2. ENVIRONMENTAL SETTING

In order 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 2006 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. These studies provided 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 empties through Morrison Creek into 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 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 a periods of low flow in late summer and fall. 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 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.

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 Creek	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 spatially and seasonally variable. In general, the concentration of phosphorus, nitrogen, and total organic carbon in the Morrison Lake watershed is relatively low. This is likely due to 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^3 to 7.2 organisms/m^3 with biomass ranging between 0.00025 mg/m^3 and 0.0016 mg/m^3 (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 rainbow trout and coho salmon captured between 2006 and 2009, Streams 7 and 8 are the two 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 all included within habitat preferences as 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 fore-shore 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 beneath 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 evenly 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 Creek until fall rains increase river flow. Sockeye and coho salmon spawn in Morrison Creek in late September and early October, respectively. Coho salmon typically spawn in swift, shallow gravelly areas of Morrison Creek and Tahlo Creek and, to a lesser extent, within smaller Morrison Lake tributaries. Sockeye salmon appear to utilize the rocky reefs and gravel-cobble substrates within shoal habitats of Morrison Lake and Morrison Creek. 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 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 young-of-the-year 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;
- Limited riffle-pool habitats 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 salmonids limits the production and recruitment of adult salmonids in Morrison Lake and tributaries. 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. Juvenile salmonids within Morrison Lake likely must share higher value overwintering habitats with large predatory lake trout.

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.

3. CALCULATING HABITAT AND PRODUCTIVE CAPACITY LOSSES AND GAINS

3.1 General

A detailed quantitative and qualitative assessment of the habitat and productive capacity values within the proposed Project site is important in achieving a no-net loss, and requires an evaluation of the quantity and quality of all habitat types lost and gained. The habitat losses and gains have been subdivided into: 1) Fish bearing; and 2) Non-fish bearing, and described in the following sections. The habitat lost to infrastructure of the Project is shown in Figure 3.1.

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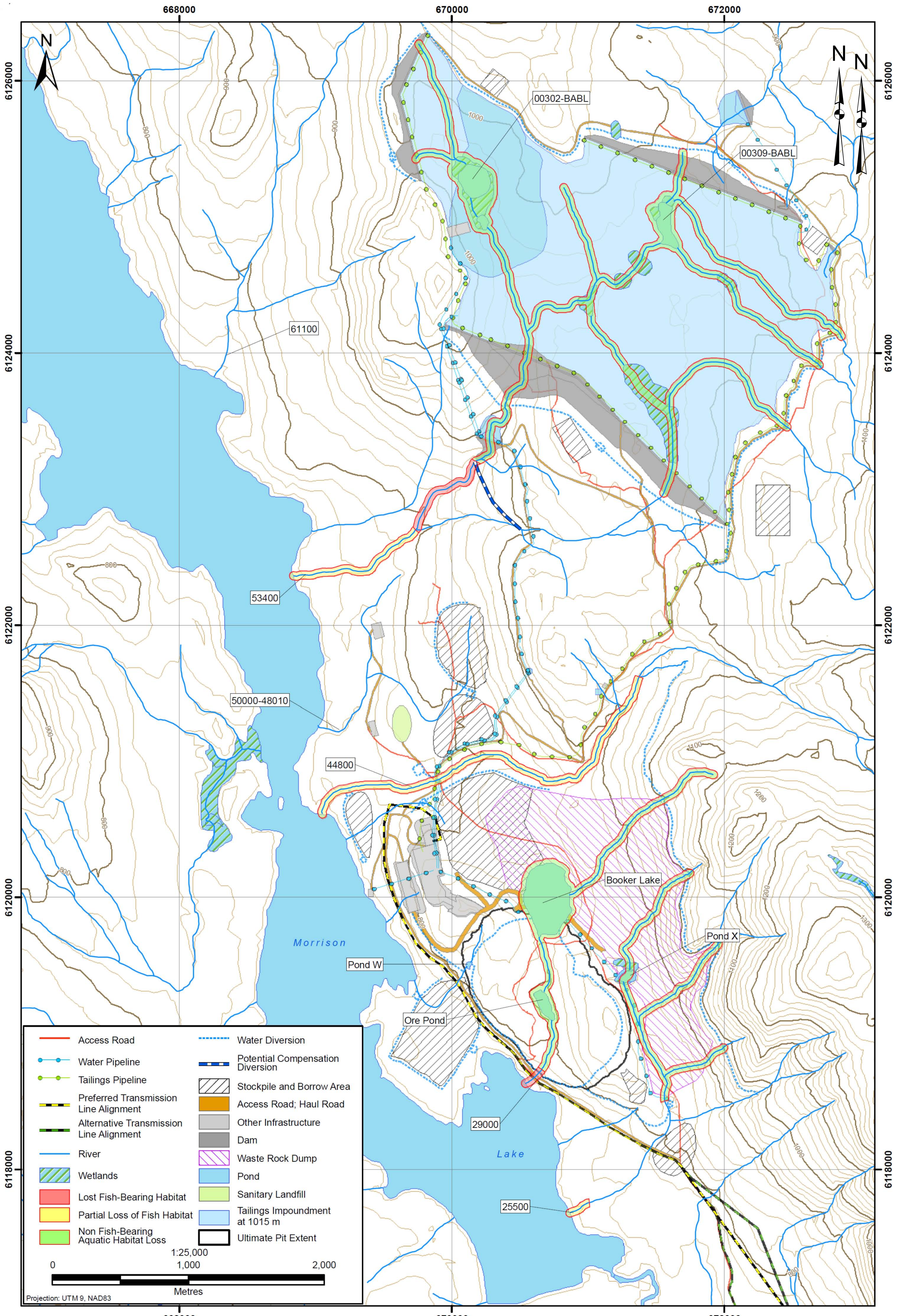

