This LSA coincides with a portion of the hydrology and surface water quality LSAs. Hydrology and surface water quality LSAs include the entire Clary Creek watershed and the Illiance River. This is because the Project has the potential to directly affect water quality and stream flows in these watercourses. Any potential direct effects to surface water quality and hydrology become indirect effects to Rainbow trout. Potential indirect effects of the Project on rainbow trout were addressed in the Regional Study Area described below.

6.7.4.3.2 Regional Study Area

The Regional Study Area (RSA) for rainbow trout includes the lakes and streams within the LSA plus Clary Creek from the outlet of Clary Lake downstream to the impassable waterfalls near the confluence with the Illiance River. This RSA was selected because it encompasses the spatial extent of all potential direct and indirect effects of the Project on rainbow trout. These indirect effects include potential changes in water quality due to tailings seepage, potential changes in stream flows due to diversions and changes in catchment area, and potential changes in lake levels due to water withdrawals and changes in catchment areas.

This RSA was consistent with the RSAs for the surface water quality and hydrology disciplines because it reflects all potential indirect effects of the Kitsault Project on rainbow trout through changes in water quality and stream flows.

6.7.4.3.3 Cumulative Effects Study Area

The Cumulative Effects Study Area (CESA) for rainbow trout includes the entire Clary Lake watershed. This CESA was selected because it includes the Bell Moly Project, the only other project with past or current residual effects that could cumulatively affect resident rainbow trout populations in the Clary Creek watershed because of temporal or spatial overlap with the Kitsault Project (Section 8.2.9).

In addition to the lakes and streams already included in the LSA and RSA, the CESA for rainbow trout includes:

- **Killam Lake**: the reference lake for monitoring potential Project effects on lake habitats and biotic communities; and
- **Unnamed lakes and streams draining the north-eastern portion of the Clary Creek watershed to Clary Lake**: potential cumulative effects on rainbow trout from past and current exploration activities at the Bell Moly deposit. Includes the reference stream site for future monitoring of potential Project effects on stream habitats and biotic communities.

6.7.4.4 Temporal Boundaries

Temporal boundaries for assessment of potential effects of the Kitsault Project on rainbow trout were based on the reasonable expectation of the time over which the proposed Project has had and would have effects on rainbow trout in the Clary Creek watershed. Thus, the selection of temporal boundaries for rainbow trout was driven by the duration of each of the four primary phases of the proposed Project:

1. Construction Phase: estimated 25 month period that includes preparation of land for construction of mine infrastructure, construction of mine infrastructure including the tailing management facility, camp complex, processing plant, and access roads and transmission lines, and implementation of the construction phase water management plan;
2. Operations Phase: estimated at approximately two months of commissioning, and 15 to 16 years of mining (last two years are milling low grade ore). Phase includes progressive reclamation
3. Decommissioning and Closure Phase: estimated at 15 to 17 years. Includes a closure period during which the buildings and un-needed infrastructure would be removed, facilities reclaimed and closure water management plan is enacted;
4. Post-Closure Phase: estimated at five years or more. Includes post-closure monitoring until on-site water quality has stabilised and indicates no future adverse effects on local receiving waters; stabilisation of waste rock and TMF would also be considered in post-closure monitoring.

6.7.4.5 Information Source and Methods

6.7.4.5.1 2010 Field studies

Baseline information on rainbow trout in the Clary Creek watershed was collected during the winter, spring, and summer of 2010 (Appendix 6.7-A). Winter sampling was conducted in March 2010 in headwater lakes in the northeastern portion of the Clary Creek watershed upstream of Clary Lake. The objectives of this program were to: 1) determine the fish-bearing status of lakes potentially affected by one of the alternative TMF locations (i.e., option 10b); 2) determine if overwintering conditions were suitable for rainbow trout in these lakes; and 3) identify potential barriers to upstream fish passage in the Clary Creek watershed upstream of Clary Lake.

Ice-fishing and minnow trapping were the methods used to capture fish in these lakes during the 2010 winter survey (Section 6.7-A, Aquatics Baseline Report). Vertical temperature and dissolved oxygen profiles were conducted in each lake using a digital temperature / dissolved oxygen multi-meter with a 50 metre probe. Potential barriers (e.g., waterfalls and cascades) were identified during a reconnaissance over-flight in a helicopter. The winter survey was conducted over eight days between March 16 and March 22, 2010.

Spring sampling in 2010 included hoopnetting in Clary Creek immediately upstream of Clary Lake. The objective of this study was to document spawning movements of Clary Lake rainbow trout into Clary Creek downstream of Lake 493 and Lake 901. The meet this objective, two hoopnets were set to capture downstream migrating rainbow trout returning to Clary Lake after spawning. Nets were set for two days between June 3 and June 4. Nets were removed on June 4 due to decreasing water levels in the braided channels downstream of the canyon between the confluence of the Lake 493 and Lake 901 outlets and Clary Lake.

Clary Lake and Lake 901 and their tributaries were sampled for fish in the summer of 2010. The objectives of these efforts were to: 1) determine the species composition and relative abundance of the fish communities of both lakes; 2) identify likely spawning locations for rainbow trout populations in both lakes; 3) collect rainbow trout for analysis of tissue metal burdens; 4) collect rainbow trout for diet analysis; and 5) to determine the fish-bearing status of inlet tributaries to Lake 901 potentially lost or altered by construction and operation of th e TMF.

RISC standard floating and sinking gillnets and minnow traps were set in both lakes in the summer survey in 2010. Nets and traps were set in Lake 901 on July 9 and 10th while nets and traps were set in Clary Lake on August 31st and September 1st.

Backpack electrofishing was conducted in the main inlet (stream 910-929800-05800-76800), two smaller inlets tributaries and the outlet of Lake 901 in July 2010. This included over 1,100 seconds of electrofishing in the reach immediately upstream of the first bedrock cascade located approximately 580 metres upstream from Lake 901. This is the first impediment to upstream fish migration in this stream. The purpose of this sampling was to determine the fish-bearing status of this stream upstream of this impediment and to determine whether fish-bearing habitat exists within the footprint of the future TMF. Backpack electrofishing was not conducted in any of the Clary Lake inlets or outlets in 2010 because they were either classified as non-classified drainages (NCD) or had no visible channel (NVC) during the survey or because the fish-bearing status of permanent tributaries to Clary Lake could be assumed from past and current fishing efforts in the lake.

A total of 21 rainbow trout were sacrificed and analyzed for tissue metal concentrations from Clary Lake in 2010. Metal concentrations were analyzed by Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) by ALS Environmental in Burnaby, BC. Stomachs and ageing structures were collected from all of these sacrificed fish. Stomachs contents were identified to Order, weighed, and enumerated. Ageing was conducted by North/South Consultants in Winnipeg, Manitoba.

In addition to fish sampling, stream habitat in Clary Creek and in tributaries to Clary Lake and Lake 901 was assessed and mapped using the standardised methods. Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Stream Inventory Standards and Procedures (RISC 2001) site cards were completed in 12 Clary Lake tributaries, both Clary Lake outlets, six Lake 901 tributaries (including separate site cards upstream and downstream of the cascade impediment), in the Lake 901 outlet, and at 16 sites along the proposed new access road between the existing Kitsault Road and the processing plant / camp facility location. Level 1 Fish Habitat Inventory Procedures (FHAP; Johnston and Slaney 1996) were used to quantify and map stream habitat in the following streams:

- The main Lake 901 inlet tributary (910-929800-05800-76800) from Lake 901 upstream to the first cascade impediment;
- The outlet of Lake 901 (910-929800-05800-76800) from Lake 901 to the confluence with Clary Creek (910-929800-05800) upstream from Clary Lake; and
- Clary Creek upstream of Clary Lake to the beginning of the canyon.

Lake habitat was assessed in Clary Lake and in Lake 901 in 2010 by conducting a bathymetry surveys with a digital GPS / depth sounder, by conducting vertical temperature / dissolved oxygen profiles, and by classifying littoral habitat during shoreline cruises of both lakes by boat. Habitat was classified by:

- Dominant (>80%) substrate type (e.g., silt / sand, cobble, bedrock). Substrate types were determined from visual observation, probing with an avalanche probe, and / or collection of samples with an Ekman dredge;
- Presence or absence of aquatic vegetation;
- Percent of area with overhanging riparian vegetation cover (i.e., within 1 m of water surface and 1 m of shoreline); and
- Depth.

6.7.4.5.2 2011 Field Studies

Additional sampling was conducted in the spring of 2011. The objectives of this survey were two-fold: 1) to identify barriers (i.e., waterfalls with >2 m vertical drop or stream channels with >20 % gradient) and impediments to upstream fish passage in the two main Lake 901 inlet tributaries (910-929800-05800-76800 and ILP 887); 2) to determine the fish-bearing status of both streams, streams potentially affected by construction and operation of the TMF, and in particular, habitat within the footprint of the TMF that would be potentially affected by the deposit of deleterious substances (i.e., mine tailings) and, therefore, potentially a trigger for an amendment of Schedule 2 of the *Metal Mine Effluent Regulation* (*MMER*) under the federal *Fisheries Act*; and 3) to quantify and map all habitat in these two tributaries upstream and downstream of the first cascade impediments to upstream fish passage in both streams.

Habitat assessments, barrier identification, and fish sampling was conducted in Stream 76800 and ILP 887 (and their tributaries) upstream of the cascade impediments on 24 and 25 June and between 14 and 18 July 2011. These efforts included sampling in each reach of both streams upstream of the first cascade impediments, sampling in all tributaries upstream of these first cascades, and sampling in three unnamed ponds upstream or within the TMF footprint. A summary of the stream reaches, tributaries and waterbodies sampled for fish in June and July is provided in Table 6.7.4-1.

Fish sampling included minnow trapping, backpack electrofishing, and visual observations. A two-person crew conducted all field work on both surveys of both creeks. Fish-bearing status was determined using the “First-fish-captured” method as recommended in the Fish-stream Identification Guidebook (Forest Practices Code of British Columbia (FPCBC) 1998). Fish habitat was assessed using methods described for a Level 1 Fish Habitat Assessment Procedure (FHAP; Johnston and Slaney 1996).

The June survey was timed during the descending limb of the spring freshet. This timing allowed for increased safety and a higher fishing efficiency than during the spring freshet peak without significantly compromising the likelihood of capturing any ripe or post-spawned rainbow trout upstream of the cascades. The July survey was conducted during the beginning of the summer low flow period and was conducted to increase the spatial extent of sampling conducted in June.

Table 6.7.4-1: Summary of Fish Sampling Effort in Stream 76800 and ILP 887 Watersheds in June and July, 2011

Watershed	Watercourse / Waterbody	Reach	Date	Method	Effort		
					Distance (m)	Duration (sec)	Total Soak Time (hours)
Stream 76800	Stream 76800 mainstem	5	June 24	EF	192	1,208	
			June 25	MT			117[a]
			July 14	EF	192	395	
			July 14	EF	185	276	
			July 15	MT			127[a]
			July 14	EF	231	350	
			July 15	MT			75[b]
			July 14	EF	100	165	
			July 15	MT			24[c]
	ILP 910	1	July 14	EF	100	147	
			July 15	MT			24[c]
	ILP 900	1	July 14	EF	100	151	
	Pond A[f]		July 17	MT			70[b]
	Pond B[g]		July 17	MT			76[b]
				Total effort	1,100	2,692	513
ILP 887	ILP 887 mainstem	2	June 24	EF	680	1,949	
			June 25	MT			126[a]
		3	July 17	MT			42[d]
	ILP 890	2	July 17	MT			39[d]
		2	July 22	EF	120	296	
	Pond C[h]		July 18	MT			100[e]
				Total effort	800	2,245	307

Note: EF - electrofishing; ILP - Interim Locational Point; MT - minnow trap

[a] cumulative soak time for five minnow traps; [b] cumulative soak time for three minnow traps; [c] cumulative soak time for one minnow trap; [d] cumulative soak time for two minnow traps; [e] cumulative soak time for four minnow traps

[f] Lake A is a small pond located on ILP 900

[g] Lake B is a pond located south of Stream 76800 with no visible outlet channel; during high water, pond would drain north to Stream 76800

[h] Lake C is a pond located adjacent to ILP 890 with no visible outlet channel

ILP 895 was not sampled for fish because it was assumed fish bearing because its confluence with Stream 76800 is located between Lake 901 and the first cascade on Stream 76800

6.7.4.6 Detailed Baseline for Rainbow trout

6.7.4.6.1 Species Composition and Relative Abundance

Rainbow trout were the only fish species captured in the Clary Creek watershed in 2010 and 2011. These results indicate that rainbow trout are the only fish species present in the Clary Creek watershed upstream of the impassable waterfalls located approximately 250m from the confluence of Clary Creek and the Illiance River. These falls are over 30 m in height and, therefore, present a permanent barrier to upstream passage of anadromous fish from the Illiance River into Clary Creek.

The source of rainbow trout in the Clary Creek watershed upstream of the waterfalls is from stocking. The BC MOE has stocked rainbow trout into Killam Lake, upstream of Clary Lake, on at least six occasions since 1988 (Table 6.7.4-2). However, the presence of rainbow trout in Clary Lake during the 1979 survey conducted by Fanning (1980) indicates that rainbow trout were stocked into the Clary Creek watershed either before the province began keeping stocking records or were stocked by someone or some other agency before the province began stocking in 1988. The road from the Kitsault Townsite to Nass Camp was not completed until 1982 (Greg Smyth, pers. comm.). This suggests that the initial stocking of rainbow trout into the Clary Creek watershed would most likely have been done from float plane or helicopter by the province or by employees of previous Kitsault mine operations after the road from Kitsault to Clary Lake was built in 1967.

Table 6.7.4-2: Summary of Known Rainbow Trout Stocking in Killam Lake by the BC MOE

Date	# of Fish Released	Life Stage Released	Brood Stock	Hatchery
1 June 1988	3,300	unknown	NRT Premier	Loon Creek
16 June 1989	3,000	yearling	NRT Premier	Loon Creek
8 September 1990	3,000	Fall fry	Sheridan	Loon Creek
4 September 1996	3,000	Fall fry	NRT Premier	Loon Creek
12 September 2000	3,000	Fall fry	Badger Tunkwa	Clearwater
11 September 2003	3,000	Fall fry	Dragon	Clearwater

Source: Habitat Wizard Lake Report (waterbody identifier 00486KSHR)

6.7.4.6.2 Catch Per-Unit-Effort in Lakes

A total of 21 rainbow trout were captured in gillnets set in Clary Lake in 2010(Table 6.7.4-3). CPUE for rainbow trout captured in the sinking gillnet was 2.4 fish/100 m^2/24 hours while the CPUE for rainbow trout captured in the floating gillnet was 8.9 fish/100 m^2/24 hours. The higher CPUE in the floating gillnet was likely due to the pelagic nature of adult rainbow trout (Bassista and Maiolie 2004), especially in lakes devoid of other predatory fish species.

Only two rainbow trout were captured in gillnets set in Lake 901 in 2010 (Table 6.7.4-3). This was because soak times for all three gillnet sets were short (<2 hours) to minimise mortalities in this small lake. Despite the short sets, CPUE for rainbow trout captured in the sinking and floating gillnets were higher in Lake 901 (16.0 fish/100 m^2/24 hours and 18.3 fish/100 m^2/24 hours, respectively) than in similar nets set in Clary Lake.

Although too few net sets were conducted in either lake to make statistically comparisons, the greater rainbow trout CPUE in Lake 901 may be due to greater catchability of rainbow trout in Lake 901 due to its shallower depth (< 6 m maximum depth) and shallower littoral gradient than in Clary Lake. However, this may also be due to Lake 901's great habitat diversity, warmer summer water temperatures, and greater proportion of littoral area to total lake area (and correspondingly higher benthic invertebrate production). No fish were captured in the six minnow traps set in the littoral area during 110.8 trap-hours of effort.

6.7.4.6.3 Length, Weight, and Condition

Rainbow trout captured in Clary Lake in 2010 ranged in length between 112 mm and 282 mm with a modal length class of 241 mm to 260 mm (Figure 6.7.4-2). These 21 fish had a mean length and mean weight of 205 mm, 105 g, respectively, with a mean condition factor of 1.02 (Table 6.7.4-3). The weight-length relationship for Clary Lake rainbow trout is presented in Table 6.7.4-4.

The two rainbow trout captured in Lake 901 were both 270 mm in length and weighed 200 g and 210 g each. These fish were 4+ and 5+ years old and had condition factors of 1.02 and 1.07, respectively.

