9 Site Water Management and Treatment

The following sections focus on a number of key water quality and water management issues related to the operation and closure of the Wolverine Mine project. The discussions supersede those presented previously in EAR Section 2.9 and their applicability to receiving environment water and biological communities (EAR Sections 7.5, 7.7 and 7.8). Specifically, Section 9.1 provides a discussion of water quality in Go Creek and Wolverine Creek and includes the most recent water quality data. Site-specific water quality objectives for Go Creek are proposed and are relevant to the latter discussions regarding water treatment and discharge to this watershed. No discharges to the Wolverine Creek watershed are proposed or anticipated. Section 6.4 documents the expected effects of the mine on groundwater and related surface flows in the Wolverine Creek basin.

Section 9.2 provides an overview of the revised site water management plan. The operations and closure water balance for the site is described in Section 9.3. The operational and closure water balance are subsequently superimposed on the receiving environment and used to develop a rigorous water management and water treatment system for the project (Section 9.4). The management and treatment system will ensure that site specific water quality objectives will be met at all times in Go Creek at the compliance point. Section 9.5 discusses potential effects on water quality and aquatic communities.

Finally, Section 9.6 presents the monitoring and mitigation plans for the project in Go Creek.

Table 9-1 provides a summary of the reviewer comments and the location of the response.

Table 9-1 Site Water Management Table of Conformance

Reviewer	EAR Section	Reviewer Comment	Response Report Section Where Addressed
9 Site Water Management and Treatment			
Environment Canada	Section 2.9	**Improved Sampling Coverage** The company indicates several additional monitoring stations for the Go Creek downstream of the confluence Hawkowl creek and at the upper reach of the fish distribution. Another monitoring station on Wolverine Creek to deal with the water quality of the underground is to be established downgradient of the portal.	Sections 6.4 and 9.5
Environment Canada	Section 2.9	**Discharge of High Metal Water** The discharge of water from the tailings to Go Creek will result in changes in quality and increases concentration of compounds such as ammonia, cadmium and selenium may be problematic, and cadmium, selenium and zinc in Wolverine Creek. Furthermore the quality may be as well degraded with respect to the tailings impoundment.	Sections 9.2 - 9.4
Environment Canada	Section 2.9	**Post-Closure Monitoring** The proponent suggests post-closure monitoring for Wolverine Creek to deal with uncertainty. Does this mean the proponent is committed to staying on site for at least 52 years post-closure, with the means to monitor and to collect and treat contaminated groundwater if necessary?	Section 6.4
Environment Canada	Section 2.9	**Site Specific Water Quality Objective** The company indicates that their preferred approach to deal with these increases above the CCME with a site specific water quality objective. We are of the opinion that protective values need to be achieved above the upper limit of fish distribution in Go Creek. There is no proposal in the EAR as to how Yukon Zinc is planning to derive a site specific water quality objective for Wolverine and Go creeks.	Section 9.1
YTG - Environment Yukon	Section 2.9.6.5; Section 2.9.6.6; Section 2.9.6.7	**Data - Effectiveness of Water Treatment and Sludge Stability** It should be demonstrated how low a treatment level can be obtained via this mitigation at end of pipe.	Section 9.4
YTG - Environment Yukon	Section 2.9	**Baseline Conditions** More data is needed to define baseline conditions.	Section 9.1 and EAR Addendum Report
YTG - Environment Yukon	Section 3.3.1	**Methods Used to Predict Effects** Very little has been said about the modeling, the assumptions, the limitations, quality of data output, confidence levels etc for the mine water and tailings pond water quality modeling.	Sections 5.1, 6.3, 6.4, 7.4 and 7.6; Appendices D, F2 and F3

Reviewer	EAR Section	Reviewer Comment	Response Report Section Where Addressed
YTG - Environment Yukon	Section 3.4.1	**Mitigation – Predicted Damage** Environment and/or social and economic conditions - include a description of commitments, approaches and specific options for restoration, replacement and/or compensation for any potential/predicted damage.	EAR Section 9
YTG - Environment Yukon	Section 2.9	**Cumulative Environmental Effects** Water quality emanating from the underground has not been "quantified" for the mine at closure.	Sections 6.3 and 6.4
SRK Consulting	Section 3.2	**Water Balance - Sensitivity** The site water balance was not provided in the EAR. The water balance for a dry and wet year should also be calculated to ensure that appropriate design criteria are used for the engineered structures.	Sections 9.3, 7.6, and Appendix F3
SRK Consulting	Section 2.9	**Inputs to Water Treatment Plant** Runoff from the industrial complex area, the dirty water storage pond and the temporary waste rock storage pad is to be directed to the water treatment plant. However, this input to the water treatment plant is not shown in the diagram of the water balance.	Section 9.3
SRK Consulting	Section 2.9	**Design Criteria** The design criteria for the dirty water storage pond and the industrial complex runoff collection pond are not in the EAR.	Sections 1.2 and 7.9
SRK Consulting	Section 2.9	**Potable Water** The water balance shows no potable water use during inactivity stages.	Section 9.3
SRK Consulting	Section 2.9	**Sewage Treatment Plant Sludge Disposal** Details regarding sewage sludge management should be provided.	Sections 9.2 and 9.4
SRK Consulting	Section 3.2	**Underground Mine at Closure** SRK does recognize that Wolverine Creek is naturally impacted by the local mineralization. However, a more robust evaluation of the potential impact of uncontrolled contaminated groundwater discharge should be done.	Section 6.4
SRK Consulting	Section 2.4	**Three Water Quality Models** Tailings pond water, underground flood water and overall site discharge - the actual models were not included in the EAR.	Sections 6.3, 7.6 and 9.3; Appendices D and F3
YTG - Environment Yukon	Section 2.9	**Effects on Wolverine Lake** Monitoring of mine water and Wolverine watershed quality will be required until the water chemistry is stable or improving.	Section 6.4
SRK Consulting	Section 2.4	**Source Concentrations used in Site Water Quality** An updated underground model that includes the effect of the paste backfill will be needed prior to estimating the water treatment plant influent quality.	Sections 6.3, 9.3, 9.4, and Appendix D