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From Rescan Environmental Assessment Application dated Septermber, 2009

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 PROJECT
TITLE	WATERBODIES TO BE LOST TO INFRASTRUCTURE OF THE MORRISON COPPER/GOLD PROJECT
PROJECT No.	M09382A04
FIG No.	3.1

3.2 Fish Bearing Habitat Losses (HADDs)

All fish habitat affected by the proposed Project was evaluated for each of 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.

Fish-occupied habitats affected by the Project include Stream 29000, Stream 25500, Stream 44800, Stream 53400, Stream 6070, and the Morrison Lake foreshore at the proposed freshwater and treated effluent pipeline locations (Figure 3.1). 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)

Fish habitat in Stream 25500 has marginal value for rainbow trout. Average depth of Stream 25500 during the peak of spring freshet is 0.02 m. A series of waterfalls approximately 1000 m upstream of Morrison Lake serve as permanent fish barriers.

Beaver activity is common in the lower reaches, resulting in the accumulation and build-up of thick organics and undefined channels. Although juvenile rainbow trout and coho salmon are known to utilize the lower ~182 m of the stream, the marginal habitat conditions in the lowermost reaches likely limits the number and extent of spawning rainbow trout entering Stream 25500 under natural conditions.

Encroachment of the waste rock dump into Stream 25500 will reduce the average annual discharge in Stream 25500 resulting in a loss of approximately 20 m^2 (0.002 ha) of wetted stream area. A reduction in discharge of 34% will likely exclude rainbow trout from the creek in most, if not all, years.

3.2.2 Stream 29000 (aka Stream 5)

Fish habitat in Stream 29000 has only marginal value for rainbow trout. A 10 m high waterfall exists approximately 75 m upstream from the confluence with Morrison Lake precluding upstream migration of fish, potentially to the 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 habitat in the form of gravel riffles within the lower 75 m of the stream below the falls. 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.

Although the fish-occupied habitat in Stream 29000 will not be physically altered by the Project, flows will be reduced during mine life by 90%, limiting the survival chances of isolated rainbow trout in the lowermost section.

Dewatering of Stream 29000 within the mine area will alter 230 m^2 of habitat and fish productive capacity. During mine operations, average annual flows in Stream 29000 will be reduced up to 90%. The largest changes in monthly flows in Stream 29000 will occur during the spring freshet as water is diverted when flows are highest.