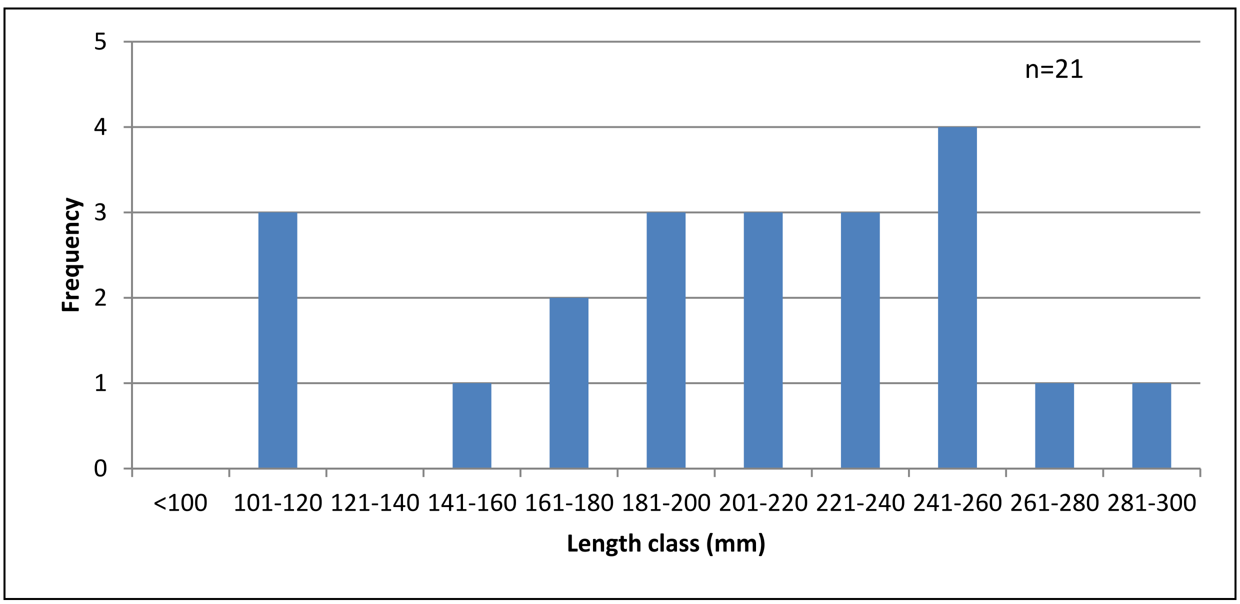


Figure 6.7.4-2: Length-Frequency Distribution of Rainbow Trout Captured in Clary Lake in 2010

Table 6.7.4-3: Average Length, Weight, and Condition Factor of Rainbow Trout Captured in Clary Lake and Lake 901 Creek in 2010

Lake	Length (mm)				Weight (g)				Condition			
	n	Mean	SE	Range	n	Mean	SE	Range	n	Mean	SE	Range
Clary Lake	21	205.1	11.2	112-282	21	105.3	15.0	14.2-260	21	1.02	0.02	0.83-1.21
Lake 901	2	270.0	0.0	270-270	2	205.0	5.0	200-210	2	1.04	0.03	1.02-1.06

Note: n - number of samples; SE - standard error

Table 6.7.4-4: Weight-Length Relationship for Rainbow Trout Captured in Clary Lake and Lake 901 in 2010

Lake	Sample size (n)	Equation	r^2
Clary	21	LnWt=3.10LnLt-12.00	0.99
Lake 901[a]	14	LnWt=2.89LnLt-10.90	0.99

Note: [a] includes two fish captured by gillnetting in the lake, five fish captured by electrofishing in inlet tributary 901 and seven fish captured in inlet tributary 887

6.7.4.6.4 Age, Growth, and Maturity

Rainbow trout captured in Clary Lake in 2010 ranged in age from 2+ to 8+ years old with a modal age class of 6+ years old (Figure 6.7.4-3). Mean age of these 21 rainbow trout was 5 years old and 67% of these fish were greater than 4 years old.

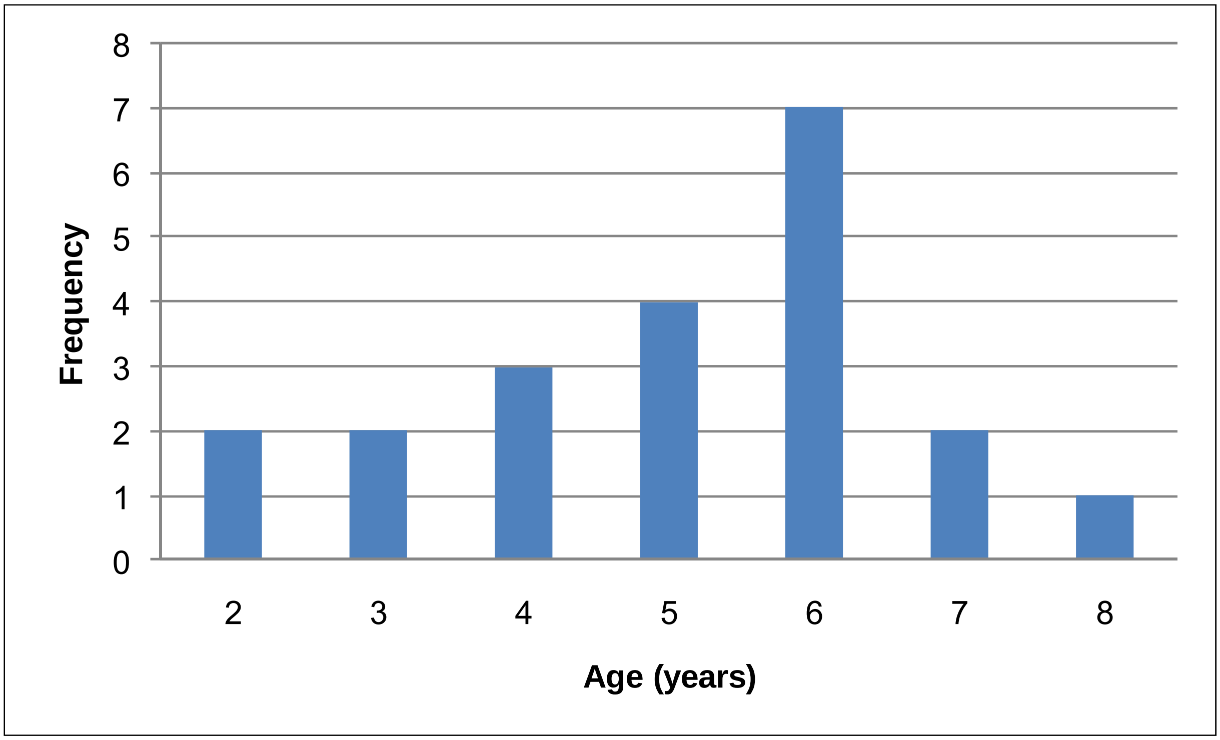


Figure 6.7.4-3: Age-Frequency Distribution of Rainbow Trout Captured in Clary Lake in 2010

Average length, weight, and condition factor at age for rainbow trout captured in Clary Lake in 2010 is presented in Table 6.7.4-5. A von Bertalanffy growth curve is fitted to the length-at-age data in Figure 6.7.4-4. Based on the 21 fish captured in 2010, rainbow trout in Clary Lake have a theoretical maximum length (L_∞) of 350 mm, a growth coefficient (K) of 0.1774, and an age at theoretical zero length (t_0) of -0.261 years.

Rainbow trout exhibit a high degree of variability in growth pattern (Ford et al. 1995; McPhail 2007). This growth is influenced by factors including, but not limited to, elevation, latitude, water temperature (i.e., degree days above threshold for growth), life history pattern (i.e., lacustrine, fluvial, or adfluvial), genetic strain, inter- and intra-species competition for space and food, and prey availability and their associated energy content. Lake resident rainbow trout, such as those in Clary Lake, typically grow faster and larger than stream resident rainbow trout in similar locations. This is because lake resident fish have lower energy requirements than stream resident fish that need to maintain position in flowing water. Similarly, rainbow trout eating fish or benthic or terrestrial invertebrates will grow faster than rainbow trout feeding more exclusively on zooplankton due to their higher energy content

(Siesennop 1998). Rainbow trout in Clary Lake feed primarily on zooplankton (see Section 6.7.4.5.5).

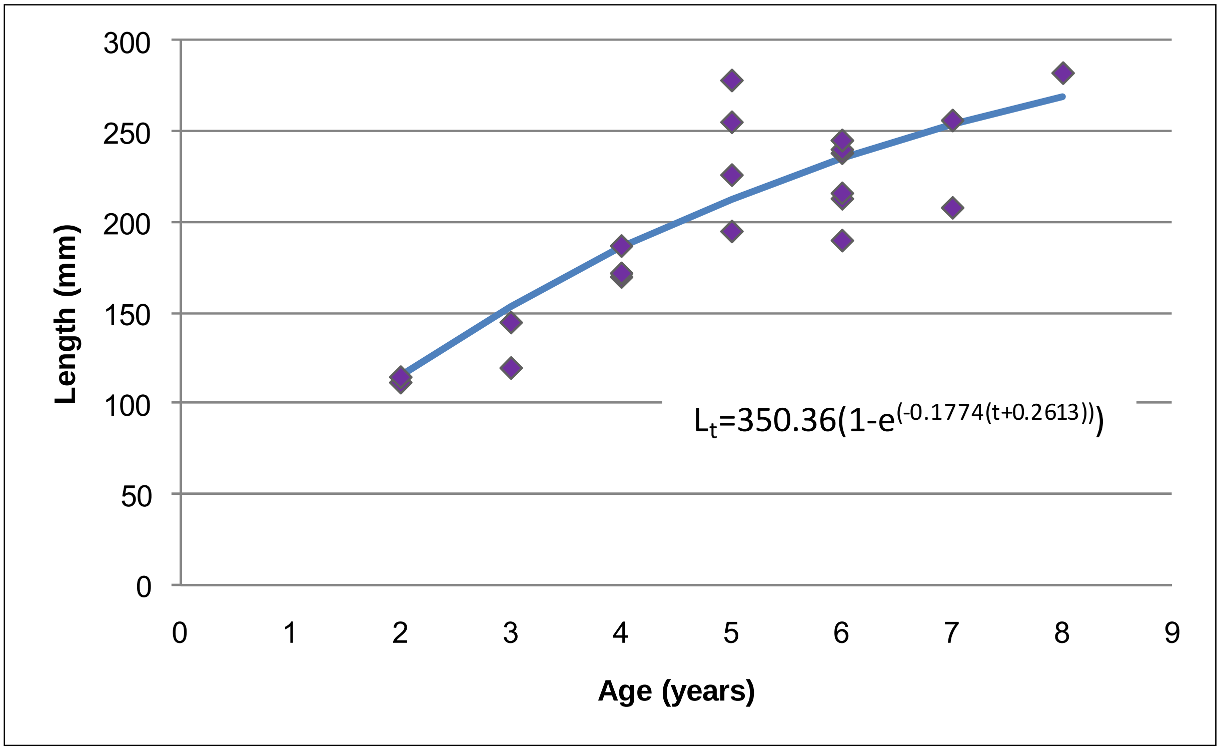


Figure 6.7.4-4: Von Bertalanffy Growth Curve for Rainbow Trout Captured in Clary Lake in 2010

State of sexual maturity of rainbow trout captured in Clary Lake could not be accurately determined due to the timing of the survey in late summer (rainbow trout are spring spawners). However, an estimate of the age and length at sexual maturity of Clary Lake rainbow trout can be approximated from the rainbow trout captured in a Clary Lake inlet tributary in spring 2010 (Table 6.7.4-5). From the eight rainbow trout captured in spring for which sex and maturity could be determined, it appears that males reach sexual maturity at a length of at least 118 mm and 2+ years old while females reach sexual maturity at a length of at least 135 mm and 3+ years old (Table 6.7.4-6). Such a difference in maturity between sexes is common and male rainbow trout usually mature at least one year before females (McPhail 2007). Although considerable variability exists between populations of rainbow trout across their distribution in BC, maturity at the ages observed in the rainbow trout captured in the Clary Lake inlet tributary are consistent with many BC lake resident populations (Giroux and Lough 2004).

Table 6.7.4-5: Average Length, Weight, and Condition Factor at Age for Rainbow Trout Captured in Clary Lake in 2010

Age	Length (mm)				Weight (g)				Condition			
	n	Mean	SE	Range	n	Mean	SE	Range	n	Mean	SE	Range
2+	2	113.5	1.5	112-115	2	15.5	1.3	14.2-16.7	2	1.05	0.04	1.01-1.10
3+	2	132.5	12.5	120-145	2	21.0	5.4	15.5-26.4	2	0.88	0.02	0.87-0.90
4+	3	176.3	5.4	170-187	3	55.1	3.9	47.9-61.1	3	1.01	0.05	0.93-1.11
5+	4	238.5	18.0	195-278	4	152.9	41.9	61.6-260.0	4	1.03	0.08	0.83-1.21
6+	7	226.7	7.9	190-245	7	122.1	10.0	68.7-145.4	7	1.04	0.04	0.97-1.21
7+	2	232.0	24.0	208-256	2	141.0	43.7	97.2-184.7	2	1.09	0.01	1.08-1.10
8+	1	282.0	-	-	1	225.0	-	-	1	1.00	-	-
Total	21				21				21			

Note: n - sample size; SE - standard error

Table 6.7.4-6: Length and Age of Mature Female and Male Rainbow Trout Captured in the Clary Lake Inlet (910-929800-05800-76800) in Spring 2010

Spent Females		Spent Males	
Length (mm)	Estimated age[b]	Length (mm)	Estimated age[b]
135	3+	118[a]	2+
148	3+	119	2+
218	5+	152	3+
		176	4+
		194	4+

Note: [a] ripe male

[b] ages estimated from von Bertalanffy growth curve for Clary Lake rainbow trout

6.7.4.6.5 Diet

Zooplankton comprised approximately 85% of the total wet weight of all prey items found in the 17 rainbow trout stomachs from Clary Lake with identifiable prey items (Figure 6.7.4-5). Aquatic dragonfly (Odonata) nymphs (12%) and terrestrial Hemipterans (3%) comprised the remainder of identifiable prey items in rainbow trout stomachs. The other four rainbow trout stomachs were either empty or contained unidentifiable material.

Zooplankton were found in all 17 stomachs with identifiable prey items and 13 of these 17 rainbow trout stomachs (76%) contained zooplankton exclusively. In contrast, only three of the 17 rainbow trout (18%) have been feeding on Odonata nymphs and only one rainbow trout had been feeding on Hemipterans. Interestingly, this one fish was feeding on Hemipterans exclusively. These data suggest that although zooplankton are the primary prey item of Clary Lake rainbow trout, they feed opportunistically on aquatic insect larvae and terrestrial insects. These preys are larger and have a higher lipid content than the smaller zooplankton and, therefore, provide higher energy meals for rainbow trout, which they take advantage of when present on the water surface or in the littoral areas of the lake.

The opportunity for rainbow trout to eat these higher energy preys is likely limited in Clary Lake due to its bathymetry and shoreline characteristics. Clary Lake has a steep shoreline gradient around most of its perimeter and cobbles are the most common littoral substrate type. These two features limit the amount and suitability of Clary Lake's littoral habitat for aquatic insect production. Coupled with the absence of benthic invertebrate prey in the profundal (>20 m) areas that comprise most of the Clary Lake (see Appendix 6.7-A Section 1.6) and the absence of other prey fish species, it is not unexpected that rainbow trout in Clary Lake feed primarily on zooplankton.

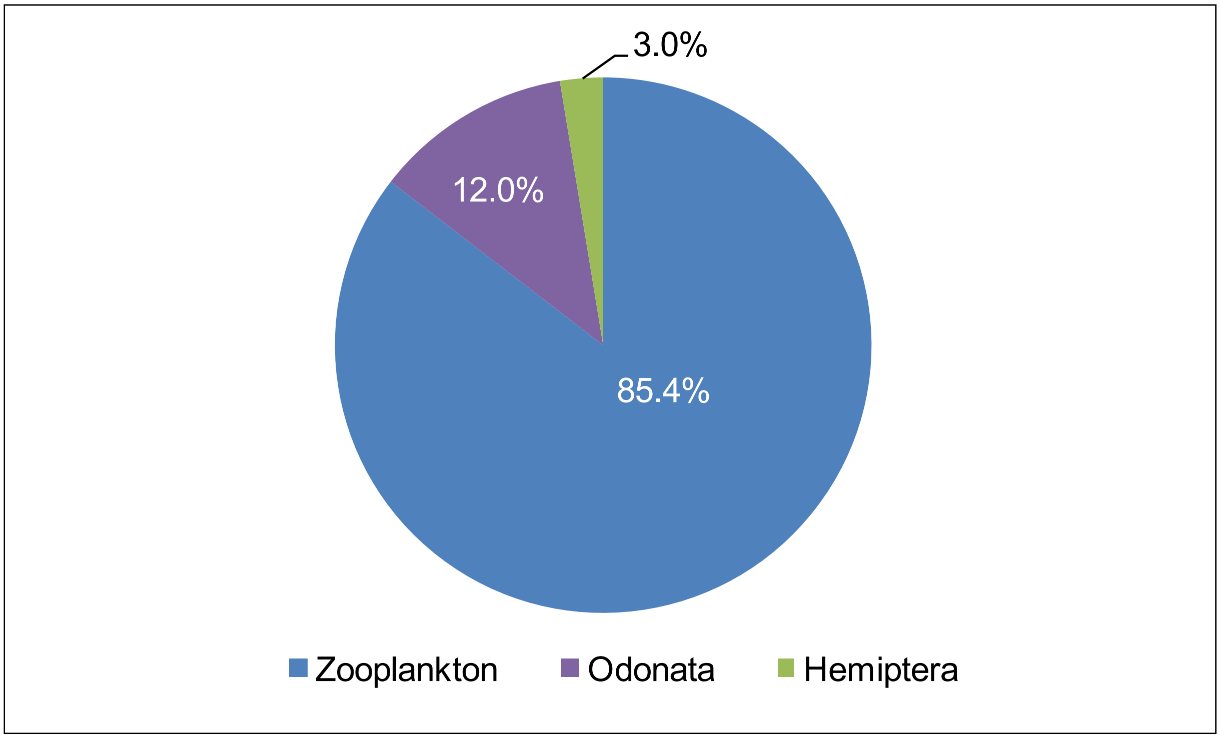


Figure 6.7.4-5: Stomach Contents, as Percent of Total Weight by Major Taxa, of Rainbow Trout captured in Clary Lake in 2010

6.7.4.6.6 Tissue Metal Residues

Mean, standard error, and minimum and maximum total metal concentrations in the 21 rainbow trout analysed from Clary Lake are presented in Table 6.7.4-7. Mean total mercury concentration in rainbow trout in Clary Lake (0.045 mg/kg) was lower than the Canadian Action Level guideline for the protection of human health (0.5 mg/kg; CFIA 2009). None of the fish captured had total mercury concentrations higher than this guideline. However, the mean total mercury concentration in these 21 fish was greater than the provincial and the federal screening value for the protection of piscivorous wildlife from methylmercury (0.033 mg/Kg; BC MOE 2001a; CCME 2000). Only four individual rainbow trout had total mercury concentrations lower than this guideline. Based on these data, mercury in Clary Lake rainbow trout may be a chemical of concern for the health of piscivorous wildlife under current baseline conditions.