Reviewer	EAR Section	Reviewer Comment	Response Report Section Where Addressed
SRK Consulting	Section 2.4	**Sensitivity Testing for Water Quality Models** For all the water quality models, it is assumed that average conditions were modeled. The models should be run for a dry year, wet year as well as worst case source concentrations.	Sections 6.3; 7.6, 9.3, 9.4, Appendices D and F3.
YTG - Environment Yukon	Section 2.9	**Models** The models should be completely described and documented to facilitate review and discussion.	Sections 7.6, 9.3, and Appendix F3
YTG - Environment Yukon	Section 2.9	**CCME criteria** The proponent, using established methods, can develop site specific water quality objectives (SSWQO) where CCME criteria are not appropriate or available.	Section 9.1
YTG - Environment Yukon	Section 2.9	**Sampling of Discharges** Discharges from the WTP should be continuously sampled and monitored for selected parameters to assure proper plant operation.	Section 9.4
YTG - Environment Yukon	Section 2.9	**Water Quality Monitoring Network** A water quality-monitoring network should be developed. It should be statistically based to provide data to demonstrate performance against company and regulatory standards.	Section 9.5
Environment Canada	Section 2.9	**Flow Routing** Linkages don't always seem to be complete. Discharge to Go Creek is indicated by a range: what is the average condition?	Section 9.2
Environment Canada	Section 2.9	**Water Balance** A treat, store, sample, release scenario is envisaged for effluent from the water treatment plant. Details should be made available to understand pond size requirements for the conceivable operating conditions for the treatment system / polishing ponds.	Sections 9.3 and 9.4
Environment Canada	Section 2.9	**Hydrologic and Hydrogeologic Estimates** As previously indicated: some of the hydrologic and hydrogeologic estimates used for input and output values for the water balance need to be supported with source data and analysis and/or confirmed for the site.	Sections 5.1, 6.4, 7.2, 7.6 and 9.3.
Environment Canada	Section 2.9	**Cyanide Degradation** Were metal-cyanide complexes present in mill test discharge / tailings supernatant samples?	Appendix F-2
Environment Canada	Section 2.9; Table 2.9-1 and 2.9-3	**Water Quality Estimate** Water quality estimate tables (Table 2.9-1 & 2.9-3) produced in this section need to be revisited.	Sections 6.3, 7.4, 9.1 and 9.3.

Reviewer	EAR Section	Reviewer Comment	Response Report Section Where Addressed
Environment Canada	Section 2.9	**Tailings Supernatant Aging Test** The validity behind that assumption taken for using the 60 day period for tailings supernatant aging test results for a dynamic pond should be presented.	Section 9.4
Environment Canada	Section 2.9	**Source Data for Water Quality Predictions** Source data for water quality predictions needs to be confirmed and raw data presented for reviewers.	Section 6.3, 6.4, 7.4, 7.6, 9.1 and 9.4
Environment Canada	Section 2.9	**Water Treatment Discharge Quality** Sensitivity analysis is required for the project assessment.	Section 7.6, 9.3, and Appendix F3
Environment Canada	Section 2.9	**Bench Scale Water Treatment Testing** Bench scale water treatment testing should be initiated on representative effluent to demonstrate that treatment levels required for discharge are attainable.	Section 9.4
Environment Canada	Section 2.9	**Downstream Water Quality Objectives** Improved supporting information, including additional testwork to demonstrate this will be the case needs to be provided.	Section 9.1
Environment Canada	Section 2.9	**Water Sampling** One of the more critical baseline sites, W12, appears to have been sampled only twice (full suite: July and August) in 2005. The proponent should consider improved coverage, especially for key stations.	Sections 9.1, 9.5, and 6.4
Environment Canada	Section 2.9	**Tailings Humidity Cell Data** Where is this data?	Sections 9.4, 7.3, and Appendix F3
Environment Canada	Section 2.9	**Post-Closure Monitoring** The proponent also suggests that deep-seated groundwater from underground contact may take 52 years to daylight in Wolverine Creek. Does this mean the proponent is committed to staying on site for at least 52 years post-closure, with the means to monitor and to collect and treat contaminated groundwater if necessary?	Section 6.4
Environment Canada	Section 2.9	**Tailings Impoundment Data** Additional work respecting the tailings impoundment (e.g. groundwater flow conditions, pore water quality, expected time before contaminants daylight and period of daylighting, etcetera) need to be explored before much more can be said about protection of Go Creek.	Sections 7.4, 7.6, 9.2 and 9.3

9.1 Surface Water Quality and Related Aquatic Issues

The EAR presented water quality results for a suite of stations in the Go Creek, Money Creek and Wolverine Creek watersheds. For the present response document, water quality for Go Creek in the immediate vicinity of the proposed Wolverine Mine project facility is described, with particular focus on the most recent data collected as part of the 2005 monitoring program. Specifically, water quality data describing baseline conditions at the Wolverine Project compliance point are presented. These data form an important foundation for the discussions on establishing water quality objectives for the protection of aquatic life, the assimilative capacity of Go Creek and water treatment requirements for excess water from the tailings facility. Treated effluent will be discharged to Go Creek approximately 200 m downstream of water sampling station W16 (Figure 9-1).

