructed on-site with "issued for construction" drawings and with this FHCP document;
- Identifying any remediation or additional engineering design required for the constructed habitats as well as the identifying any unintended impacts to aquatic habitat; and
- Measuring riparian re-vegetation success and survivorship.

Surveys using date-stamped photographs from standardized locations, and regular inspections of the major habitat features at each site will serve to verify compliance with the FHCP and to ensure the compensatory habitat is adequately designed and physically and hydraulically stable.

6.4 Operation Phase – Effectiveness Monitoring

6.4.1 General

Long-term monitoring of the compensatory habitats will be important in determining utilization by salmonids. Effectiveness monitoring will be conducted to determine both the performance of the fish habitat compensation works and the need for any additional mitigation or adaptive compensatory works. Performance of the off-lake channels and Olympic Creek and Olympic Lake access improvements and habitat enhancements in providing habitat for juvenile and adult trout and salmon will be assessed each year for the first 3 years, and then bi-annually for the mine life. The success of the constructed compensation work in increasing rainbow trout and coho salmon habitat will be determined by sampling each habitat using non-lethal methods. Specific success criteria for each compensation site are described in the sections below.

6.4.2 Morrison Lake Off-Channels

Monitoring the effectiveness of the Morrison Lake off-lake channels and habitat complexes to increase production of rainbow trout and Coho salmon will include:

- Transect surveys at 20 m intervals within the channels and comparison of data to habitat suitability indices for rainbow trout and other salmonids.
- Routine monitoring and maintenance of the inlet/outlet channel fish ladders during mine life and, as needed, thereafter. It is expected that the fish ladders at the inlet and outlet of both channels will remain open and flooded without further human effort.
- Routine monitoring and maintenance of the stability of the LWD, boulder clusters, and adjacent channel banks noting any unintended bank or channel erosion, sedimentation, or movement of habitat complexes.
- Monitoring the use of the channels by conducting visual observations of adults and or spawning redds from shore, as well as through snorkel surveys, electro-fishing, and/or minnow trapping during spring. Data on species, size, and sexual maturity of all fish captured will be collected.
- Quarterly measurements of water quality and quantity to confirm that channel flows, depths, dissolved oxygen concentrations (mg/L), are adequate to support salmonids.
- Conducting fish presence/absence surveys annually for up to three years to determine the effectiveness of the channels and complexing structures in creating additional spawning and rearing habitat.
- Measuring the ice thickness, water depths, and dissolved oxygen concentrations under the ice in the deepest portions of each channel.
- Measuring the survivorship of riparian vegetation plantings and taking remedial action to attain a >80% survival rate after 2 years.

6.4.3 Olympic Creek and Olympic Lake Access Improvements and Habitat Enhancements

Monitoring fish populations in Olympic Lake and Olympic Creek will be important in determining the effectiveness of the access improvement and habitat enhancement works. Monitoring the effectiveness of the constructed fish ladders, riffle-pool sequences, and LWD and boulder placements to increase production of rainbow trout will include:

- Routine monitoring and maintenance of the Olympic Lake outflow discharge throughout the year, particularly during low flow periods and during spring spawning.
- Assessing fish utilization by conducting snorkel surveys, electro-fishing, and/or minnow trapping in riffle-pool sequences, behind LWD complexes, and within boulder cluster placements.
- Conducting stream transect surveys within the newly created riffle-pool sequences, and LWD and boulder cluster habitats, and comparing average wetted depths and widths between years.
- Routine monitoring and maintenance of Olympic Creek/Lake fish ladders during mine life and as needed thereafter.

Fish presence/absence surveys will be conducted annually for up to three years to determine the effectiveness of the access improvements in creating additional spawning and rearing habitat.

6.5 Beaver Management Program

Existing beaver dams at the outlet of Olympic Lake will be removed after the fish weir and fish ladder is constructed. As beavers are regulated under Section 9 of the *Wildlife Act,* a management program is required to be developed and accepted by DFO and MoE at the Olympic Creek fish compensation sites.

A beaver management program will include working with the LBN to promote traditional land-based activities such as the trapping of beavers and, if necessary, may involve providing assistance for the ongoing use of existing trap lines. An annual monitoring survey of beaver activity will also be conducted as part of the program. This will include the determination of the extent of dam and lodge construction as potential barriers to fish passage

6.6 Remedial Works

If the constructed compensation works are found to be non-functioning or unstable, remedial works including additional design and construction will be used to correct the deficiencies. Such work would only be done with proper authorizations from the regulatory agencies.

6.7 Reporting

A monitoring report prepared by a third-party consultant will be submitted to DFO annually during the monitoring program. The reports will include details of monitoring activities with results and discussion of trends, photo documentation, and recommendations to address deficiencies (if any) in the constructed compensatory habitats.

7. ADAPTIVE MANAGEMENT PLAN

The fish habitat compensation sites at Olympic Lake, Olympic Creek and Morrison Lake are expected to create long-term functioning spawning and rearing habitat within the watershed. The objective of the plan is to facilitate the successful creation of the required amount of spawning and rearing habitat for salmonids in the Morrison watershed to achieve a no-net-loss of fish habitat with the proposed Project.

An Adaptive Management Plan has been developed to evaluate the success of compensation and to identify opportunities for improvement, if necessary. As a component of an adaptive management strategy contingency compensation options have been developed. The contingency options will only be developed if the compensation works do not meet the design objectives.

The adaptive management option, which could be considered for future works, includes:

- Enhancements to rearing and over-wintering habitats for salmonids in Morrison River. This area is ideally suited to construction of a meandering channel similar in design to the off-lake channel proposed in this FHCP and has been identified by LBN as a favourable option.
- Development of a beaver management program upstream of Olympic Lake and construction of additional control weirs.
- Placement of shoal reefs in Morrison Lake. This could be constructed with mine rock materials and has been identified by LBN as a favourable option. However, DFO have raised a significant concern with this alternative with respect to loss of habitat on the lake bottom and potential lake navigation concerns.

8. CONCLUSION

The FHCP provides compensation for fish habitat and productive capacity that is impacted as a result of the Project. The FHCP provides fish habitat compensation at a ratio of 2:1 for fish-bearing habitat and increases local productive capacity to compensate for loss of nutrients from non-fish bearing habitat. The FHCP includes four associated compensation works (sites) which provide a range of spawning, rearing, and foraging habitat. The benefit of developing compensation at a number of sites with planned alternatives, rather than a single location, will further reduce the risk of compensation failure and thereby increase the success of the overall program. The FHCP is feasible to construct both technically and financially and construction will not result in significant adverse effects. Environmental management including monitoring during all phases of the project has been identified. As well an adaptive management plan framework is provided.

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