Mean total selenium concentration in rainbow trout in Clary Lake (0.4 mg/kg) was lower than the BC MOE guideline for the protection of piscivorous wildlife (1.0 mg/kg; BC MOE 2001b). No individual rainbow trout had a total selenium concentration above this guideline.

Table 6.7.4-7: Metal Concentrations in Rainbow Trout Muscle Tissue from Clary Lake

Metal	Frequency of Detection	Mean	Standard Error	Minimum	Maximum	Screening Value for Protection of Human Health	Screening Value for Protection of Piscivorous Wildlife
Aluminum	0/21	1.1	0.1	1.0	2.0	n/a	n/a
Antimony	0/21	0.005	0.000	0.005	0.010	n/a	n/a
Arsenic	17/21	0.015	0.002	0.005	0.043	n/a	n/a
Barium	15/21	0.018	0.003	0.005	0.074	n/a	n/a
Beryllium	0/21	0.055	0.003	0.050	0.100	n/a	n/a
Bismuth	0/21	0.016	0.001	0.015	0.030	n/a	n/a
Cadmium	19/21	0.013	0.001	0.003	0.028	n/a	n/a
Calcium	21/21	242	17	152	501	n/a	n/a
Chromium	7/21	0.12	0.03	0.05	0.45	n/a	n/a
Cobalt	2/21	0.01	0.00	0.01	0.04	n/a	n/a
Copper	21/21	0.302	0.009	0.238	0.409	n/a	n/a
Lead	0/21	0.01	0.00	0.01	0.02	n/a	n/a
Lithium	1/21	0.06	0.00	0.05	0.11	n/a	n/a
Magnesium	21/21	213	5	168	249	n/a	n/a
Manganese	21/21	0.358	0.074	0.132	1.650	n/a	n/a
Mercury	21/21	0.045	0.003	0.025	0.082	0.5[c]	0.033[a]
Molybdenum	3/21	0.007	0.001	0.005	0.020	n/a	n/a
Nickel	4/21	0.08	0.01	0.05	0.25	n/a	n/a
Selenium	20/21	0.45	0.03	0.20	0.76	n/a	1.0[b]
Silver	0/21	0.005	0.000	0.005	0.010	n/a	n/a
Strontium	21/21	0.262	0.022	0.148	0.556	n/a	n/a
Thallium	0/21	0.005	0.000	0.005	0.010	n/a	n/a
Tin	5/21	0.049	0.011	0.025	0.213	n/a	n/a
Uranium	0/21	0.001	0.000	0.001	0.002	n/a	n/a
Vanadium	0/21	0.05	0.00	0.05	0.10	n/a	n/a
Zinc	21/21	8.65	0.40	5.78	12.40	n/a	n/a

Note: All metal concentrations are in milligrams of total metal per kilogram of wet weight fish tissue (mg/kg ww muscle filet); n/a - not applicable (no published Canadian screening value exists);
Descriptive statistics were calculated using data for 21 rainbow trout with a mean (± 1 SD) length of 205 ± 51 mm and a mean of weight 105 ± 69 g

Grey highlights represent chemical that may be of potential concern to the health of piscivorous wildlife. Refer to Section 6.12 for discussion of potential ecological health risks.

Source: [a] BC MOE guideline for methylmercury (BC MOE 2001a, based on CCME 2000); [b] BC MOE guideline for total selenium (BC MOE 2001b), [c] Canadian Action Level for contaminants in fish and fish products (CFIA 2009)

6.7.4.6.7 Lake 901 Inlet Tributaries

6.7.4.6.7.1 2010 Results

Rainbow trout were captured or observed in the both of the two main inlet tributaries of Lake 901 in 2010. No fish were captured in Stream 76800 in 2010. However, adult rainbow trout were observed in the lower 50 m of the creek in spawning colors in June. These fish, combined with the abundance of pool with undercut banks and woody debris and riffles with suitably sized gravels in the lower 300 metres of the creek, indicates that this stream is one of the primary spawning sites for Lake 901 rainbow trout.

Table 6.7.4-8: Summary of Fish Captured in Lake 901 Inlets in Summer, 2010

Watershed Code / ILP #	Reach	Total Effort (seconds)	# of Rainbow Trout Captured	CPUE[1]
910-929800-05800-76800	5[2]	1,116	0	0.0
910-929800-05800-76800	3[3]	1,193	0	0.0
887	1[3]	597	7	1.2
Total		2,906	7	

Note: [1] catch-per-unit-effort (CPUE) is in fish/100 seconds of backpack electrofishing
[2] upstream of 1st cascade impediment
[3] downstream of 1st cascade impediment
ILP - Interim Location Point

Similar high quality spawning and rearing habitat for rainbow trout exists in Stream 887, the second largest inlet tributary to Lake 901 after Stream 76800. Seven rainbow trout were captured in the lower reach of this stream in July 2010 downstream of the first cascade impediment to fish passage located approximately 250 metres upstream from the lake. Because all other Lake 901 inlet tributaries are either ephemeral or lack sufficient depth, gradient, or suitably sized substrates, Stream 887 and Stream 76800 are the only two Lake 901 tributaries useable by Lake 901 rainbow trout for spawning. The Lake 901 outlet does not provide suitable spawning habitat for rainbow trout because it lacks gravel substrates; substrates in the outlet are comprised exclusively of bedrock or angular cobbles and boulders.

No fish were captured upstream of the first cascade impediment to fish passage in Stream 76800 in July 2010 despite 1,116 seconds of electrofishing (Table 6.7.4-8). Fishing was not conducted above the first cascade impediment in Stream 887 in 2010.

6.7.4.6.7.2 2011 Results

Three rainbow trout were captured in the Stream 76800 watershed upstream of the first cascade impediment (Cascade C1) in 2011 (Table 6.7.4-9): one in June and two in July. All three fish were captured in minnow traps in the Stream 76800 mainstem within 100 metres of this cascade (Figure 6.7.4-6) The fish captured in June was a juvenile (56 mm in length) while the two fish captured in July included a juvenile (65 mm) and a mature female

(187 mm). No fish were captured above the second cascade (Cascade C2) in the Stream 76800 mainstem, in ILP 900, in ILP 910 or in Pond A or Pond B in July.

Six rainbow trout were captured or observed between the first and second cascade impediments on the ILP 887 mainstem in June (Figure 6.7.4-6): three fish were captured electrofishing, one fish was captured in a minnow trap, and two fish were visually observed (Table 6.7.4-9). The four captured fish ranged in length between 110 mm and 180 mm while the two observed fish appeared to be approximately 170 mm. All four of the captured fish were ripe males.

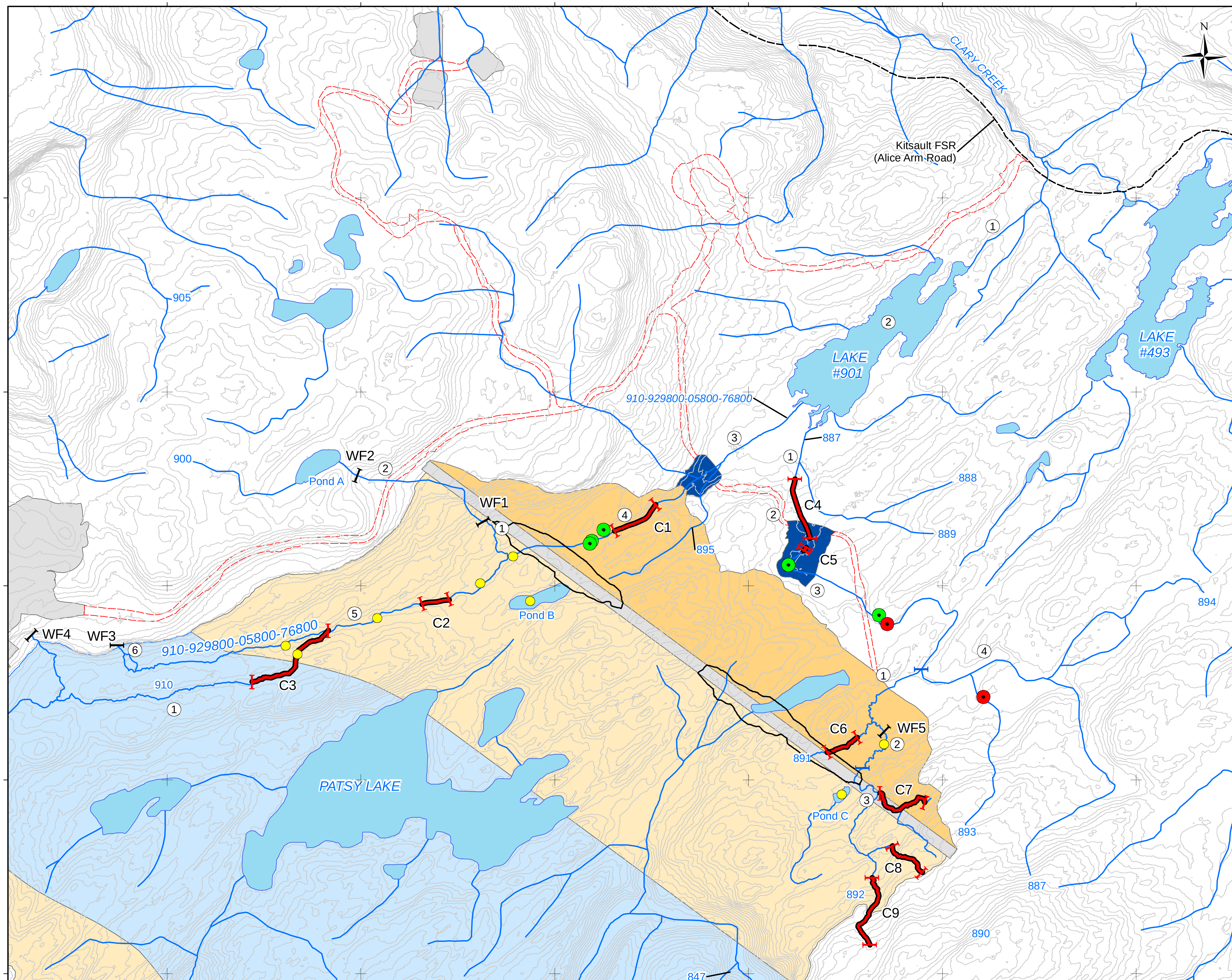
Three other rainbow trout were captured or observed upstream of the second cascade impediment (Cascade C5) on ILP 887 in July. These fish confirm that Cascade C5 is not a barrier to upstream fish passage. One rainbow trout (190 mm) was captured in a minnow trap set in ILP 887 immediately upstream of the second cascade. The two other rainbow trout were visually observed: one 150 mm rainbow trout was observed at the minnow trap site above cascade C5 in ILP 887 and one 110 mm rainbow trout was observed in ILP 893. No fish were captured in ILP 890 upstream of the 3 m high waterfall (Waterfall WF5) and this reach is considered non-fish-bearing. Similarly, no fish were captured in minnow traps set in Pond C on ILP 891 and this pond is also considered no-fish-bearing.

Table 6.7.4-9 Summary of Fish Captured in Stream 76800 and ILP 887 Watersheds in June and July, 2011

Watershed	Watercourse / Waterbody	Reach	Date	Method	Catch and Catch-Per-Unit-Effort	
					Catch	CPUE[a]
Stream 76800	Stream 76800 mainstem	5 (between Cascades C1 and C2)	June	EF	0	0.000
			June	MT	1	0.009[b]
			July	EF	0	0.000
			July	MT	2	0.157[c]
		5 (upstream of Cascade C2)	July	EF	0	0.000
			July	MT	0	0.000
		6		Not sampled		
	ILP 895	1	July	Not sampled		
	ILP 910	1	July	EF	0	0.000
			July	MT	0	0.000
	ILP 900	1	July	EF	0	0.000
	Pond A		July	MT	0	0.000
	Pond B		July	MT	0	0.000
				Total catch	3	
ILP 887	ILP 887 mainstem	2 (between Cascades C4 and C5)	June	EF	3	0.154
			June	MT	1	0.008[d]
			June	VO	2	
		3 (upstream of Cascade C5)	July	MT	1	0.024[e]
			July	VO	1	
	ILP 890	1	July	Not sampled		
		2	July	MT	0	0.000

Watershed	Watercourse / Waterbody	Reach	Date	Method	Catch and Catch-Per-Unit-Effort	
					Catch	CPUE[a]
			July	EF	0	0.000
	ILP 891	1	July	Not sampled		
	ILP 892	1	July	Not sampled		
	ILP 893	1		VO	1	
	Pond C		July	MT	0	0.000
				Total catch	9	

Note: [a] catch-per-unit-effort for electrofishing is presented in fish per 100 seconds of electrofishing; catch-per-unit-effort for minnow trapping is presented as fish per trap-hour
[b] CPUE based on total fish captured in five minnow traps with a cumulative soak time of 117 trap-hours
[c] CPUE based on total fish captured in five minnow traps with a cumulative soak time of 127 trap-hours
[d] CPUE based on total fish captured in five minnow traps with a cumulative soak time of 126 trap-hours
[e] CPUE based on total fish captured in two minnow traps with a cumulative soak time of 42 trap-hours
CPUE - catch-per-unit-effort; EF - electrofishing; ILP - interim locational point; MT - minnow trap; VO - visually observed



Legend

- Stream
- Waterbody
- 888 Watershed Code / (ILP) Interim Locator Point
- 1 Reach Number
- C1 Cascade
- WF1 Waterfall
- Reach Break
- No Fish Captured
- Fish Captured - Rainbow Trout (all electrofishing and minnow trap sites)
- Visual Observation - Rainbow Trout
- Access Road
- Mine Site Road
- Contour (5 m)
- Project Infrastructure
- Northeast Embankment
- Northeast Seepage Collection Ponds
- Tailings Beach
- Tailings Management Facility (TMF) Supernatant Pond

KEY MAP

YUKON, NORTHWEST TERRITORIES, BRITISH COLUMBIA, ALBERTA, Project Location, UNITED STATES

Scale: 1:10,000

0 50 100 200 300 400 500 Metres

Reference
1. Base Data
Geobase 1:20,000 (TRIM)
Land and Resource Data Warehouse 1:20,000 (TRIM)
2. Kitsault Mine General Layout
Supplied by AMEC and Knight Piesold on March 2011

CLIENT: Avanti Kitsault Mine Ltd.

PROJECT: Kitsault Mine Project

Location of Fish Captured or Observed in Lake 901 Tributaries Potentially Affected by the Tailing Management Facility

DATE: November 2011	ANALYST: MY	**Figure** 6.7.4-6
JOB No: VE51988	QA/QC: BH	PDF FILE: 10-50-083_fish_caught_v3.pdf
GIS FILE: 10-50-083_v3.mxd		
PROJECTION: UTM Zone 9	DATUM: NAD83	amec

Y:\GIS\Projects\VE\VE51988_Kitsault\Mapping\10_fisheries-aquatics\Baseline\10-50-083_v3.mxd

The presence of rainbow trout upstream of the first cascades upstream from the Lake 901 in both Stream 76800 and ILP 887 indicates that these cascades are impediments and not barriers to the upstream migration of rainbow trout from Lake 901. The first cascade in Stream 76800 (Cascade C1 in Figure 6.7.4-6) is a bedrock/boulder cascade approximately 195 m long that begins approximately 350 m upstream from Lake 901 and gradual increases in gradient from 10% to its culmination in a 35 m long, 20% gradient, bedrock-confined, boulder cascade approximately 550 m upstream from Lake 901 (Figure 6.7.4-7). This geometry creates a potential velocity barrier in most springs when water is sped up and concentrated between the bedrock banks. This cascade also hinders upstream fish passage during the low flow summer period because there are no pools at the bottom or in the middle of the cascade deep enough for fish to attain the speeds necessary for jumping (e.g., <25 cm deep pool at the bottom). Nonetheless, the presence of fish upstream of this cascade indicates that rainbow trout can move upstream past this cascade in some years. It is unknown at this time what flow conditions are necessary for this passage to occur.