In contrast to information presented in the EAR, which suggested the potential for direct discharges to Wolverine Creek, environmental and water management plans currently dictate that there will be no discharges to the Wolverine Creek watershed. For these reasons, only a brief discussion of water quality and related issues for Wolverine Creek is provided below.

9.1.1 Revised Compliance Point in Go Creek

As described previously in the EAR and herein in Section 5.2, the upper limit of fish migration in Go Creek occurs at station W80 (Figure 9-1). While the EAR proposed a compliance point at station W12, just upstream of the confluences of Go Creek, Pup Creek and Money Creek, subsequent project environmental management planning has resulted in revising the compliance point a further 2.5 km upstream to W80. This revision ensures that fish-bearing waters in Go Creek would be protected from any potential impacts from the Wolverine Project operations.

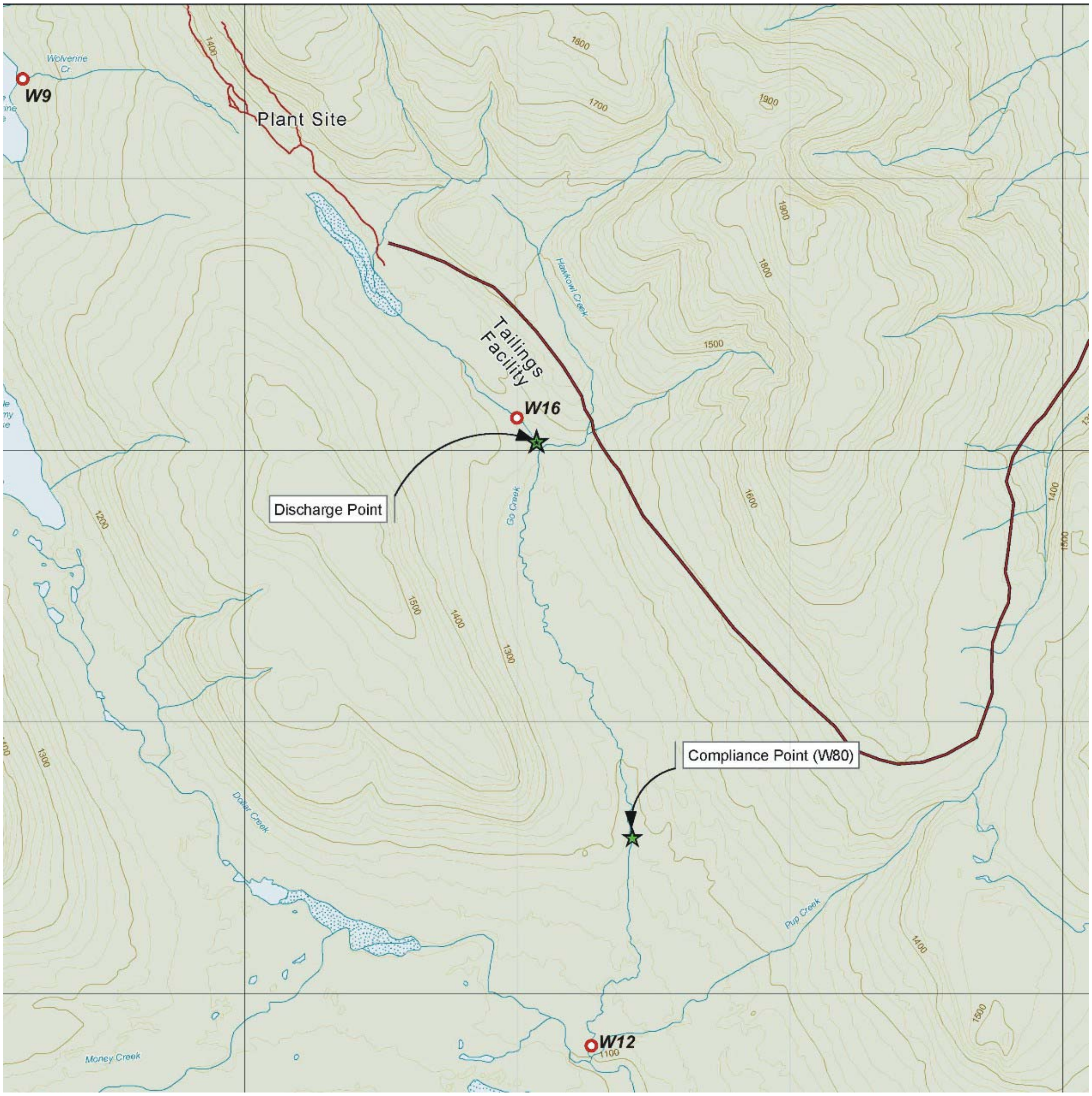

Figure 9-1 Base Map of Wolverine Project in Relation to Go Creek and Wolverine Creek and Depicting Important Water Management Features

9.1.2 Baseline Water Chemistry at Compliance Point

No direct measurements of water quality at station W80 occurred during early baseline monitoring for the project. Subsequent to fisheries studies, water quality monitoring at W80 did commence but data are limited to post-October 2005. However, water quality measured at W12, for which a longer period of record exists, presents a reasonable proxy for W80, recognizing that no tributaries enter Go Creek between these two stations (Figure 9-1).