3.2.3 Stream 44800 (aka Stream 6)

Fish habitat in Stream 44800 has moderate value for rainbow trout. Average depth of Stream 44800 during the peak of spring freshet is 0.3 m. Habitat in the stream within the upper reaches upstream from Morrison Lake includes steep sections of riffle-run, run-pool, and step-pool habitat with some cover in form of overhanging riparian vegetation. Beaver dams and low topography wetland fens with undefined channels near the mouth of Morrison Lake limit the number of salmonids utilizing more suitable fish habitat upstream.

Encroachment of the waste rock dump into Stream 44800 will reduce the average annual discharge in the stream resulting in a loss of approximately 90 m^2 (0.009 ha) of wetted area. A reduction in flows to Stream 44800 will likely exclude rainbow trout from the creek in most, if not all, years.

3.2.4 Stream 53400 (aka Stream 7)

Fish habitat in Stream 53400 provides marginal to moderate value habitat for rainbow trout and coho salmon. A ~2000 m length of the stream upstream from Morrison Lake provides valuable rearing and spawning habitat for rainbow trout and coho salmon. This length of the stream is characterized by riffles, runs, and pools with significant gravel, cobble and boulder substrates. The relatively small discharge in Stream 53400 and excess outwash cobbles blocking the main channel limits upstream access to these habitats.

Construction of the TSF will result in the temporary dewatering of 760 m^2 (0.076 ha) of wetted fish habitat in Stream 53400. A reduction in flows to Stream 53400 will exclude rainbow trout and coho salmon from the creek during periods of naturally low discharge. After mine closure, most of the upstream catchment flow will be returned to the creek, such that it will continue to support fish to the same extent as at present.

3.2.5 Stream 6070 (aka Stream 10)

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. Construction of the TSF north dam and proposed seepage control (reclaim) dam will displace the headwaters of Stream 6070 and potentially reduce flows by 22% within the upper reach for a total mean reduction in wetted area of approximately 400 m^2 (0.04 ha).

Fish habitat in stream 6070 provides moderate value for rainbow trout. The lower reaches (~100 m) of the stream below the beaver pond adjacent to Nakinilerak Lake provides suitable rearing habitat for juvenile salmonids. No fish are present in Stream 6070 upstream of the beaver pond. This is likely due to the ephemeral nature of Stream 6070 during most months, with episodic flows only during spring freshet. High gradient and relatively small discharge above the un-named pond limit the suitability for juvenile rearing habitat and adult foraging habitat. Thick layers of organic material have accumulated behind beaver dams restricting access to the upper reaches of Stream 6070.

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 which will be overlain by the freshwater and treated effluent pipelines.

3.2.7 Summary of Affected Fish Habitat

Habitat areas affected by the Project were calculated using GIS mapping and field data collected during habitat assessments in 2009 and 2010. HADD's are due to project footprint (e.g. covering the area) or due to reduced stream flows due to the project. Mean bank-full widths calculated during habitat assessments were multiplied by the length of each habitat class affected by the Project, including habitat affected by downstream flow reductions. The length and width of each habitat class was multiplied to calculate stream area. Table 3.1 shows the fish habitat displaced by Project infrastructure and/or partial/full dewatering.

Table 3.1 Fish Bearing Habitat Displaced by Project Infrastructure or Partial/Full Dewatering

STRUCTURE	STREAM	FISH HABITAT "VALUE"	STREAM AREA AFFECTED (m^2)
Mine Area	25500 (Stream 4)	marginal	20
	29000 (Stream 5)	marginal	230
	44800 (Stream 6)	moderate	90
	53400 (Stream 7)	marginal to moderate	760
	6070 (Stream 10)	moderate	400
Diffuser Pipeline	Morrison Lake Shoreline	moderate	300
Water Supply Pipeline	Morrison Lake Shoreline	high	50
TOTAL HADD		**1,850 m^2**	

3.3 Productive Capacity Losses from Barren 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 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. The current mean annual flow of the streams affected by the Project is approximately 0.15 m^3/s. This flow will be reduced by approximately 30%, such that the reduction in nutrient bearing stream flow is 0.05 m^3/s.