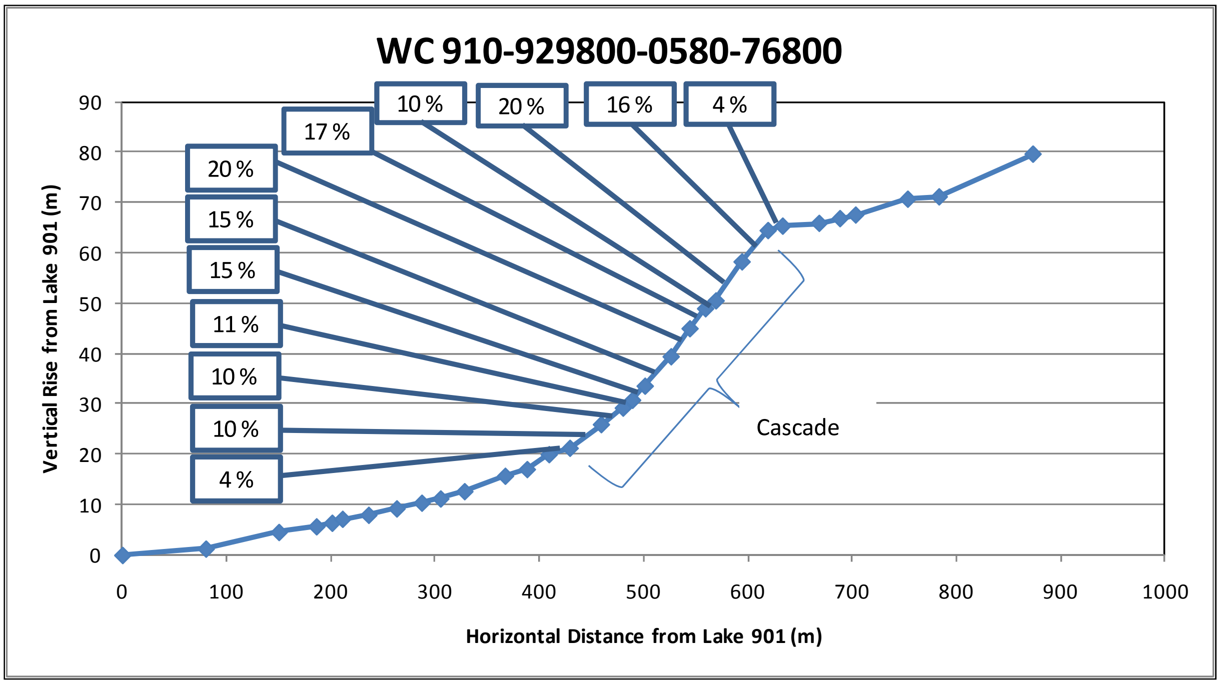


Figure 6.7.4-7 Longitudinal Gradient Profile of Stream 76800 from Lake 901 Upstream Past the 1st Cascade Impediment to Fish Passage.

The cascade in ILP 887 is an approximately 120 m long, boulder cascade with a gradient that increases from 10% to its culmination in an approximately 18% gradient, bedrock-constricted cascade located approximately 250 m upstream from Lake 901 (Cascade C4 in Figure 6.7.4-6; Figure 6.7.4-8). This cascade includes numerous drops up to 1 m high over large woody debris and bedrock outcrops. Similar to the first cascade in Stream 76800, high flows in spring and low flows in summer would hinder the upstream movement of rainbow trout from Lake 901 into the upper reaches of the watershed. Nonetheless, the presence of fish above this cascade and above the second most upstream cascade (Cascade C5 in Figure 6.7.4-6) indicates that rainbow trout can pass upstream past these impediments at certain flows. The second cascade is an approximately 100 m long, 10% gradient, boulder cascade located approximately 750 m upstream of Lake 901.

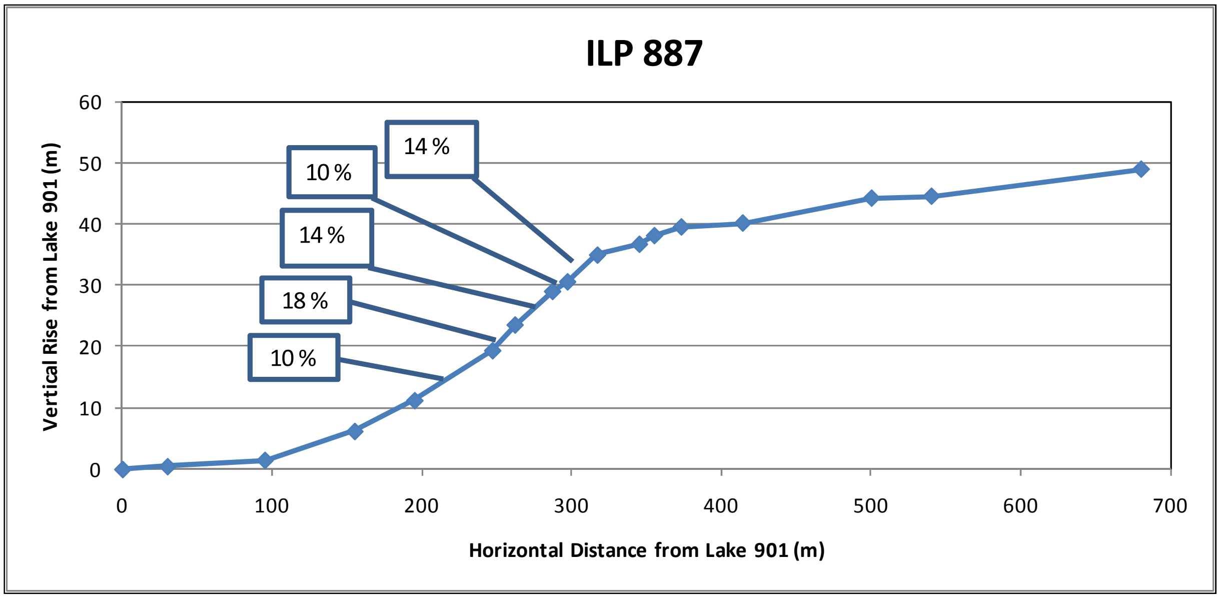


Figure 6.7.4-8 Longitudinal Gradient Profile of ILP 887 from Lake 901 Upstream Past the 1st Cascade Impediment to Fish Passage

In addition to these larger, mainstem cascades, there are shorter, less steep cascades and waterfall barriers in both the Stream 76800 and ILP 887 watersheds (Figure 6.7.4-6). In Stream 76800 watershed, these include an approximately 55 m long, 16% gradient, boulder cascade on the Stream 76800 mainstem (Cascade C2) approximately 1.1 km upstream from the first cascade and an approximately 330 m long, 6% gradient, boulder cascade in ILP 910 located approximately 50 m upstream from its confluence with Stream 76800 (Cascade C3). Waterfalls in the Stream 76800 watershed include: 1) a 16 m long cascade / waterfall with multiple >2 m high vertical drops in ILP 900 (Waterfall WF1); 2) an approximately 16 m high waterfall on Stream 76800 at its headwaters (Waterfall WF4); and 3) an approximately 12 m high waterfall on ILP 910 at its headwaters (Waterfall WF3). The barrier on ILP 900 (Waterfall WF1) excludes fish from accessing a steep gradient stream leading to a small headwater pond on an elevated plateau. The other two barriers (Waterfalls WF3 and WF4) exclude fish from very small (<0.5 m wide), ephemeral headwater streams with little to no useable fish habitat for rainbow trout. An approximately 3 m high waterfall located in ILP 890 in the ILP 887 watershed (WF5 in Figure 6.7.4-6) excludes fish from headwater tributaries under the TMF northeast embankment and within the TMF.

6.7.4.7 Cultural Ecological or Community Knowledge

The Kitsault Project is within the Nass Area and the Nass Wildlife Area (NWA) as defined by the Nisga'a Final Agreement (NFA). The Nisga'a Nation has a right to harvest fish within the Nass Area for domestic, ceremonial, and cultural purposes within limits of conservation, health, and safety measures. While the NFA does not specifically provide for allocations of rainbow trout, the species is of importance to the Nisga'a Nation for environmental reasons. Trout have been studied and monitored by the Nisga'a Nation "because of their importance to both the environment and the future of the overall fishery" (NLG 2001). Additional information on Nisga'a fish rights and management are contained in Part C (Sections 13).

There are five potentially affected Aboriginal groups that have interests in rainbow trout, including:

- **Metlakatla First Nation**: Desk-based research did not result in any specific information on Metlakatla interests related to rainbow trout. Ongoing future consultation may provide additional information and understanding into their interests;
- **Kitselas First Nation** has interests in fishing for rainbow trout, which is importance for subsistence, economic, and cultural purposes;
- **Kitsumkalum First Nation**: Kitsumkalum Lake is stocked with rainbow trout, and Kitsumkalum members have an interest in fishing rainbow trout;
- **Gitanyow Hereditary Chiefs** have interests in rainbow trout in terms of harvesting and managing populations along the Kitwanga and Cranberry Rivers. In 2010, Gitanyow Fisheries Authority caught 216 rainbow trout smolt at the Kitwanga fish fence; and
- **Gitxsan Chiefs** Desk-based research did not result in any specific information on Gitxsan Chiefs interests related to rainbow trout. Ongoing future consultation may provide additional information and understanding into their interests.

6.7.4.8 Past, Present or Future Projects / Activities

Tables 6.7.4-10, 6.7.4-11 and 6.7.4-12 below present a review of the historical land use, present land use and reasonably foreseeable projects, respectively, which have been identified within the rainbow trout CESA. The number of projects listed in these tables is restricted to those past, present, and reasonably foreseeable land use activities either located in the Clary Creek watershed, the boundaries of the rainbow trout cumulative effects study area, or that have the potential to affect rainbow trout in the Clary Creek watershed due to increased access and fishing pressure. This is because rainbow trout are resident to the Clary Creek watershed and there is no opportunity for rainbow trout outside of the Clary Creek watershed from moving upstream into Clary Creek due to the impassable waterfalls near the confluence of Clary Creek and the Illiance River and because any rainbow trout moving downstream past these falls are permanently lost to the Clary Creek system.

Table 6.7.4-10: Historical Land Use Activities in Biophysical Cumulative Effects Assessment Study Area

Project/Activity	Description
Kitsault Mine and exploration	Exploration, which appears to have begun in the area in 1911, identified the presence of an orebody in late 1964. The mine was owned by B.C. Molybdenum, a subsidiary of KEL from 1963 to 1972 and by Climax Molybdenum Company of British Columbia (CMC) and affiliates from 1973 to 1998. Between January 1968 and April 1972, approximately 9.3 million tonnes of ore were produced with about 22.9 million pounds of molybdenum recovered. CMC returned the mine to production in 1981 but production was terminated again because of low metal prices in 1982.
Kitsault Townsite	The Kitsault Townsite, built in the 1970s and opened in 1981 to support the Kitsault Mine, was occupied for less than two years. The Kitsault Townsite, which is located approximately 5 km from the proposed Project, was purchased by Kitsault Resort Ltd. in 2005 and has been, and continues to be, maintained by caretakers.

The historical land use with the greatest potential to cumulatively affect rainbow trout is the past mining activities at the Kitsault Mine site. Of particular relevance to rainbow trout was the previous utilisation of Clary Lake as the freshwater supply for potable water and processing plant requirements. To facilitate water withdrawals from the lake, a pump house was constructed on the western side of the main basin of Clary Lake. Water levels in the main basin were raised in the early 1970s by approximately 1 metre by constructing a dyke at the western outlet of Clary Lake so that pumps would not be "cut-off" from the majority of inflows to Clary Lake by the shallow narrows between the north and south basins of the lake during summer and winter low flow conditions. This was likely also around the time when rainbow trout were first introduced to Clary Lake, presumably by mine workers or residents with new access to the lake provided by the road to the pumphouse.

While it is highly unlikely any effects of fish mortalities in Clary Lake due to impingement or entrainment in the pumps are reflected in current size or age structure of the Clary Lake rainbow trout population, any residual effects on rainbow trout due to potential mobilisation of soil bound contaminants such as mercury due to raising of Clary Lake water levels will be reflected in the baseline tissue concentrations in rainbow trout presented in Freshwater Aquatics Baseline Report Appendix 6.7-A and summarised in Section 6.7.4.6 above. Given that this flooding occurred over 30 years ago and lasted less than five years, it is unlikely that any remnants of this flooding on rainbow trout health or tissue metals concentrations persist today. Nevertheless, any past residual effects of the former Kitsault mine operations on rainbow trout are automatically included within the temporal boundaries of the current assessment.

Table 6.7.4-11: Present Land Use Activities in Biophysical Cumulative Effects Assessment Study Area

Project / Activity	Description
Transportation and access	Within the CESA, Highways 113 and 37 are used by local residents and tourists as well as commercial / industrial traffic associated with activities such as exploration. The Nass Forest Service Road (FSR) and Alice Arm Road currently provides access to the Kitsault exploration camp and reclamation area, and access to the town of Kitsault and Alice Arm. This road provides access to lakes in the Clary Creek watershed, principally Killam Lake and Clary Lake.
Mining exploration	Mining exploration activities at the Bell Moly deposit by the proponent is located in the northeastern headwaters of the Clary Creek watershed upstream of Clary Lake.
Trapping and guide outfitting	The proposed Project footprint falls within one trap line tenure area that is routinely used in the winter. The eastern section of the access road leading from Highway 37 falls within another trap line tenure area. The Land Use RSA (and Wildlife RSA) falls within the boundaries of one Guide Outfitter.
Nisg̱a'a Nation hunting, trapping, fishing, and other uses	Nisg̱a'a Nation has guiding entitlements in the Kitsault and Illiance Rivers under the Nisg̱a'a Final Agreement
Aboriginal hunting, trapping, fishing and other uses	There is no known hunting, trapping, or fishing by Aborginal groups in the Clary Creek watershed

Highway 37, the Nass FSR, and the Alice Arm Road currently provide access to lakes and streams known to support rainbow trout, including Killam and Clary Lakes. However, none of these roads would be upgraded and no new roads would be built for the Kitsault Project that would increase access to rainbow trout bearing streams. No potential cumulative interaction between existing transportation and access with the Kitsault Project exists (Table 6.7.4-13).

Exploration of the Bell Moly deposit has the potential to alter water quality and stream flows in the northeastern portion of the Clary Creek watershed. Any residual effects from this exploration has the potential to cumulatively affect rainbow trout that may also be affected by residual effects from construction and operation of the TMF in the southeastern portion of the Clary Creek watershed (i.e., Lake 901 catchment). Potential cumulative effects from the Bell Moly exploration on rainbow trout would most likely occur in Clary Lake, the lake where water from the northeastern and southeastern portions of the Clary Creek watershed meets. Modern exploration operations must follow strict government permit requirements which include best management practices to reduce or eliminate potential effects to fish-bearing habitat downstream. Thus, an interaction is possible but this is not considered a key interaction (Table 6.7.4-13).

There is no potential cumulative interaction between residual effects of the Kitsault Project on rainbow trout any residual effects from trapping or guide outfitting (Table 6.7.4-13). The Nisga'a Nation has angling guide tenures on the Illiance and Kitsault rivers under the NFA. Such tenures would affect steelhead but not resident rainbow trout in the Clary Creek watershed.

Table 6.7.4-12: Reasonably Foreseeable Projects in Biophysical Cumulative Effects Assessment Study Area

Project / Activity	Construction	Operation	Area and Rationale
Northwest Transmission Line Project	Spring 2011 - 2013	Unknown – with routine maintenance it would operate into the foreseeable future	The Northwest transmission line is a 287 KV 335 km transmission line between the Skeena substation (near Terrace) and Bob Quinn Lake.

There are no potential interaction to Rainbow trout from residual effects from the Northwest Transmission Line Project and residual effects from the Kitsault Project. This is because the Northwest Transmission Line Project does not cross any watersheds draining into Alice Arm. Table 6.7.4-13 summarises potential interactions between rainbow trout and historic, present, and reasonably foreseeable land use activities.