Detailed historical water quality was presented previously in the EAR appendices for Go Creek and is not repeated herein. Although water quality data for Go Creek and station W12 extend back to 1995, continuous improvements to metal detection limits in more recent years has made some aspects of the historical data set obsolete. For the purposes of this response document, and to establish the most accurate depiction of baseline water chemistry at the Go Creek Compliance location, only the 2005 monitoring data are described.

Table 9-2 presents a summary of the most salient water quality parameters measured during water quality sampling at station W12 for the period May to November 2005 in Go Creek. Water quality is characterized by seasonably variable hardness and alkalinity, with lower values occurring during peak snowmelt periods when flows in Go Creek are dominated by these surface contributions. Hardness and alkalinity values reach maximum levels (~70 mg/L CaCO3) later in the summer months, after freshet subsides. Nutrient and metal levels in Go Creek are very low, and for those metals of particular environmental interest (e.g. As, Cd, Cu, Pb, Hg, Se and Zn) concentrations are present at or below analytical detection limits (Table 9-2).

Based on the 2005 monitoring data, baseline concentrations characterizing Go Creek at the compliance point are proposed for a suite of water quality parameters and are summarized in the final column of Table 9-2. For the parameters pH, hardness and alkalinity a range is provided to account for the observed variability due to flow conditions. For those metal parameters that were present at concentrations below the analytical detection limit, baseline values were set at the respective detection limit.

These baseline values are subsequently used in establishing site-specific water quality objectives, treatment target concentrations and estimates of water quality at the compliance point during discharge.

Table 9-2 Summary of Baseline Water Quality (mg/L) at the Compliance Point in Go Creek

	Go Creek - Baseline Chemistry for Compliance Point May to November - 2005						Proposed
Date Sampled	*May 16*	*June 16*	*July 7*	*Aug 3*	*Sept 7*	*Nov 5*	**Baseline**
Physical Tests							
Conductivity (uS/cm)		126	143	140	152		**140**
Total Dissolved Solids		78	86	73	99		**85**
Hardness ($CaCO_3$)	41.5	65.3	72.5	71.3	73.1	86.0	**40 to 70**
pH		8.01	7.30	8.03	7.92		**7.5 to 8.0**
TSS	6.1	<3.0	<3.0	<3.0	<3.0		**3**
Dissolved Anions							
Alkalinity-Total ($CaCO_3$)	32.7	55.3	63.4		72.7	65.6	**30 to 70**
Fluoride	0.028	0.029	0.038	0.037	0.050	0.044	**0.035**
Sulphate	5.50	7.8	12.4	11.9	14.3	17.0	**10**
Nutrients							
Ammonia-N	<0.020		<0.020	<0.020	<0.020	<0.020	**0.02**
Nitrate-N	0.0143	0.0146	<0.0050	<0.0050	<0.0050	0.0286	**0.008**
Nitrite-N	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	**0.001**
Total Phosphate			0.0055	0.0065	0.0039		**0.005**
Total Metals							
Aluminum	0.0898	0.0089	0.0143	0.0143	0.0092	<0.0050	**0.01**
Antimony	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	**0.0005**
Arsenic	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	**0.0005**
Cadmium	<0.000020	0.000025	<0.000050	0.000022	0.000017	<0.000017	**0.000017**
Calcium	12.9	21.9	22.3	22.5	21.3	27.1	**20**
Copper	0.0021	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	**0.001**
Iron	0.212	0.032	0.069	0.092	0.085	0.041	**0.05**
Lead	<0.00050	<0.00050	0.00068	<0.00050	<0.00050	<0.00050	**0.0005**
Magnesium	1.93	2.58	3.79	3.72	3.92	5.52	**3.5**
Manganese	0.0353	0.00958	0.0167	0.0227	0.0168	0.0123	**0.02**
Mercury	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	**0.00002**
Molybdenum	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	**0.001**
Nickel	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	**0.001**
Selenium	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.0010	**0.0005**
Silver	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	**0.00002**
Zinc	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	**0.005**

9.1.3 Additional Aquatic Issues in Wolverine and Go Creeks

Reviewers of the EAR raised several questions and issues related to receiving environment water quality (EAR Section 7.5), benthic invertebrates and periphyton (EAR Section 7.7) and fish/fish habitat resources (EAR Section 7.8). These issues have been addressed through revisions and improvements to the mine plan, water management plans, hydrological data, tailings impoundment design and water treatment.

Wolverine Creek

Wolverine Creek differs markedly from Go Creek watershed in chemical and hydrological characteristics. Wolverine Creek water has higher hardness, alkalinity and metal concentrations as compared to Go Creek. Baseline water chemistry for station W9, near the mouth of Wolverine Creek (Figure 9-1) indicates elevated levels of Se (~3 μg/L), Cd (~1.3 μg/L) and Zn (~130 μg/L). Other parameters of environmental interest (e.g. aluminum, arsenic, copper, lead, iron, lead, nickel and silver were not elevated and often present at concentrations at or below the analytical detection limit.