Nutrient Supply

> 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 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 a flow reduction of 0.05 m^3/s, this is equivalent to a loss of up to 12 million organisms per year into Morrison Lake.

3.4 Habitat Balance

3.4.1 General

A habitat balance has been prepared to summarize habitat losses from the Project and habitat gains from the FHCP. The objective was to compensate for total habitat losses of 1,850 m^2 (0.185 ha) of fish-bearing habitat, and for the loss of non-fish bearing habitat (providing productive capacity). The habitat balance is summarized in Table 3.2 and discussed in the following sections.

Table 3.2 Habitat Balance

Fish Habitat	Area
Fish Bearing Area Losses (HADDs) in Morrison Lake Tributaries	1,850 m^2
Fish Bearing Area Gain from Morrison Lake off-channel FHCP	3,700 m^2
Fish Bearing Gain/Loss Ratio	2:1
Non-Fish Bearing Productive Capacity Habitat Losses in Morrison Lake Tributaries	Stream flow reduction of 0.05 m^3/s transporting nutrients
Increased Productive Capacity via Habitat Gain in Olympic Lake system	Increasing productive capacity by improved access to food supply.

3.4.2 Fish-Bearing Habitat

Losses of 1,850 m^2 of fish-bearing spawning and rearing habitat is compensated at the normally accepted ratio of 2:1 (equivalent to 3,700 m^2 or 0.37 ha of new spawning and rearing habitat) used by DFO to provide an adequate factor of safety.

For calculation purposes, foraging habitat has been included in the habitat balance as equal to rearing habitat. Although foraging habitat is typically used by adult fish and includes open water areas and channel habitat where food is abundant, it may also be associated with rearing areas used by juveniles. Rearing habitat, on the other hand, contains areas of quiet shallow water with abundant food supply and cover. This habitat is predominantly used by juveniles but can also be used by adults for foraging. The proposed compensation options will be developed primarily as spawning and rearing habitat; however, habitat may also potentially be used by adults for foraging, while migration and over-wintering areas are also often used concurrently by different species and life stages.

3.4.3 Non Fish-Bearing Habitat

The FHCP for loss of productive capacity for non-fish bearing habitat is to increase the effective productive capacity of the Olympic Lake system with improvements in fish access and flow stabilization. The Olympic Lake system comprises the following components:

- Olympic Creek (Stream 77300): 1,265 m^2 of stream joining Olympic Lake with Morrison Lake. The stream flow varies throughout the season due to poor channel habitat and uncontrolled flows from Olympic Lake. The average annual flow of Olympic Creek is approximately 0.05 m^3/s.
- Olympic Lake is approximately 171,000 m^2 and is partially formed with a beaver dam at the outlet. The lake is fish bearing (low numbers) and has a high nutrient density.
- Upstream of Olympic Lake is a series of beaver dams and ponds (including Oval Lake) that encompass an aquatic habitat area of approximately 53,000 m^2.

  NB: Within other EAC documents Olympic Creek is referred to as Stream 77300 and also Stream 9 discharging into Morrison Lake at Site E.

The gain in productive capacity of the Olympic Lake system is summarized as follows:

- Assuming an equivalent nutrient production rate of up to 7 organisms per cubic meter of stream flow and an average flow of 0.05 m^3/s, Olympic Creek provides Morrison Lake fish with up to 11 million organisms per year. In addition, fisheries data (2009 Fish and Fish Habitat and Aquatic Resources Report (EAC Application Addendum Appendix AE)) for the Olympic Creek system indicates an average density of 15,000 organisms per square meter, indicating that the new available habitat of 1,265 m^2 may potentially provide up to 19 million additional organisms to Morrison Lake fish.
- Within Olympic lake an additional 171,000 m^2 of underutilized habitat will become accessible. 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.

Ponds and streams upstream of Olympic Lake will also provide nutrient production.