Table 6.7.4-13 Assessment of Linkages Between Other Projects, Human Activities and Reasonable Foreseeable Projects with Rainbow Trout

Freshwater Aquatic Resources VC	Historical Land Use					Representative Current and Future Land Use					Reasonably Foreseeable Projects
	Kitsault Mine and exploration	Kitsault Townsite (on-going)	Alice Arm townsite (on-going)	Previous mine operations	Previous mine exploration	Transportation and access	Mining exploration	Trapping and guide outfitting	Nisga'a Nation hunting, trapping, fishing, and other uses	Aboriginal hunting, fishing, and other uses	Northwest Transmission Line Project
Rainbow trout	-	-	NI	NI	NI	NI	o	NI	NI	NI	NI

Note: Interaction definitions: o - interaction; - - key interaction; + - benefit; NI - no interaction

6.7.4.9 Potential Effects of the Proposed Project and Proposed Mitigation

This section presents the likelihood that different Project components and activities would have a direct, indirect, or combined effect on rainbow trout during the construction, operations, closure / decommissioning and post-closure phases of the Kitsault Project. It does so by:

- Identifying each potential direct, indirect, and combined effect that may occur to rainbow trout during each phase of the Project;
- Identifying any direct, indirect, or combined effects on rainbow trout that may indirectly effect other Valued Components (e.g., human health), including other Freshwater Aquatic Resource VCs;
- Identifying any potential direct, indirect, or combined effects on Rainbow trout that are eliminated through implementation of changes to the Project design; these potential effects are not carried forward in the assessment; and
- Identifying and rating the likelihood of mitigation measures that would be implemented to reduce or eliminate potential direct, indirect, or combined effects on Rainbow trout; potential effects where mitigation measures are determined to complete break the linkage between the Project component or activity and the VC are not carried forward in the assessment.

Those direct, indirect, and combined effects carried forward in the effects assessment are presented and rated for their significance to the health, growth, survival, and / or recruitment of Rainbow trout in Section 6.7.4.10.

6.7.4.9.1 Identification and Analysis of Potential Project Effects

6.7.4.9.1.1 Potential Direct Effects on Rainbow trout

For the purposes of this assessment, direct effects to Rainbow trout were considered to occur from those Project components or activities that would result in the direct mortality of individual rainbow trout or the direct loss of their habitat under or downstream of the Project footprint. Based on this definition, there are six potential direct effect of the Kitsault Project on rainbow trout:

- Impingement and entrainment of rainbow trout in the pumps placed in Clary Lake for the freshwater supply needs of the Project;
- Impingement and entrainment of rainbow trout in the pipe (if this option is selected) placed in the Lake 493 outlet to mitigate potential flow reductions, lake level changes, and water quality changes in Lake 901;
- Loss of habitat in two Lake 901 inlet tributaries affected by construction and operation of the northeast embankment of the TMF and the associated seepage collection ponds;

- Loss of habitat and upstream fish passage at stream crossings during upgrading of the existing Kitsault access road;
- Loss of habitat and upstream fish passage at stream crossings during construction of the new mine access road; and
- Increased fishing pressure due to the presence of anglers within the Kitsault mine workforce (Table 6.7.4-14).

Table 6.7.4-14: Potential Direct Project Effects on Rainbow trout

Project Component	Project Phase	Potential Direct Project Effect	Likelihood of Occurrence
Process and potable water supply and storage	Construction, operations	Impingement and / or entrainment of fish in the pumps	Likely
Diversion of water from Lake 493 to Lake 901	Construction, operations, closure / decommissioning	Entrainment of fish in the pipeline (if this option is selected)	Likely
Development and reclamation of the northeast embankment of the TMF	Construction, operations, closure / decommissioning	Mortality of fish and / or loss of habitat used by rainbow trout for spawning and rearing	Likely
Development, reclamation, and decommissioning of the northeast sediment control ponds	Construction, operations, closure / decommissioning	Mortality of fish and / or loss of habitat used by rainbow trout for spawning and rearing	Likely
Overdue maintenance of existing access roads	Construction, operations, closure / decommissioning	Improvement of fish passage at existing culverts	Likely
Construction, maintenance, and decommissioning of new mine access road to processing plant	Construction, operations, closure / decommissioning	Loss of habitat under culverts and / or obstruction of fish passage	Unlikely
Firearms, fishing, and hunting	Construction, operations, closure / decommissioning, post-closure	Potential increase in fishing pressure due to presence of anglers in Kitsault Mine workforce	Likely

Note: TMF - Tailings Management Facility

Besides construction of the new mine access road, all other potential direct Project effects on rainbow trout are carried forward in the assessment. This is because, without mitigation, potential direct effects from these Project activities are likely to occur.

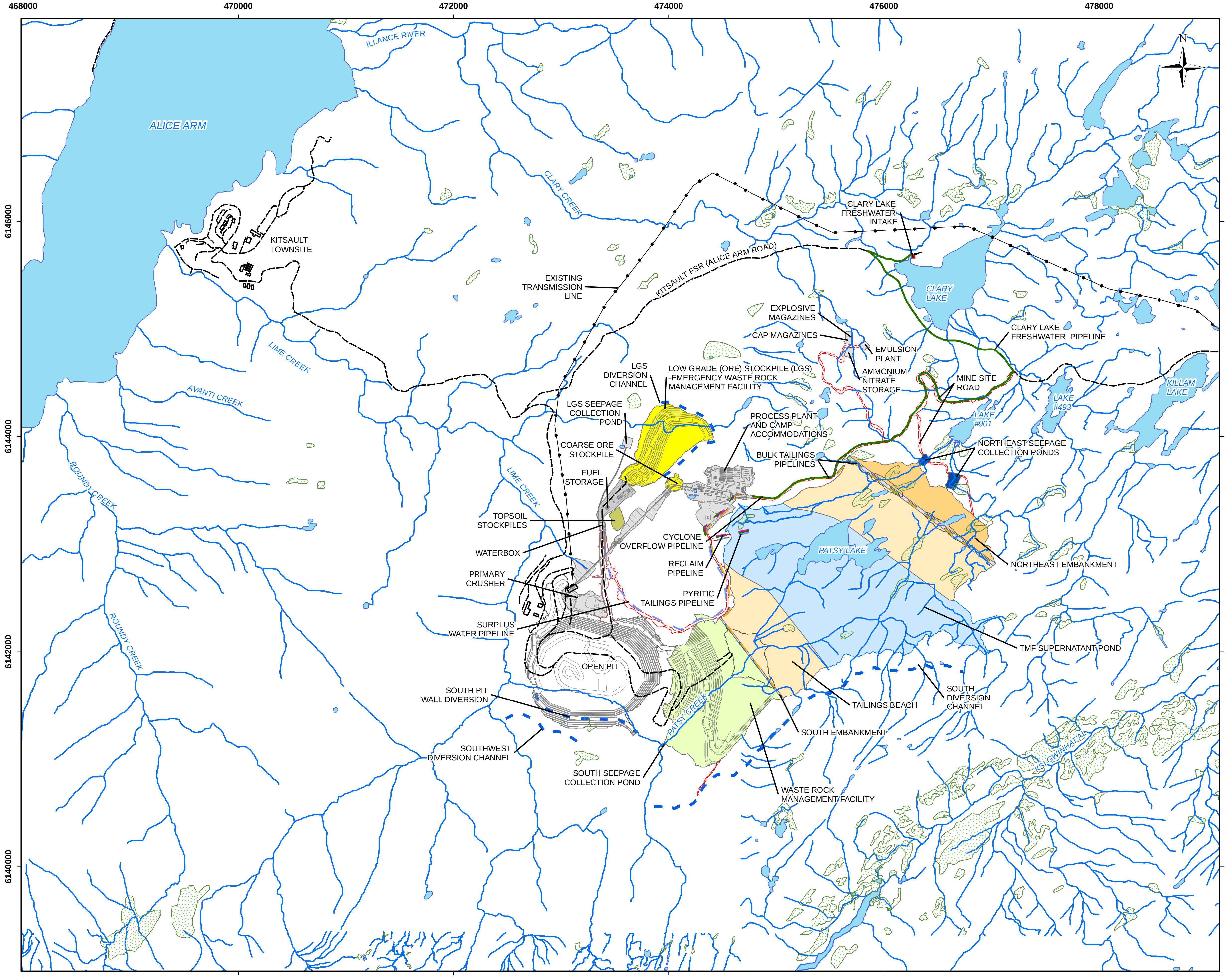
6.7.4.9.1.1.1 Construction of the New Mine Access Road

A new spur road off the existing Kitsault Road would be constructed during the initial stages of the construction phase to allow the transportation of equipment, buildings and supplies to the site of the future processing plant and camp (Figure 6.7.4-9). The proposed road alignment would start at the existing Kitsault Road just downstream of the existing Lake 901 outlet stream crossing and follow a widening route along the western side of Lake 901 and Patsy Lake to the process plant / camp complex location near the western edge of the proposed TMF. Approximately half way along this road, a spur road would be built to provide access to the explosives magazine, cap magazine, and explosives emulsion plant located north of the TMF.

This proposed road alignment would have 14 stream crossings on small (first or second order streams) headwater tributaries of Clary Lake and Lake 901, two lakes known to support populations of rainbow trout. Each of these potential stream crossing sites was investigated in the summer of 2010 (Freshwater Aquatics Baseline Appendix 6.7-A). In summary, four of these sites were identified as having no fisheries potential because they were either non-classified drainages (NCD), did not have a visible channel (NVC), or were located on streams with gradients in excess of 25%. The other 10 stream crossing sites were inferred to be fish-bearing. However, streams at each of these potential crossing sites had gradients >10%, had pool depths <0.25 m, or had bankfull widths <1.0 m. Based on the small size of these creeks, their location upstream of existing culverts (on Clary Creek tributaries), their distance upstream from the lakes (>500 m), and the presence of larger, more suitable tributaries elsewhere, it is unlikely that any of the streams at these sites are used by rainbow trout for spawning, rearing, foraging, or overwintering.

Appropriately sized culverts would be installed at each of these stream crossings according to BC Forest Road Engineering Guidelines (BC MOF 2002). Best management practices, such as those described in “Standards and Best Practices for Instream Works” (BC Ministry of Water, Land, and Air Protection 2004) would be followed and incorporated into a site-specific environmental management plan prior to construction.

These measures, combined with the unlikely presence of rainbow trout in or immediately downstream of the proposed stream crossings, make it highly unlikely that a potential effect to rainbow trout would occur during construction of this new mine access road. For this reason, this potential effect is not carried forward in the assessment.



Legend

- Access Road
- Mine Site Road
- Transmission Line
- Stream
- Waterbody
- Wetland
- Diversion Ditch
- Pipeline - Bulk Tailings
- Pipeline - Cyclone Overflow
- Pipeline - Pyritic Tailings
- Pipeline - Reclaim
- Pipeline - Surplus Water
- Pipeline - Freshwater
- Process Plant
- Open Pit
- Ore Stockpile
- Clary Lake Freshwater Intake
- Topsoil Stockpiles
- Waste Rock Management Facility
- Northeast Embankment
- Tailings Beach
- Tailings Management Facility (TMF) Supernatant Pond

KEY MAP

Scale:1:35,000

1 0.5 0 1

Kilometres

Note:

Drawing is preliminary and subject to revision during ongoing design as additional information is obtained.

Reference

1. Base Data
Geobase 1:20,000 (TRIM)
Land and Resource Data Warehouse 1:20,000 (TRIM)
2. Kitsault Mine General Layout
Supplied by AMEC and Knight Piesold on March 2011

CLIENT:
AVANTI MINING INC
Avanti Kitsault Mine Ltd.

PROJECT:
Kitsault Mine Project

Kitsault Mine Project General Layout

DATE: November 2011	ANALYST: MY	**Figure** 6.7.4-9
JOB No: VE51988	QA/QC: TT	PDF FILE: Other-50-012_project_layout_v8.pdf
GIS FILE: Other-50-012_v8.mxd		amec
PROJECTION: UTM Zone 9	DATUM: NAD83	

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6.7.4.9.1.2 Potential Indirect Effects on Rainbow trout

For the purposes of this assessment, indirect effects to rainbow trout were considered to occur from those Project components or activities that had the potential to indirectly affect the health, growth, survival or recruitment of rainbow trout through direct Project effects to other VCs. The primary VCs through which indirect effects to rainbow trout could occur are changes in surface water quality, changes in lake levels, and changes in stream flows.

Indirect effects to rainbow trout due to changes in surface water quality included direct effects to Lake 901 from seepage through the northeast embankment of the TMF, changes in groundwater quality or quantity, and changes in air quality (e.g., dust deposition and atmospheric deposition of contaminants from burning of fossil fuels). Indirect effects to rainbow trout due to changes in lakes levels included direct effects to Clary Lake due to water withdrawals for potable water supply and direct effects to Clary Lake and Lake 901 due to changes in upstream catchment areas. Indirect effects to rainbow trout due to changes in hydrology included direct effects on stream flows due to changes in upstream catchment areas and diversion of streams.

Other potential indirect effects to rainbow trout included direct Project effects riparian vegetation and direct and indirect effects on benthic macro-invertebrates, one of the principle prey items of rainbow trout in the Clary Lake watershed. All potential indirect effects on rainbow trout were identified after review of the residual effects sections of the hydrology (Section 6.5), surface water quality (Section 6.6), vegetation (Section 6.10), air quality (Section 6.2), and wildlife (Section 6.11) effects assessments. Table 6.7.4-15 summarises all of the potential indirect effects of the Kitsault Project, before mitigation, on rainbow trout during all phases of the Project.

Table 6.7.4-15 Potential Indirect Project Effects on Rainbow Trout

Project Component	Project Phase	Potential Indirect Effect	Likelihood of Occurrence
Land clearing, top-soil stripping, and grading of land for mine infrastructure installations	C	Potential increase in suspended solids in Lake 901 and Clary Lake decreases growth and survival of rainbow trout and their eggs	Likely
Emissions and dust generation (fugitive emissions, equipment operation and movement)	C,O, D/C, PC	Potential increase in suspended solids in Lake 901 and Clary Lake decreases growth and survival of rainbow trout and their eggs	Likely
Coffer dams, sumps, pump systems, and diversion ditches	C, O, D/C	Potential change in stream flows in Lake 901 inlet tributaries; potential decrease in growth and survival of Rainbow trout and their eggs	Likely
Explosives manufacturing facility and explosives magazine	C, O, D/C	Potential increase in suspended solids in Lake 901 and Clary Lake decreases growth and survival of rainbow trout and their eggs	Unlikely

Project Component	Project Phase	Potential Indirect Effect	Likelihood of Occurrence
Water management including dewatering, diversions, and downstream discharges	C, O, D/C	Potential change in lake levels in Lake 901 and Clary Lake; Potential change in stream flows in Lake 901 tributaries and Clary Creek; Potential change in discharge in Lake 493 outlet; potential decrease in growth, survival, and recruitment of rainbow trout	Likely
Surface water management and diversion systems	O, D/C, PC	Potential change in lake levels in Lake 901 and Clary Lake; Potential change in stream flows in Lake 901 tributaries and Clary Creek; potential decrease in growth, survival, and recruitment of rainbow trout	Likely
Storm-water run-off measures (northeast embankment spillway)	O	Potential change in suspended sediments and discharge of Lake 901 inlets; potential decrease in growth and survival of Rainbow trout and their eggs	Likely
Decommissioning and removal of mine explosives manufacturing facility	D/C	Potential increase in suspended solids in Lake 901; potential decrease in growth and survival of Rainbow trout and their eggs	Unlikely
Surface water and groundwater management	D/C, PC	Potential change in water quality and lake levels in Lake 901 and stream flows in Lake 901 inlets; potential decrease in growth, survival, and recruitment of rainbow trout	Likely

Project phase: C - construction; O - operations; D/C - decommissioning and closure; PC - post-closure

Without mitigation, the only mine components or activities unlikely to result in indirect, adverse effects on rainbow trout in the Clary Creek watershed is construction, operation, and decommissioning of the explosives manufacturing facility and explosives magazine. These mine activities are not carried forward in this assessment because they were assumed not to involve physical disruption of land in the upper Clary Creek watershed. Instead, this activity was assumed to involve only the placement or removal of buildings, pipelines, and conveyors on the land. Clearing, excavating, or grading of the land prior to installation or removal of these infrastructure components was assumed to be the activity with the potential to impact rainbow trout through changes in surface water quality due to potential increased suspended sediment loading. This activity was carried forward in the assessment but installation and decommissioning of the explosive magazine and was not.

All other mine components and activities occurring in the Clary Creek watershed during construction, operations, closure / decommissioning phases of the Project were carried forward in this assessment. This was because, unmitigated, all of these other mine components and activities had the potential to indirectly affect rainbow trout through:

- Direct changes to surface water quality in Lake 901;
- Direct changes to stream flow in Lake 901 tributaries and Clary Creek (including the Lake 493 outlet); and / or
- Direct changes to water levels in Lake 901 and Clary Lake.

Although these components and activities were carried forward into the effects assessment, this does not imply that these mine components or activities would necessarily cause an adverse effect to rainbow trout. It only implies that, without mitigation, these mine component and activities have the potential to adversely affect rainbow trout. The likely effectiveness of the various mitigation measures available to minimise or eliminate these potential effects on rainbow trout are assessed in Section 6.7.4.9.2. The significance of any residual effects to rainbow trout is assessed in Section 6.7.4.10.