Benthic studies conducted during September 2005 indicate that there are functioning benthic communities adapted to conditions in Wolverine Creek. Periphyton and benthic invertebrate communities at W9 in Wolverine Creek differ substantially in species composition and community structure from those observed at W12 and W16 in the Go Creek watershed.

For the benthic invertebrate community:

- total density at W9 is intermediate between W12 (lowest) and W16 (highest);
- total taxon richness and diversity are lower at W9 than W12 and W16 and per cent dominance (% abundance of the top three taxa) is higher, indicating a less diverse community at W9;
- presence of a variety of "intolerant" (mayflies and stoneflies) and facultative (chironomids) taxa are present at all three sites; however, "tolerant" taxa (blackflies) are very abundant in one sample from W9 (tolerance defined in terms of organic matter and sediment inputs); and
- there are differences in common and predominant species.

The periphyton community at W9 differed from those at Go Creek sites W12 and W16 in similar ways (i.e., intermediate values for chlorophyll or abundance, lower taxon richness and different species composition at W9).

Fish appear to use Wolverine Creek habitat on an opportunistic basis (one adfluvial juvenile lake trout was captured from W9 in August 2005). A flow monitoring weir 40 m upstream of the lake outlet is impassable to fish. The lower creek has the potential to provide moderately good spawning habitat for arctic grayling, but poor habitat for all species for overwintering, as it either freezes or has very limiting flows and water depth. It has a small width (0.3 m) and residual pool depth (0.16 m). Little Wolverine Lake is known to contain lake trout, arctic grayling and long nose sucker (EA Report Section 7.8).

Go Creek

Protecting water quality and stream health in Go Creek is integral to the success of the Wolverine Project, although there are no fish in upper Go Creek in the vicinity of the discharge point (Figure 9-1). Given that bull trout, arctic grayling and other fish are known to inhabit the lower 2.5 km of Go Creek, as well as Money Creek upstream and downstream of the Go Creek confluence, site water management is designed to protect these resources by ensuring that all water quality objectives (either site-specific or CCME) are met in fish-bearing water.

Benthic studies conducted during September 2005, indicate the presence of functioning benthic communities in Go Creek, differing in composition from those in Wolverine

Creek. Both periphyton and benthic invertebrate communities had higher density at W16 than W12, downstream (more than ten-fold higher benthos density and chlorophyll a). For benthos, total taxon richness and percent dominance (% abundance of the top three taxa) were similar at the two sites; however, diversity was notably higher at W16. There were minor differences in abundance of common and predominant species, with a variety of "intolerant" (mayflies and stoneflies) and facultative (chironomids) taxa present at both sites (tolerance defined in terms of organic matter and sediment inputs). Higher proportions of "intolerant" invertebrate taxa at W16 than W12, coupled with higher density, community diversity and periphyton chlorophyll a indicate that W16 is a more productive site (on an areal basis) than is W12. Results for the benthic communities correspond with higher observed nutrient levels during the summer growing season at W16.

9.1.4 Water Quality Objectives

Establishing water quality objectives (WQO) for the compliance point in Go Creek that are protective of aquatic life is an integral component of the overall water management plan for the Wolverine Project. In developing water quality objectives for the compliance point, guidelines/objectives/criteria established by CCME, BC Ministry of Environment (BC MOE) and the United States Environmental Protection Agency (USEPA) for a suite of parameters have been utilized. Guidelines typically are recommendations; objectives or criteria may have legal standing, depending on the jurisdiction. Discharges, on the other hand, are typically regulated through permits for "end of pipe" rather than for the receiving environment.

Additional considerations for developing site-specific WQO include:

- baseline conditions, especially if parameters are close to or exceed current guidelines/objectives/criteria;
- hardness, pH, temperature or dissolved organic carbon levels in water, which can affect toxicity of some constituents;
- recent information on toxicology and bioaccumulation potential; and
- the most sensitive aquatic species in the area (e.g., species of fish) and their biological response to elevated metals levels in the cold water environment of the Yukon.

Typical approaches for developing site-specific WQO are discussed by CCME (1999: A protocol for the derivation of water quality guidelines for the protection of aquatic life) and the BC MOE (1997: Methods for deriving site-specific water quality objectives in British Columbia and Yukon). Data requirements for guideline derivation are discussed in both documents.

The recommended approaches (BC MOE 1997) are:

- direct adoption of generic water quality guidelines and criteria (e.g. CCME);
- derivation of site-adapted water quality criteria (using the background concentration, recalculation or water effect ratio procedure); and
- development of new WQO using the resident species procedure.

A combination of the first two approaches has been employed for the Wolverine Project. The resident species procedure would require extensive toxicity assessments and the low level of productivity and populations of resident fish would result in significant detrimental impacts as a consequence of the study.

CCME guidelines for many constituents (aluminum, arsenic, copper, iron, lead, mercury, nickel, silver, zinc, nitrate and ammonia) have been directly applied to Go Creek at the compliance point. In contrast, WQO for Cd and Se are proposed for the Go Creek compliance point utilizing criteria/objectives more recently established by USEPA and BC MOE, respectively.