6.7.4.9.1.3 Potential Combined Effects

Potential combined effects to rainbow trout were considered those indirect effects that would occur simultaneously or through time in the same waterbody or stream to potentially change the growth, survival, health, and / or recruitment of rainbow trout. Table 6.7.4-16 summarises the potential combined effects on rainbow trout due to potential indirect Project effects to air quality (i.e., air-borne deposition of contaminants), surface water quality, lake levels, stream flows in the Clary Creek watershed, and the potential change in the benthic macro-invertebrate community which may result from these indirect effects.

Any change in the benthic macro-invertebrate community in Lake 901, Clary Lake or the streams that drain into or out of these lakes has the potential to directly affect rainbow trout because they are one of the primary food sources of rainbow trout. Such a change in prey would create the potential for a combined effect on rainbow trout health, growth, survival and recruitment with concurrent effects due to changes in water quality, lake levels, and stream flows.

Finally, a potential combined effect exists between the potential stressors placed on rainbow trout due to changes in surface water quality, lake levels, stream flows, and the benthic macro-invertebrate community and the additional stressor placed on rainbow trout due to increased fishing pressure. The abundance of rainbow trout in the Clary Creek watershed may be reduced through all of these potential direct and indirect effects.

Table 6.7.4-16: Potential Combined Project Effects by Project Phase on Rainbow Trout

Potential Indirect Project Effect	Potential Combined Project Effect	Project Phase	Likelihood of Occurrence
Change in surface water quality in Lake 901 and Clary Lake	Change in rainbow trout health, growth, survival and recruitment due to combined effect with potential changes in stream flow, lake levels, and resulting change in their benthic macro-invertebrate prey	C, O, D/C, PC	Likely
Change in stream flow in Lake 901 tributaries and Clary Creek	Change in rainbow trout health, growth, survival and recruitment due to combined effect with potential changes in surface water quality, lake levels, and resulting change in their benthic macro-invertebrate prey	C, O, D/C, PC	Likely
Change in lake levels in Lake 901 and Clary Lake	Change in rainbow trout health, growth, survival and recruitment due to combined effect with potential changes in water quality, stream flow, and resulting change in their benthic macro-invertebrate prey	C, O, D/C, PC	Likely
Change in benthic macro-invertebrate community in Lake 901, Clary Lake and their tributaries	Change in rainbow trout health, growth, survival and recruitment due to combined effect with potential changes in surface water quality, lake levels, and stream flows	C, O, D/C, PC	Likely
Change in fishing pressure due to presence of work-force	Change in the abundance of rainbow trout due to combined effect with potential changes in surface water quality, lake levels, stream flow, and benthic macro-invertebrate prey	C, O, D/C, PC	Likely

Project phase: C - construction; O - operations; D/C - decommissioning and closure; PC - post-closure

6.7.4.9.1.4 Potential Indirect Effects on Other Valued Components

Potential direct, indirect, or combined effects on rainbow trout have the potential to indirectly affect other VCs (Table 6.7.4-17). These include potential indirect effects on piscivorous wildlife that eat rainbow trout (e.g., Grizzly bears, otters, or eagles), on other Freshwater Aquatic Resource VCs (i.e., benthic macro-invertebrates) that co-exist with rainbow trout in the Clary Creek watershed and on humans that harvest and eat rainbow trout opportunistically as recreational fishermen. The potential indirect effects identified in Table 6.7.4-17 represent those that could occur without considering the likely effectiveness of mitigation measures.

There is no potential interaction between potential changes in rainbow trout health, growth, survival or recruitment with any other biophysical VC (e.g., air quality, surface water quality, hydrogeology, soil and vegetation). Other biophysical VCs have the potential to interact indirectly with rainbow trout through changes in air quality, surface water quality, lake levels and hydrology but the reverse linkage from rainbow trout to these other VCs is not valid (e.g., changes in rainbow trout health, growth, survival, and recruitment cannot affect air quality).

There is no potential interaction between potential changes in rainbow trout health, growth, survival or recruitment with any other socio-economic VCs. This is because, unlike salmon, rainbow trout are not an economically valuable sport or commercial fish species in the Alice Arm area and because neither the Nisga'a nor any of the identified Aboriginal groups are known to fish for rainbow trout in the Clary Creek watershed. A summary of the potential interactions between potential direct, indirect, and combined effects of the Project on Rainbow trout and other biophysical, social, and economic VCs is provided in Table 6.7.4-18 below.

Table 6.7.4-17: Potential Indirect Project Effects on Other Valued Components

Direct Project, Indirect, or Combined Effect (adverse or positive)	Project Phase	Potential Indirect Project Effect	Carried Forward (yes / no)	Rationale
Potential change in abundance of rainbow trout in the Clary Creek watershed due to increased fishing pressure	Construction, operations, decommissioning, post-closure	Change in the number of rainbow trout in Clary Creek watershed may affect Nisga'a Nation land use	No	Any change in the number of rainbow trout in Clary Creek will not affect Nisga'a guiding entitlements in the Kitsault and Illiance rivers.
		Change in the number of rainbow trout in Clary Creek watershed may affect Aboriginal trapping, fishing, and hunting	No	Any change in the number of rainbow trout in Clary Creek will not affect Aboriginal trapping, hunting, and fishing because no identified Aboriginal group routinely fishes in the Clary Creek watershed.
Potential change in health, growth, survival and recruitment of rainbow trout due to changes in water quality, lake levels, and stream flow in the Clary Creek watershed	Construction, operations, decommissioning, post-closure	Change in tissue metal concentrations and size and abundance of rainbow trout in the Clary Creek watershed may affect piscivorous wildlife	Yes	Elevated tissue metal concentrations in rainbow trout may result in acute and / or chronic toxicity to piscivorous wildlife, especial for those metals known to bioaccumulate in higher trophic levels (e.g., mercury). Reduced size and abundance of Rainbow trout in Clary Creek may indirectly reduce the health, growth, survival and abundance of piscivorous wildlife that rely on rainbow trout for all or part of their dietary needs.
		Change in the tissue metal concentrations in rainbow trout in the Clary Creek watershed may affect human health	Yes	Elevated tissue metal concentrations in rainbow trout may result in acute and / or chronic toxicity humans, especial for those metals known to bioaccumulate in higher trophic levels (e.g., mercury).

Direct Project, Indirect, or Combined Effect (adverse or positive)	Project Phase	Potential Indirect Project Effect	Carried Forward (yes / no)	Rationale
		Change in the fish tissue metal concentrations and size and number of rainbow trout in the Clary Creek watershed may affect environmental health	Yes	Elevated tissue metal concentrations may result in acute and / or chronic toxicity in freshwater and terrestrial animals, especial for those metals known to bioaccumulate in higher trophic levels (e.g., mercury).
		Change in size and abundance of rainbow trout in the Clary Creek watershed may affect other Freshwater Aquatic Resource VCs in Lime Creek (e.g., benthic macro-invertebrates)	Yes	Change in the health, size and abundance of Rainbow trout has the potential to influence the density and community composition of benthic macro-invertebrates upon which rainbow trout feed.

Note: VC - valued component

Table 6.7.4-18: Summary of Potential Interaction Between Project Effects on Rainbow Trout and Other Valued Components

Direct, Indirect, or Combined Project Effect on Rainbow trout	Air Quality and Climate Change	Noise and Vibration	Hydrogeology	Groundwater Quality	Freshwater and Sediment Quality	Surface Hydrology	Freshwater Aquatic Resource	Marine Water Quality	Marine Biota	Terrestrial Environment	Wildlife and Their Habitat	Environmental Health	Economic	Social	Heritage	Human Health	Nisga'a Nation Land Use	Aboriginal Groups Land Use
Potential change in health, growth, survival, recruitment, and abundance of rainbow trout in the Clary Creek watershed	NI	NI	NI	NI	NI	NI	-	NI	NI	NI	o	o	NI	NI	NI	o	NI	NI

Note: Interaction definitions: o - interaction; - - key interaction; + - benefit; NI - no interaction

6.7.4.9.1.5 Potential Project Effects Carried Forward for Assessment

A summary of the potential direct and indirect Project effects on rainbow trout that were carried forward into the assessment is presented in Table 6.7.4-19.

Effects on rainbow trout due to potential changes in surface water quality were assessed based on results of a surface water quality model that predicted metal, ion, cation, and nutrient concentrations in Lake 901 and Clary Lake. Similarly, effects on rainbow trout due to potential changes in lake levels and stream flows were assessed based on results of a watershed model that predicted annual, monthly, peak instantaneous, and 7-day low flows at the Lake 901 outlet, the Clary Lake outlet and in Clary Creek at its confluence with the Illiance River.

Both models incorporated all of the various mine activities and components that could potentially affect surface water quality, lake levels, and stream flows in the Clary Creek watershed during each phase of the Project (i.e., all activities, components, and mitigation measures included in the Project water management plan). However, because neither model explicitly linked any single mine component or activity to a predicted change in water quality, lake level, or stream flow during any phase of the Project (e.g., separate effects of decrease in upstream watershed area and water withdrawals on Clary Lake water levels during operations), neither could the indirect effects of any single mine component or activity be linked to potential effects on rainbow trout. Instead, the assessment of potential changes in surface water quality, lake levels, and stream flow on rainbow trout were based model predictions at specific points in time when the combined effects of the different mine components would be greatest. Therefore, it is the potential combined effects of all mine component or activities with the potential to affect surface water quality, lake levels, and stream flows that were carried forward in the assessment. This reality did not limit the credibility or accuracy of the assessment (in fact it was a conservative approach) but it did limit the ability of the assessment to explicitly identify which mine component or activity was most likely to the cause the predicted change in water quality, lake levels or stream flow, and hence the predicted effect on rainbow trout.

Table 6.7.4-19: Summary of Potential Project Effects to be Carried Forward Into the Assessment for Rainbow trout

Adverse Effects / Positive Effects	Direct or Indirect Effect	Project Phase	Direction
Increased fishing pressure due to presence of work force	Direct	C,O, D/C, PC	Negative
Impingement and / or entrainment of fish in pumps needed for potable water supply	Direct	C, O	Negative
Entrainment of fish in the pipeline (if this option is selected) needed to divert water from Lake 493 to Lake 901	Direct	C, O, D/C, PC	Negative
Mortality of fish and / or loss of fish habitat due to development of the northeast embankment of the TMF and the northeast seepage control ponds	Direct	C, O, D/C, PC	Negative
Improvement of fish passage at stream crossings along the Kitsault Road	Direct	C, O, D/C, PC	Positive

Adverse Effects / Positive Effects	Direct or Indirect Effect	Project Phase	Direction
Change in surface water quality in Lake 901 and Clary Lake due to air-borne deposition of dust and contaminants	Indirect	C,O, D/C	Negative
Change in surface water quality in Lake 901 and Clary Lake due to land clearing for mine infrastructure installations	Indirect	C	Negative
Change in surface water quality in Lake 901 and Clary Lake due to seepage from the TMF	Indirect	C, O, D/C, PC	Negative
Change in lake levels in Lake 901 and Clary Lake due to flow reductions in Lake 901 tributaries, water withdrawals for potable water and change in upstream catchment areas	Indirect	C, O, D/C, PC	Negative
Change in stream flows due to development of the northeast embankment of the TMF, water withdrawals, and diversion of flows	Indirect	C, O, D/C, PC	Negative / Positive
Change in benthic macro-invertebrate community in lakes and streams in the Clary Creek watershed	Indirect	C, O, D/C, PC	Negative

Note: C - construction; O - operations; D/C - decommissioning and closure; PC - post-closure TMF - Tailings Management Facility

6.7.4.9.2 Mitigation Measures

Mitigation measures to reduce or eliminate each of the potential direct, indirect, and combined effects of the Project on rainbow trout in the Clary Creek watershed are described in the sections below. Potential effects and the measures that would be employed to mitigate these potential effects are presented by Project phase in Table 6.7.4-20. These measures include those already included in the Project design plus additional mitigation measures that the proponent would commit to implementing should the Project be approved and permitted.

Table 6.7.4-20: Potential Project Effects on Rainbow Trout and Mitigation Measures

Project Effect	Project Phase	Mitigation / Enhancement Measure	Mitigation Success Rating
Increased fishing pressure due to presence of mine workforce	C,O, D/C, PC	Continued stocking of rainbow trout in the Clary Creek watershed	Medium prevention / reduction
		Implementation of watershed-specific daily and possession quotas and / or size restrictions	Medium prevention / reduction
		Implementation of a no-fishing policy for all mine workers and contractors on-site	High prevention / reduction
Impingement and / or entrainment of fish in pumps needed for the potable water supply	C, O	Freshwater End-of-Pipe Intake Fish Screen Guidelines (DFO 1995)	High prevention / reduction
Entrainment of fish in pipeline (if this option is selected) required to divert water from Lake 493 to Lake 901	C, O, D/C, PC	Freshwater End-of-Pipe Intake Fish Screen Guidelines (DFO 1995)	High prevention / reduction
		Cover intake pipe in rip-rap to prevent fish from swimming near intake pipe mouth	High prevention / reduction
Improvement of fish passage at stream crossings along the Kitsault Road	C, O, D/C, PC	Replacement of all closed-bottom culverts on fish-bearing streams according to DFO Pacific Region's Operational Statementa	High prevention / reduction
Change in surface water quality in Lake 901 and Clary Lake due to air-borne deposition of dust and contaminants	C, O, D/C	Regular dust suppression on haul and access roads	High prevention / reduction
		Use of low sulphur diesel fuels and regular maintenance of the mine fleet	High prevention / reduction
		Use of diesel generators only as back-up to hydroelectricity	High prevention / reduction
Change in surface water quality in Lake 901 and Clary Lake due to land clearing for mine infrastructure installations	C	Implement sediment and erosion control plan prior to construction and utilise "Best management Practices" during construction	High prevention / reduction
		Seepage control ponds built in the two Lake 901 inlet tributaries prior to construction of the northeast embankment of the TMF	Medium prevention / reduction

Project Effect	Project Phase	Mitigation / Enhancement Measure	Mitigation Success Rating
Mortality of fish and / or loss of fish habitat due to development of the northeast embankment of the TMF and northeast seepage control ponds	C,O, D/C, PC	Implementation of a Fish habitat mitigation and compensation plan that meets DFO's no-net-loss policy and provincial and NLG fisheries management objectives	High prevention / reduction
		Conduct a fish-salvage in streams within and downstream of the TMF and seepage control ponds prior to construction	High prevention / reduction
Change in surface water quality of Lake 901 and Clary Lake due to seepage from the northeast embankment of the TMF	C, O, D/C, PC	Construction of seepage control ponds downstream of the northeast embankment of the TMF and pumping of collected seepage back to the TMF during mine operations	Medium prevention / reduction
		Diversion of water from Lake 493 to Lake 901 via a gravity-fed pipeline (if this option is selected)	Medium prevention / reduction
		Decommissioning of seepage control ponds and pumps only when water quality objectives are met	High prevention / reduction
Change in water levels in Lake 901 and Clary Lake due to flow reductions, change in upstream catchment areas, and water withdrawals for potable water	C, O, D/C, PC	Diversion of water from Lake 493 to Lake 901 via a gravity-fed pipeline (if this option is selected)	High prevention / reduction
		Minimise water-withdrawals from Clary Lake to requirements for potable water, firefighting, reagent mixing, and pump gland water	High prevention / reduction
Change in stream flows due to development of the northeast embankment of the TMF, water withdrawals, and diversions	C, O, D/C, PC	Decommissioning of seepage control ponds and pumps at closure	Low prevention / reduction
		Diversion of water from Lake 493 to Lake 901 via a gravity-fed pipeline (if this option is selected)	Medium prevention / reduction
		Restriction of diverted flow volumes to only those necessary to offset flow reductions to Lake 901 due to construction of the northeast embankment of the TMF	Low prevention / reduction
		Implementation of a Fish habitat mitigation and compensation plan that meets DFO's no-net-loss policy and provincial and NLG fisheries management objectives	High prevention / reduction

Project Effect	Project Phase	Mitigation / Enhancement Measure	Mitigation Success Rating
Change in benthic macro-invertebrate community in lakes and streams in the Clary Creek watershed	C, O, D/C, PC	Implementation of the Project water management plan and the mitigation measures listed above to reduce or eliminate potential effects to rainbow trout from changes in surface water quality, lake levels, and stream flows	High prevention / reduction

Note: C - construction; O - operations; D/C - decommissioning and closure; PC - post-closure

6.7.4.9.2.1 Increased Fishing Pressure Due to Presence of Mine Workforce

The Kitsault Project would require a workforce of approximately 500 people during construction and a workforce of approximately 360 people during operations. Many of these people would be anglers wishing to fish for rainbow trout or other fish species in the creeks and rivers in the vicinity of the Kitsault Project during their free time. Recreational anglers can have a significant impact on local fish populations (Radomski et al., 2001; Post et al., 2002; Lewin et al., 2006) and, if this fishing is unchecked, can lead to the extirpation of local populations even if fishing regulations are in place to protect the species or population.

Although not every person in the workforce would be a recreational angler, some percentage would be. Given the number of people required to build and operate the mine and the relatively easy access to Clary Lake, Killam Lake and Lake 901 provided by the existing Kitsault Road, the presence of these anglers could result in the direct mortality of individual rainbow trout in these lakes and could potentially extirpate the local population over time.