Cadmium

The CCME guideline for Cd is 0.017 µg/L and was derived by multiplying the lowest observable effect level (LOEL) of 0.17 µg/L for the most sensitive organism to Cd by a safety factor of 0.1. The CCME guideline is however, considered an “interim” guideline based on the fact that the water concentration of Cd was not verified during exposure. The CCME Cd guideline or interim status has not been updated since 1991. Because of this, and the fact that existing analytical methods for determining Cd in freshwaters cannot routinely measure Cd concentrations below the CCME guideline, more recent criteria updates for Cd performed by the USEPA were evaluated.

The freshwater cadmium criterion was updated by the USEPA in 2001 based on a rigorous and recent evaluation of scientific information on cadmium effects and chronic and acute toxicity to freshwater biota. The work underwent scientific peer and public reviews to arrive at updated criteria, using dissolved rather than total cadmium (considered more biologically relevant). The criteria supersede previous USEPA aquatic life water quality criteria for cadmium because these new criteria were derived based on the most recent science.

As mentioned in both CCME (1999) and USEPA (2001), Cd criteria are hardness dependent, based on the observations that Cd toxicity is reduced with increasing hardness. Based on more recent toxicological information, the USEPA (2001) revised the hardness dependent equation to better reflect the more recent and reliable data. Accordingly, the freshwater Final Chronic Value for dissolved cadmium at a specified hardness is given by:

$$= 0.938[e^{(0.7409[\ln(\text{hardness})]-4.719}]$$

For Go Creek at the compliance point with an assumed hardness ranging from 40 to 70 mg/L, calculated Cd criteria range from 0.15 to 0.19 µg/L. For the purposes of establishing WQO, the more conservative 0.15 µg/L is proposed for Go Creek.

Selenium

The CCME guideline for Se is 0.001 mg/L. It is noted that the BC guideline maximum is higher at 0.002 mg/L (BC Ministry of Environment, 2001) based on considerable experience with selenium issues, particularly downstream of coal mines. There are rare occurrences of elevated selenium in Go Creek (0.0015 mg/L on one date), so it is proposed that the BC guideline be adopted, as the underlying research indicates that aquatic life is protected at that level. Selenium is considered both an essential element and a toxicant, with a narrow gap between the two, approximately one order of magnitude (CCME 1999).

Table 9-3 summarizes the proposed receiving water quality objectives for the protection of aquatic life for the compliance point in Go Creek (Figure 9-1).

Table 9-3 Summary of Water Quality Objectives (mg/L) for the Compliance Point in Go Creek

Parameter	Proposed Objective	Source
Physical Tests		
pH	**6.5 to 9.0**	*CCME*
Dissolved Anions (mg/L)		
Sulphate	**100.0**	*BC*
Nutrients (mg/L)		
Ammonia-N	**1.0***	*CCME*
Nitrate-N	**1.3**	*CCME*
Total Metals (mg/L)		
Aluminum	**0.1**	*CCME*
Antimony	**0.006**	*CCME (Drinking Water)*
Arsenic	**0.005**	*CCME*
Cadmium	**0.00015**	*USEPA*
Copper	**0.002**	*CCME*
Iron	**0.300**	*CCME*
Lead	**0.002**	*CCME*
Mercury	**0.000026**	*CCME*
Molybdenum	**0.073**	*CCME*
Nickel	**0.065**	*CCME*
Selenium	**0.002**	*BC*
Silver	**0.0001**	*CCME*
Zinc	**0.03**	*CCME*

* assumed temperature of 5 to 10 C and pH of 8.0

9.2 Site Water Management

Significant revisions to the mine plan and tailings facility design have occurred since submission of the EAR. These revisions have resulted in changes to the original water balance and significant improvements to the overall site water management plan for the project. Figure 9-2 provides a schematic of the key components of the Wolverine Project water management system including tailings discharge and reclaim facilities, management of site runoff and underground water and water treatment of excess waters.

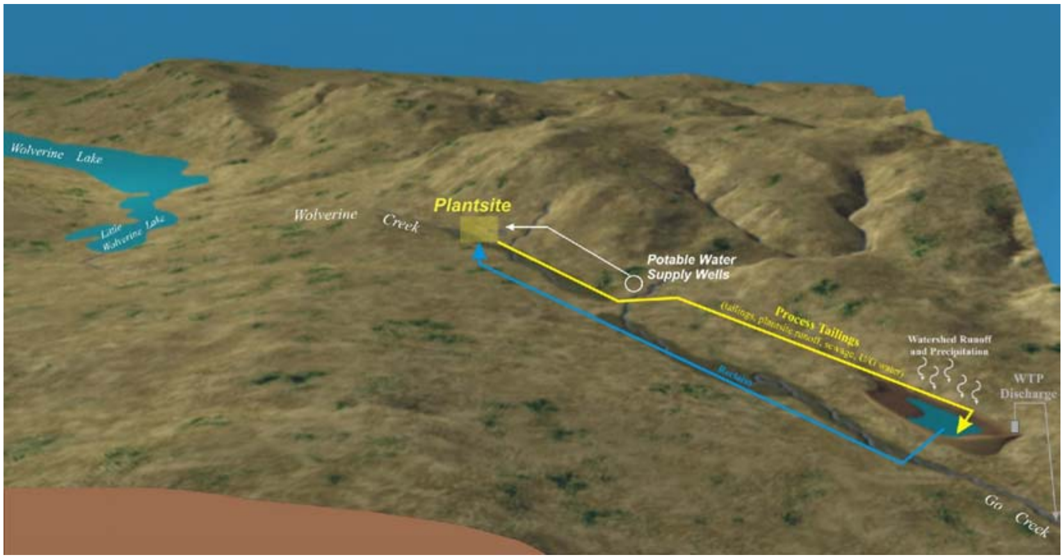

Figure 9-2 Schematic of Key Components of Wolverine Project Water Management and Water Balance