Work-force sizes would decrease substantially during closure / decommissioning and post-closure / maintenance phases of the Project. However, there would still be more people on-site than at present and these people could continue to apply fishing pressure on rainbow trout in these lakes.

The Fish and Wildlife Branch of the Environmental Stewardship Division of the BC Ministry of Environment sets regional daily catch quotas, possession quotas, and annual catch quotas for sport fish species in British Columbia. In the Skeena Region, there is no annual catch quota for rainbow trout, the possession limit is twice the daily catch quota, and the daily catch quota is five trout but no more than:

- One fish >50 cm;
- Two fish from streams; and
- No fish <30 cm captured in streams.

This means that each angler could keep up to five rainbow trout from the lakes and streams in the Clary Creek watershed each day as long as: 1) only two were taken from streams; 2) both of these fish were >30 cm long; 3) only one of the remaining three fish harvested in the lakes was >50 cm long; and 4) they did not already have more than five rainbow trout in their possession. The only other recreational fishing regulation set by the province is that all anglers must use single, barbless hooks when fishing in streams and lakes within the Skeena Region.

Monitoring and enforcement of these regulations is the responsibility of the provincial Fish and Wildlife Branch. However, given the limited resources of the department, the remoteness of the Clary Creek watershed in relation to the closest Ministry of Environment office in Terrace, and the number of potential anglers that could begin fishing for rainbow trout should the mine be approved, these regulations may not protect rainbow trout populations in the Clary Creek watershed from extirpation.

Such extirpation of rainbow trout could be mitigated in two-ways. First, rainbow trout populations could persist if the province continues stocking rainbow trout into the Clary Creek watershed during the construction and operations phases of the Project. Second, a no fishing policy could be enacted by the proponent for all workers and contractors while on-site. While poaching may still occur, such a policy would effectively eliminate this potential direct effect to rainbow trout. However, allowing fishing for stocked rainbow trout may reduce fishing pressure on other important and potentially vulnerable, native fish populations (i.e., coho, Chinook, chum, and pink salmon, Dolly Varden, and steelhead) in the Kitsault area. The proponent would work with federal and provincial regulators and Nisga'a Fisheries to determine the best option(s) for maintaining rainbow trout populations in Clary Creek watershed and anadromous fish populations in near-by rivers.

Regardless of the strategy(ies) adopted, no residual effect to rainbow trout from increased fishing pressure is expected to occur. This potential effect is not carried forward to the assessment of significance of residual effects.

6.7.4.9.2.2 Impingement and Entrainment of Fish in Pumps Needed for Potable Water Supply

Freshwater needs for the Project would be obtained from Clary Lake. These needs include freshwater for firefighting, potable water, reagent mixing, and pump gland water. To facilitate these requirements, pumps would be installed in southern basin of Clary Lake near the existing pumphouse that remains on the banks of the lake from previous mining activities. These pumps would transfer water from Clary Lake to a 1,475 m^3 freshwater storage tank near the mill site via a 5.9 km pipeline that would parallel the existing Kitsault Road and the new mine access road. Pumps and the pipeline would deliver water to the holding tank at a maximum rate of 120 m^3/hour (33 litres/second).

Pumps in Clary Lake have the potential to impinge rainbow trout, particularly weaker swimming larvae and juveniles, on the intake pipe screens. These pumps also have the potential to entrain any fish small enough to pass through the intake screens into the pumps and into the pipeline. Both of these actions have the potential to result in the direct mortality of rainbow trout in Clary Lake.

These potential effects would be mitigated by the design and installation arrangement of the intake pipes. The intakes would use a slotted pipe section at the end of the suction line placed in the lake. This length of this slotted pipe and the mesh screen enclosing this pipe would be sized for the protection of rainbow trout >25 mm long by following the "Freshwater Intake End-of-Pipe Fish Screen Guidelines" (DFO 1995). Based on these guidelines and the maximum anticipated pumping rate of 33 litres/second, the following minimum intake design criteria are required to satisfy the 0.11 m/second approach velocity at the intake (the approach velocity for protection of fish species with a subcarangiform swimming mode, such as rainbow trout, >25 mm long):

- An open screen area of 0.31 m^2;
- An effective screen area of 0.52 m^2; and
- A maximum screen opening width of 2.54 mm.

Based on these criteria, the length and diameter of screened intake pipe would be determined from the guidelines (e.g., an approximately 16 cm diameter, one meter long screen pipe would meet these criteria). While inspection and cleaning of the intake pipes would be conducted as required, the relatively low pumping volumes indicates that increasing open screen area by up to four times (as recommended in the guidelines for intakes not cleaned regularly) would not result in a prohibitively long or wide intake pipe.

Installation arrangements would follow the recommendations in the guidelines (DFO, 1995). These recommendations may include:

- Locating screens away from natural or man-made structure that may attract fish;
- Locating screens away from known or potential spawning, rearing, or overwintering locations;
- Locating screens above the bottom of the lake to prevent entrainment of sediment and benthic organisms; and
- Encasing the intake pipe in rip-rap to hold the intake in place and to increase the distance between the end of the pipe and fish in the lake.

The mitigation measures described above would effectively prevent the impingement and entrainment of rainbow trout >25 mm on the intake screens and in the pumps and pipeline. Locating the intake in the lake, at depth, away from any known rainbow trout spawning stream would effectively reduce the likelihood of any rainbow trout egg or larvae becoming entrained in the pumps. Because of this, this potential effect to rainbow trout is not carried forward in the assessment.

6.7.4.9.2.3 Entrainment of Fish in the Pipeline Needed to Divert Water From Lake 493 to Lake 901

In order to offset the potential loss of inflows to Lake 901 caused by construction and operation or the TMF and the downstream northeast seepage control ponds (see Section 6.7.4.9.2.8), water from Lake 493 would be diverted to Lake 901. Three options have been proposed to convey this diverted water from Lake 493 to 901. These include: an overland pipeline; a buried pipeline; and an open channel with habitat features for rainbow trout. Either pipeline option (Knight Piésold 2011) would be gravity-fed and would not require pumps. This is because there is sufficient elevation change (approximately 10 m) between Lake 493 (756 metres above sea level (m.a.s.l.)) and Lake 901 (746 m.a.s.l.) and sufficient gradient (average slope of 1.2%) to preclude the need for pumps.

Although pumps are not necessary and impingement on intake screens would not be an issue, rainbow trout in Lake 493, could become entrained in the pipeline. Some of these fish would undoubtedly survive. However, the potential exists for some of these fish to perish while in the pipe, particularly if the pipeline is not buried and fish are moving through the pipe in summer or winter. In summer, water temperatures in the pipe may exceed the preferred temperature range for rainbow trout. In winter, water in the pipeline may freeze. These temperature extremes would be eliminated if the pipeline was buried (Knight Piésold 2011). The final design details of the pipeline would be determined prior to construction and in consultation with federal, provincial, and NLG representatives.

Regardless of whether the pipeline is buried or not, the potential for rainbow trout to become entrained in the pipeline would be eliminated by sizing, screening, and installing the intake pipe according to the recommendations in the “Freshwater Intake End-of-Pipe Fish Screen Guidelines” (DFO 1995). In addition, the intake pipe would be encased rip-rap. This rip-rap would anchor the intake pipe in place and would exclude all but the smallest young-of-the-year (i.e., <25 mm) fish from reaching the end of the pipe. Because of these mitigation measures, this potential effect to rainbow trout is not carried forward in this assessment.

6.7.4.9.2.4 Improvement of fish passage at stream crossings along the Kitsault Road

The existing Kitsault Road crosses at least 14 streams in the Clary Creek watershed before reaching the town of Kitsault and the spur road to the existing Kitsault mine site. The majority of these streams are first or second order tributaries of Killam Lake, Lake 493, and Clary Lake. They also include crossings of the 3rd order outlets of Lake 493 and Lake 901.

The existing Kitsault Road would be subject to overdue maintenance where it is necessary to provide safe and efficient travel of conventional tractor-trailers. These tractor-trailers would be used to bring in equipment and supplies and to haul-out molybdenum concentrate from the mine.

Any existing stream crossing within sections of the Kitsault Road requiring maintenance would be assessed for its current potential to prevent the upstream passage of fish and / or its current potential to contribute sediment downstream from on-going erosion. This would be done by following the Fish Passage Culvert Inspection (FPCI) procedures (Parker 2000) and by conducting BC RISC site cards.

Any existing stream crossing on a fish-bearing stream found to block or reduce the upstream passage of fish during these surveys would be replaced with an appropriately sized structure to provide fish passage. This would include the existing closed-bottom culvert on the Lake 901 outlet. This culvert is currently a barrier to upstream fish passage because the culvert was improperly installed and now has an approximately 3 m drop at its downstream end. As a result, there is currently no opportunity for rainbow trout in Clary Lake or from upstream lakes (i.e., Killam Lake and Lake 493) to immigrate into Lake 901. Additionally, any rainbow trout in Lake 901 passing downstream through this culvert is permanently lost to the Lake 901 rainbow trout population.

The current stream crossing on the Lake 493 outlet is a double closed-bottom culvert located on a natural, approximately 5 metre high, bedrock waterfall. While the road grade and the culverts have created a large pond upstream of the road, removal of these culverts and replacement with a open-bottom arch culvert or clear-span bridge would not alleviate the natural barrier created by the waterfall.

Mitigation measures and installation criteria would follow Fisheries and Oceans Canada Pacific Region's Operational Statements (DFO 2007). On smaller, non-fish-bearing streams, appropriately sized closed-bottomed culverts would be installed only if the existing culvert was under-sized, improperly installed or damaged and currently creating increasing downstream sediment problems. Selection of closed or open-bottom culverts or clear-span bridges would be based on criteria provided in the "Fish-stream Crossing Guidebook" (BC MWLAP/MOF/MEM 2002). Any culvert replacements and road re-alignments would be designed according to criteria outlined in the "Forest Road Engineering Guidebook" (BC MOF 2002).

For the reasons stated above, upgrading of the Kitsault Road would create a positive effect for rainbow trout in the Clary Creek watershed. For this reason, this effect is carried forward in the assessment.

6.7.4.9.2.5 Change in Surface Water Quality Due to Air-Borne Deposition of Contaminants and Dust

6.7.4.9.2.5.1 Deposition of Air-Borne Contaminants

Emissions from burning of fossil fuels in trucks, shovels, and generators have the potential to affect rainbow trout in lakes in the Clary Creek watershed. Emissions such as SO_x and NO_x, have the potential to create acidic conditions in freshwater lakes if the potential acid input (PAI) exceeds the buffering capacity (i.e., critical load; typically determined by the $CaCO_3$ concentration in the lake) of the lake. The pH range at which pH alone becomes acutely lethal to fish is typically <5 (Alabaster and Lloyd 1982 in CCME 2005). However, chronic and acute toxicity of certain metals (e.g., aluminum) increases with decreasing pH and this typically occurs pH values <6.5 (CCME 2005).

Mitigation measures to reduce emissions includes use of low sulphur diesel fuels, regular maintenance of the mine fleet, and use of diesel generators only as a back-up to hydroelectric power provided by the transmission line (See Section 6.2, Air Quality). Mitigation measures to reduce fugitive dust generation include using a dust collection system during bulk materials loading and unloading, regular dust suppression on mine roads, and maintaining the operational supernatant pond in the TMF to ensure that tailings beaches are saturated.

Air quality dispersion modeling indicated that the average 24-hour and annual maximum NO_2 and SO_2 concentrations beyond the immediate project footprint would be below ambient air quality objectives (AAQO) during all phases of the Project (See Section 6.2, Air Quality). Although air deposition modeling in lakes was not conducted, the results of the dispersion models indicate that the likelihood of acid deposition occurring in Lake 901 and Clary Lake is remote. Concentrations of SO_2 were predicted to be very low throughout the Project due the use of new low-sulphur diesel fuels.

Based on the above assessment, no additional mitigation measures are necessary and no residual effects of air-borne contaminants on rainbow trout in Lake 901 or Clary Lake are expected to occur. This potential effect on rainbow trout is not carried forward in the assessment.

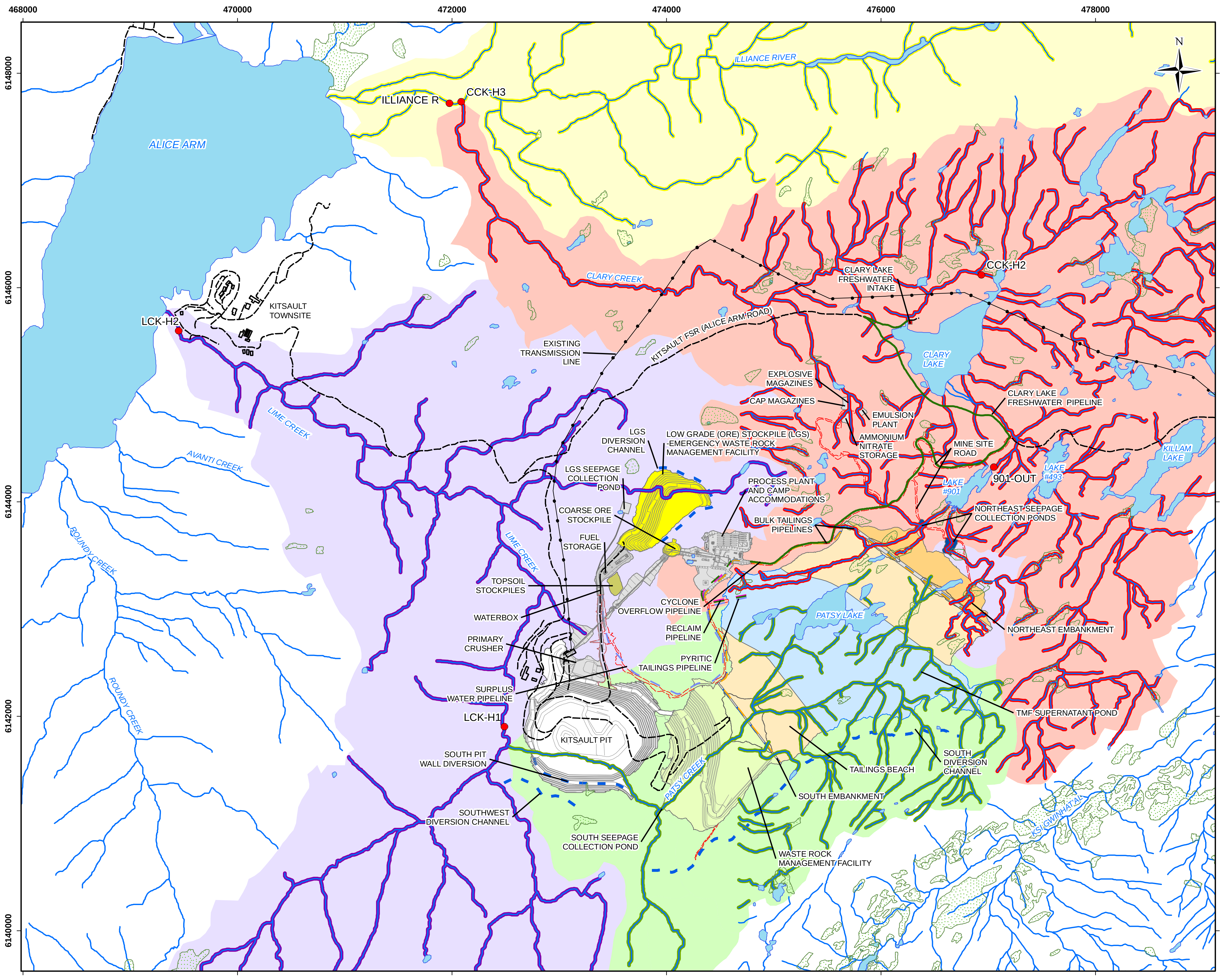
6.7.4.9.2.5.2 Deposition of dust

Dust generated from blasting, drilling, loading trucks, and driving machinery on mine roads has the potential to affect rainbow trout by Lake 901 and Clary Lake by increasing turbidity and suspended sediments concentrations. If high enough, these suspended sediments can cause behavioural effects (e.g., increased coughing rates, reduce feeding rates), sublethal effects (e.g., physiological stress), or lethal effects (e.g., impaired respiration, gill damage) (Newcombe 1994). Increased suspended sediments can also decrease egg survival by reducing the exchange of dissolved gases (i.e., oxygen and carbon dioxide wastes).

The greatest fugitive dust deposition rates are expected to occur close to haul and access roads and adjacent to ore stockpiles (See Section 6.2, Air Quality). However, the ore stockpiles will be located more than 2 km from the nearest lake in the Clary Creek watershed and at this distance are unlikely to be a source of dust to lakes. Conversely, the existing Kitsault Road and the new mine access road would be within 60 metres of Clary Lake and Lake 901, respectively. At this distance, it is predicted that particulate deposition rates would be approximately 0.11 g/m^2/month (Section 6.2, Air Quality). Such deposition would be primarily due to particles <100 µm because particles >100 µm are likely to settle within 6 to 9 m from the edge of the road (Section 6.2, Air Quality). Based on these modelling results, the potential effect of dust deposition on rainbow trout in lakes in the Clary Creek watershed is carried forward in the assessment.