The process plant, tailings facility and water treatment plant (WTP) for excess waters are integral features of the Wolverine Project water management plan. Significant changes to the water management plan presented in the EAR submission include:

- elimination of Wolverine Creek watershed groundwater supply wells and commensurate reduction in potential for impacts to flow in Wolverine Creek;
- increased amount of reclaim (90 to 94%) of process water from tailings facility;
- direction of all poor quality water, including underground mine water, to the tailings impoundment for central storage of poor quality water;
- establishment of one primary water treatment plant, located adjacent to the tailings facility, for the treatment of excess water during the six month period of approximately May to October;
- inclusion of a low permeability enviroliner beneath the tailings facility to prevent uncontrolled releases of tailings porewater to groundwater; and
- reduced tailings seepage reclaim.

Fresh water used at the industrial complex and the camp will be obtained from groundwater wells at Go Creek; no water will be obtained from the Wolverine Creek watershed. Most of the water used for domestic purposes at the camp and industrial complex will be treated by sewage treatment plants (STP) located at each facility. Water (and sludge) from the STP and surface runoff from the industrial complex will be discharged to the tailings facility.

To minimize the potential effect of site runoff on the water quality of the natural drainages, a drainage diversion system will route surface runoff around the plantsite and tailings facilities (see Figures 1.2 and 7.1-1). Surface runoff will be collected in perimeter ditches upslope of the industrial complex, the temporary waste rock pad and tailings facility. The 'clean' runoff water will be diverted away from the mine site facilities and will ultimately drain into Go Creek.

All of the water used in ore processing is obtained (reclaimed) from the tailings facility, which receives inputs from tailings discharge, direct precipitation, runoff, underground mine water and much smaller quantities from sewage treatment plant discharge as well as water contained in DMS float and waste rock placed in the impoundment. Hence, most (94%) of the water in the water management system at the mine site is actually recycled between the process plant and the tailings facility.

A positive water balance exists at the site and excess water is to be treated at a facility located adjacent to the impoundment. The water treatment plant receives only water from the tailings facility. Treated water will be directed to a retention pond for storage and monitoring prior to release to Go Creek (see Figure 9-1 for discharge location). If the water in the retention pond does not meet discharge standards, water will be pumped back to the tailings impoundment for re-treatment. Details of the water treatment process and discharge limits are provided in Section 9.4.

9.3 Site Water Balance

9.3.1 Operations

Using estimates of average annual flows (m^3/h) between the different facilities in the site water management system, a site water balance was generated for average annual conditions during operations (Figure 9-3).

Most of the water in the site water balance is continuously recycled between the process plant and the tailings facility. The process plant water balance flowsheet has been updated and is provided in Figure 1-4. In contrast to that originally presented in the EAR, all waters necessary for processing will be derived from reclaimed supernatant from the tailings facility (223 m^3/h). Higher quality water for gland seal water and reagent mixing will be available through low level water treatment (within the process plant) of a portion of reclaim water (approximately 25 m^3/h).

The largest output from the process plant will be the water that is pumped to the tailings facility (238.15 m^3/h). The estimated output accounts for the time that the paste backfill plant is expected to be operational (approximately 10 h/d) and when it is by-passed. The most significant input to the tailings discharge, apart from tailings process water, is the assumed contributions from groundwater flows to the underground mine (25 m^3/h). Additional significant inputs to the overall water balance include water in ore (3.58 m^3/h), runoff from the tailings impoundment catchment not affected by diversions channels, an assumed 10% seepage through the tailings diversion channels (4.82 m^3/h), and direct precipitation on the tailings facility (1.98 m^3/h). Much lesser quantities of input water are delivered in DMS float (0.86 m^3/h), waste rock (0.03 m^3/h), and sewage treatment from the camp.

The discharge of treated water into Go Creek (31 m^3/h) during the six month period of May to October, evaporation from the surface of the tailings pond (2.34 m^3/h) and the pore water accumulating in the deposited tailings, waste rock and DMS (5.26 m^3/h) are the main outputs from the site water balance.