6.7.4.9.2.6 Change in Surface Water Quality in Lake 901 and Clary Creek Due to Land Clearing for Mine Infrastructure Installations

Clearing of trees and grading of soils would be necessary prior to construction of the northeast embankment of the TMF, the processing plant and camp accommodations, and the explosives magazine, cap magazine, ammonium nitrate storage facility, and the emulsion plant in the Clary Creek watershed (Figure 6.7.4-10). These activities could increase sedimentation in fish-bearing streams and lakes downstream with potentially detrimental effects on rainbow trout, particularly rainbow trout eggs in streams used for spawning.



Legend

- Access Road
- Mine Site Road
- Transmission Line
- Stream
- Waterbody
- Wetland
- Pipeline - Freshwater
- Diversion Ditch
- Process Plant
- Open Pit
- Ore Stockpile
- Clary Lake Freshwater Intake
- Topsoil Stockpiles
- Waste Rock Management Facility
- Northeast Embankment
- Tailings Beach
- Tailings Management Facility (TMF) Supernatant Pond
- Watershed Model Streamflow Node
- Clary Creek
- Lime Creek
- Patsy Creek
- Illiance River
- Clary Creek Watershed
- Lime Creek Watershed
- Patsy Creek Watershed
- Illance River Watershed

KEY MAP

1 0.5 0 1
Kilometres
Scale:1:35,000

Reference
1. Base Data
Geobase 1:20,000 (TRIM)
Land and Resource Data Warehouse 1:20,000 (TRIM)
2. Kitsault Mine General Layout
Supplied by AMEC and Knight Piesold on March 2011

CLIENT: Avanti Kitsault Mine Ltd.

PROJECT: Kitsault Mine Project

Location of Mine Infrastructure in the Lime Creek and Clary Creek watershed

DATE: November 2011	ANALYST: MY	**Figure 6.7.4-10**
JOB No: VE51988	QA/QC: JW	PDF FILE: 10-50-106_location_watersheds.pdf
GIS FILE: 10-50-106.mxd		
PROJECTION: UTM Zone 9	DATUM: NAD83	

To mitigate this potential effect, a sediment and erosion control plan would be implemented before clearing and grading commenced. This sediment and erosion control plan would include the following design elements and best management practices (BMPs):

- Construction of seepage / sediment control ponds in the two Lake 901 inlet tributaries downstream of the northeast embankment of the TMF prior to preparation of the northeast embankment footprint area. These ponds would be designed according to the "Draft Guidelines for the Design, Size, and Operation of Sedimentation Ponds used in Mining (BC MOE 1996). Water collected in these ponds would be pumped to Lake 901 during construction of the northeast embankment of the TMF until the northeast embankment is completed. Water in these ponds would then be pumped back to the TMF. Water pumped to Lake 901 during construction of the northeast embankment would be monitored for total suspended solid concentrations prior to release;
- Construction of diversion ditches and run-off collection ditches around the processing plant / camp accommodation site and around the explosives magazine and associated infrastructure sites prior to clearing and grading. These ditches would collect any sediment laden run-off and convey it either to temporary sediment control ponds downstream or to the developing TMF pond;
- Implementation of best management practices to reduce the potential for erosion by stabilising exposed soils or reducing the velocity of surface run-off. These BMPs would be guided by the mitigation measures described in the "Standards and Best Practices for Instream Works" (BCMWLAP 2004) and "Land Development Guidelines for the Protection of Aquatic Habitat" (Fisheries and Oceans Canada 1993). These mitigation measures may include, but not be limited to, the following:
    - Minimising disturbance of existing vegetation on and adjacent to stream banks;
    - Isolating the work site from downstream waters to the maximum extent possible;
    - Maintaining appropriate buffer widths from streams, as necessary;
    - Storing fill or other materials above the high water mark of streams;
    - Surface roughening;
    - Temporary seeding;
    - Construction of sediment traps and sediment basins downstream; and
    - Mulching of vegetation.

Besides the northeast embankment of the TMF, none of the other mine infrastructure components that would be built in the Clary Creek watershed would be located on or near any fish-bearing watercourses (Figure 6.7.4-10): the processing plant and camp accommodations would be located upstream of impassable waterfalls in the headwaters of Stream 76800, one of the main headwater tributaries of Lake 901 while the explosives magazine, emulsion plant, ammonia nitrate storage facility and cap magazine would all be located in the headwaters of a sub-catchment of Clary Creek where average stream gradients exceed 25% over at least 500 metres. As a result, implementation of the mitigation measures and best management practices described above would eliminate the potential effect of increased suspended sediment on rainbow trout residing in creeks downstream from these mine infrastructure components.

The northeast embankment of the TMF would be built across two inlet tributaries of Lake 901 in the Clary Creek watershed (Figure 6.7.4-10). Both of these creeks are known to be used by rainbow trout in Lake 901 for spawning and rearing. The two seepage / sediment control ponds built in these two creeks are expected to effectively eliminate any increases in suspended sediments reaching these two creeks during construction of the northeast embankment of the TMF. While construction of these ponds themselves would follow similar best management practices list above, construction would also be done outside of the rainbow trout egg incubation / fry emergence period, either based on the instream work window for rainbow trout (August 15 to January 31) in the North Coast Forest District of the Skeena Region (BC MOE 2005) or a modified instream work window based on site-specific information gathered during baseline investigations.

Based on the mitigation measures described above, no residual effect to rainbow trout from land clearing or grade for construction of mine infrastructure in the Clary Creek watershed would occur. This potential effect is not carried forward in the assessment.

6.7.4.9.2.7 Mortality of Fish and Loss of Fish Habitat Due to Development of the Northeast Embankment of the TMF

As mentioned above, the northeast embankment of the TMF would be built over top of two inlet tributaries of Lake 901 in the Clary Creek watershed: WSC 910-929800-05800-76800 (hereafter referred to as Stream 76800) and an unnamed tributary ILP 887 (Figure 6.7.4-10). Both of these tributaries are fish-bearing and are known to be used by rainbow trout in Lake 901 for spawning and rearing.

Fish habitat under the northeast embankment footprint, upstream of the northeast embankment footprint within the TMF, and downstream of the northeast embankment footprint would be permanently lost following construction of the TMF. Fish habitat downstream of northeast embankment, including habitat in the two seepage / sediment control ponds, would be permanently lost even though some natural run-off and some seepage from the TMF would be continue to flow in both creeks during all phases of the mine. This is because the total combined reduction in mean monthly and mean annual flows in both creeks was predicted to be approximately 70% lower than baseline during construction and operations[9] and nearly 50% lower than baseline during closure when the pumps in the seepage ponds are decommissioned and run-off and TMF seepage is allowed to overflow to Lake 901 (Knight Piésold 2011, Appendix 6.5-D). Flow reductions of this

[9] Residual flow in both creeks during construction and operations would be due to continued run-off from unaffected headwater tributaries downstream of the TMF and from TMF seepage water not diverted or captured in the seepage/sediment control ponds and pumped back to the TMF (approximately 10% of total anticipated seepage volumes [Knight Piesold 2011. Lake Level Fluctuations in Clary Lake and Lake 901, technical memorandum from Erin Rainey to Craig Nelson, Avanti, dated July 5, 2011])

magnitude are expected to reduce the wetted width, water depth, and water velocities in both creeks sufficiently to make both creeks unsuitable for rainbow trout spawning and rearing for perpetuity.

Unmitigated, the effect of these harmful alterations, disruptions, and destruction (HADD) of fish habitat in these streams would be the potential extirpation of rainbow trout in Lake 901. This is because these two streams provide the only spawning habitat for rainbow trout in the lake; none of the other three inlet tributaries of Lake 901 are large enough, have enough flow, gradient or suitable gravel substrates for rainbow trout spawning. In addition, there is currently no spawning habitat in the Lake 901 outlet because there are no suitably sized gravel substrates present. Instead, substrates in the outlet channel are dominated by bedrock and angular cobble and boulders.

To mitigate the effect of this HADD of fish habitat, the potential mortality of rainbow trout during construction of the northeast embankment of the TMF, and the potential extirpation of rainbow trout from Lake 901, the following measures would be implemented:

- Development and implementation of a Fish Habitat Mitigation and Compensation Plan that meets DFO's "no-net-loss" guiding principle for the protection of fish habitat in Canada. Such a plan is required for the issuance of a Section 35(2) authorisation by DFO for the HADD of fish habitat. A conceptual plan with a suite of low risk options is presented in Appendix 11.2-A. This plan includes provisions for new spawning habitat for the Lake 901 rainbow trout population. During the EA review period and permitting phases of the project, these options would be prioritised and evaluated with DFO, BC MOE, the NLG, and other interest parties for:
    - Their consistency with federal, provincial, Nisga'a, and Aboriginal fisheries management objectives;
    - Their biological relevance;
    - Their stability and permanence;
    - Their cost and constructability; and ultimately;
    - Their ability to ensure that "no-net-loss" of fish habitat is achieved; and
- Development and implementation of a fish salvage prior to construction of the northeast embankment and the sediment / seepage collection ponds. This salvage would be developed in consultation with DFO, BC MOE, and the NLG and could include, but not be limited to, fish salvage best practices outlined in the "Standards and Best Practices for Instream Works" (BC MWLAP 2004) and "Fish Salvage Guidelines" (BC Ministry of Agriculture, Food, and Fisheries 2005).

If the habitat n Stream 76800 upstream of the first cascade impediment to upstream fish passage is deemed to be "frequented by fish", an amendment of Schedule 2 of the Metal Mine Effluent Regulation (MMER) by the Parliament of Canada would be required. This is because, although no fish were captured within the TMF footprint in 2011 (all three rainbow trout were captured in habitat under the northeast embankment footprint), there is no barrier to movement of these fish upstream into habitat within the TMF. Whether the presence of these fish triggers a Schedule 2 amendment of the *MMER* would be determined by DFO and Environment Canada. If it does, a separate Fish Habitat Mitigation and Compensation Plan as per Section 27.1 of the *MMER* would be required.

The presence of rainbow trout upstream of the first cascade impediment in ILP 887 would not trigger a Schedule 2 amendment of the MMER. This is because the upstream limit to the distribution of rainbow trout in the ILP 887 watershed does not extend beyond the upstream limit of the northeast embankment footrprint. This is because of the presence of a 3 m high waterfall located on a headwater tributary (ILP 890). This waterfall is located under the proposed northeast embankment footprint (Freshwater Aquatic Resources Baseline Report, Figure 6.7.4-6). No fish were captured above this waterfall in 2011 and fish habitat above this waterfall (i.e., within the proposed TMF) is considered non-fish-bearing because of this barrier.

Due to inherent uncertainty regarding fish habitat compensation, particularly in regards to replacing critical habitat such as the two known spawning streams for Lake 901 rainbow trout, the potential effect of the HADD of fish habitat on rainbow trout due to construction and operation of the northeast embankment of the TMF is carried forward in the assessment. Conversely, the fish salvage is expected to be highly effective in minimising the mortality of individual rainbow trout. This potential effect is not carried forward in the assessment.

6.7.4.9.2.8 Change in Lake Levels in Lake 901 and Clary Lake

Without mitigation, lake levels in Lake 901 and Clary Lake would be reduced during all phases of the Project. In Lake 901, such reductions would occur due to the loss of upstream catchment area and associated run-off volumes in Stream 76800 and ILP 887 under the TMF. As mentioned above, these flow reductions in these streams were predicted to be approximately 70% during construction and operations and nearly 50% during closure and post-closure phases when the pumps in the seepage control ponds are shut off.

In Clary Lake, lake levels during construction and operations would be reduced by the combined effect of reductions in total upstream catchment areas associated with encroachment of the TMF into the Clary Creek watershed upstream of Lake 901 and from pumping of water for freshwater supply requirements (i.e., potable water, fire suppression, reagent mixing, pump gland water). Lake level changes in Clary Lake during closure and post-closure phase would be limited to the effect of the altered upstream catchment area once the freshwater supply pumps are shut off.

The magnitude of these potential lake level reductions would be larger in Lake 901 than in Clary Lake. This is because a larger portion of the upstream watershed upstream of Lake 901 would be affected by the TMF in comparison to Clary Lake and because the portion of the Lake 901 watershed affected by the TMF provides a most of the total annual run-off volume to Lake 901. Approximately 47% of the upstream watershed area of Lake 901 would be lost under the TMF (Table 6.7.4-21). However, stream 76800 and ILP 887, the two streams affected by the TMF, provide 84% of the total annual inflow volume to Lake 901 (Knight Piésold 2011, Appendix 6.5-C). In contrast, potential lake level reductions in Clary Lake would be attenuated by run-off from the larger, unaffected portions of its upstream watershed (94% of the total Clary Lake watershed (Table 6.7.4-21). This would include run-off from the southeastern portion of the Clary Creek watershed draining Killam Lake and Lake 493 and from the northeastern portion of the Clary Creek watershed draining the series of unnamed lakes to the northeast. Combined, these unaffected portions of the Clary Creek watershed account for approximately 90% of the mean annual inflow volume to Clary Lake (Knight Piesold, 2011, Appendix 6.5-C).

Table 6.7.4-21: Upstream Watershed Areas at the Lake 901 Outlet and the Clary Lake Outlet During Pre-Mine and Construction, Operation, and Closure / Post-Closure Phases of the Project

Project Phase	Lake 901		Clary Lake	
	Upstream catchment area (km^2)	% change from baseline	Upstream catchment area (km^2)	% change from baseline
Baseline	3.6		29.6	
Construction / Operations	1.9	-47%	27.9	-6%
Closure / Post-closure	1.9	-47%	27.9	-6%

Potential effects of lake level reductions to rainbow trout in these lakes, particularly in Lake 901 where lake levels reductions would be highest and the lake bathymetry is shallowest (mean depth of 2 metres and maximum depth of approximately 6 m), include but are not necessarily limited to:

- Reduction in littoral areas and associated benthic invertebrate and macrophyte production;
- Increase in summer water temperatures and associated decreases in dissolved oxygen concentrations;
- Decrease in overwintering habitat volume and suitability;
- Reduction in dilution capacity of the lake for metals and nutrients in the TMF seepage not captured in the seepage control ponds; and
- Exclusion of fish from tributaries for spawning and from the outlet for emigration.

Taken together, these potential effects would likely have caused a harmful alteration, disruption, or destruction of fish habitat (HADD) in Lake 901 and cause the extirpation of the Lake 901 rainbow trout population.

To mitigate these potential adverse effects (and to avoid a potential HADD of fish habitat requiring compensation), a diversion would be constructed between Lake 493 and Lake 901 (Figure 6.7.4-11). If a pipeline is the chosen option, it would be approximately 970 metres long and would be tentatively be constructed of a solid wall 56 cm diameter HDPE pipe (Knight Piésold 2011, Appednix 6.5-D). This pipeline would be gravity-fed and would not require pumps. This is because there is sufficient elevation change (approximately 10 m) between Lake 493 (756 m above sea level) and Lake 901 (746 m.a.s.l) and sufficient gradient (average slope of 1.2%) to preclude the need for pumps. While different options exists for how this pipeline would be constructed (i.e., overland or buried), because the pipeline would be gravity-fed, this pipeline would convey water to Lake 901 for perpetuity with little to no maintenance.

The sizing and operation of the pipe would be such that the amount of water conveyed from Lake 493 to Lake 901 would approximate the total inflow volume predicted to be lost to Lake 901 due to flow reductions in Stream 76800 and ILP 887 from construction and operation of the TMF (Table 6.7.4-22). As a result, no change in lake levels were predicted to occur in Lake 901 during construction and operations phases (Knight Piésold 2011, Appendix 6.5-D).

Table 6.7.4-22: Predicted Average Monthly Flow Reductions in Lake 901 Due to Construction of the Northeast Embankment of the Tailings Management Facility

Month	Construction[1] (m^3/sec)	Construction[2] (m^3/sec)	Operations[3] (m^3/sec)	Closure / Post-closure (m^3/sec)
January	0.00	-0.01	-0.01	0.01
February	0.00	-0.01	-0.01	0.01
March	0.00	-0.02	-0.02	-0.01
April	0.00	-0.09	-0.09	-0.06
May	0.00	-0.27	-0.25	-0.22
June	0.00	-0.24	-0.24	-0.19
July	0.00	-0.13	-0.13	-0.08
August	0.00	-0.06	-0.06	-0.03
September	0.00	-0.07	-0.07	-0.04
October	0.00	-0.14	-0.14	-0.10
November	0.00	-0.05	-0.05	-0.02
December	0.00	-0.02	-0.02	0.00
Annual average	0.00	-0.09	-0.09	-0.06

Note: [1] Stages 1 and 2; [2] Stage 3; [3] Year 13 and Year 15.

During closure and post / closure periods, the pipeline would convey the maximum amount of water needed to offset the predicted flow reductions in Stream 76800 and ILP 887 during the most critical month for the rainbow trout in Lake 901. The purpose of this pipeline is two-fold: 1) to maintain lake levels in Lake 901; and 2) to maintain flow volumes in the Lake 901 outlet. Once the final design criteria are determined, this pipeline is expected to maintain lake level fluctuations in Lake 901 within 1 cm of the monthly water levels naturally occurring in Lake 901 in any given year.