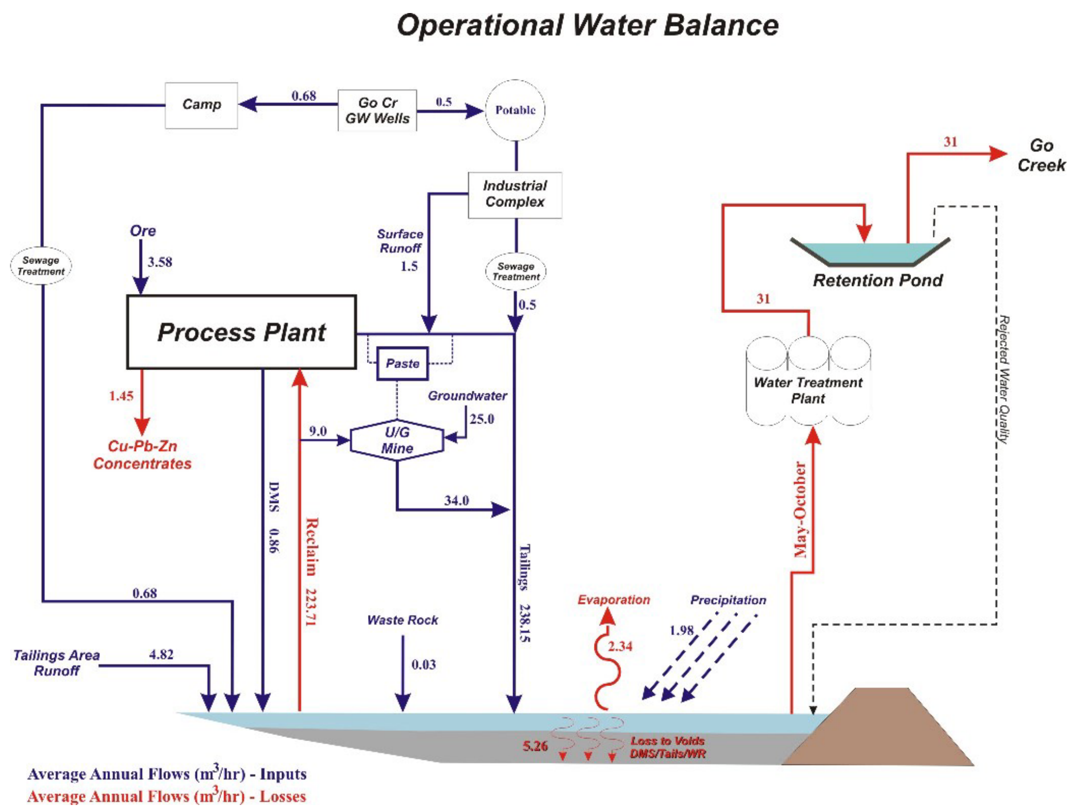

Figure 9-3 Wolverine Project Water Balance Schematic for Operations

Compared to the amount of water being recycled, the input and output of water in the site water balance are relatively small. On a monthly basis, a slight positive water balance exists (Figure 9-4). Over the course of an average year, approximately 136,000 m^3 of excess water accumulates in the tailings facility. The treated water discharge of 31 m^3/h is designed to treat and discharge that volume of excess water over a six-month period, corresponding to the periods of highest flow in Go Creek.

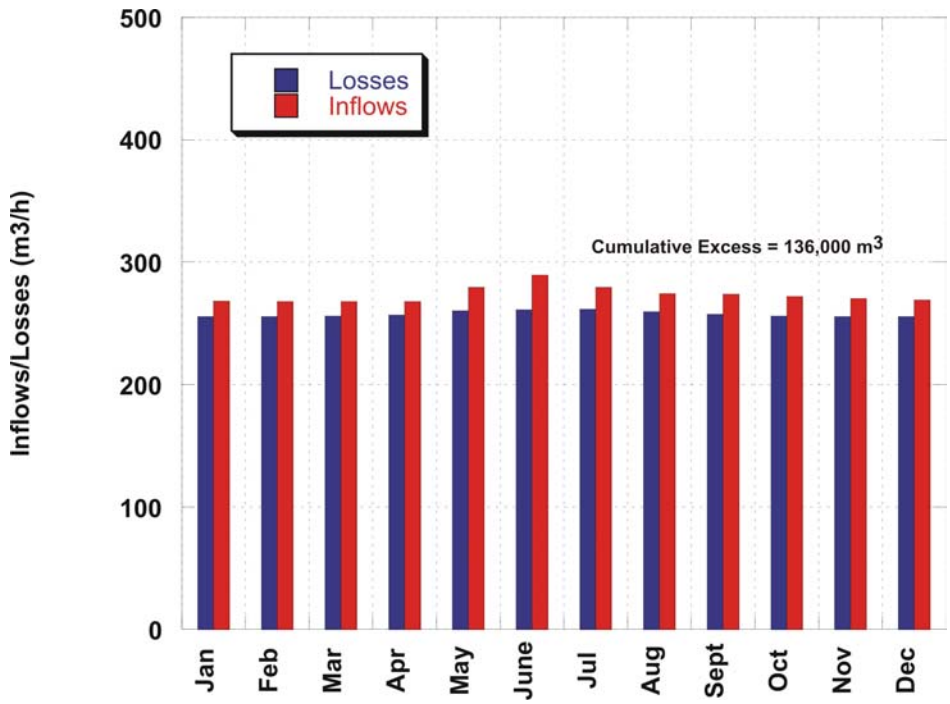

Figure 9-4 Monthly Balance of Inflows and Losses (not including water treatment) for Wolverine Project Average Year Conditions

9.3.2 Closure

At the cessation of operations, water inputs to the tailings impoundment will be altered significantly and reclaim/recycling of water will be terminated. Closure of the tailings facility requires that fresh water be directed to the facility to naturally flush out contaminants and replace tailings-affected water with clean runoff. Accordingly, tailings impoundment diversion ditches will be decommissioned and runoff from the impoundment catchment will be permitted to flow into the facility. Figure 9-5 presents a schematic of the closure water balance scenario during the first 3 years following the cessation of operations. In addition, Figure 9-6 provides a rendering of the post-closure tailings impoundment.

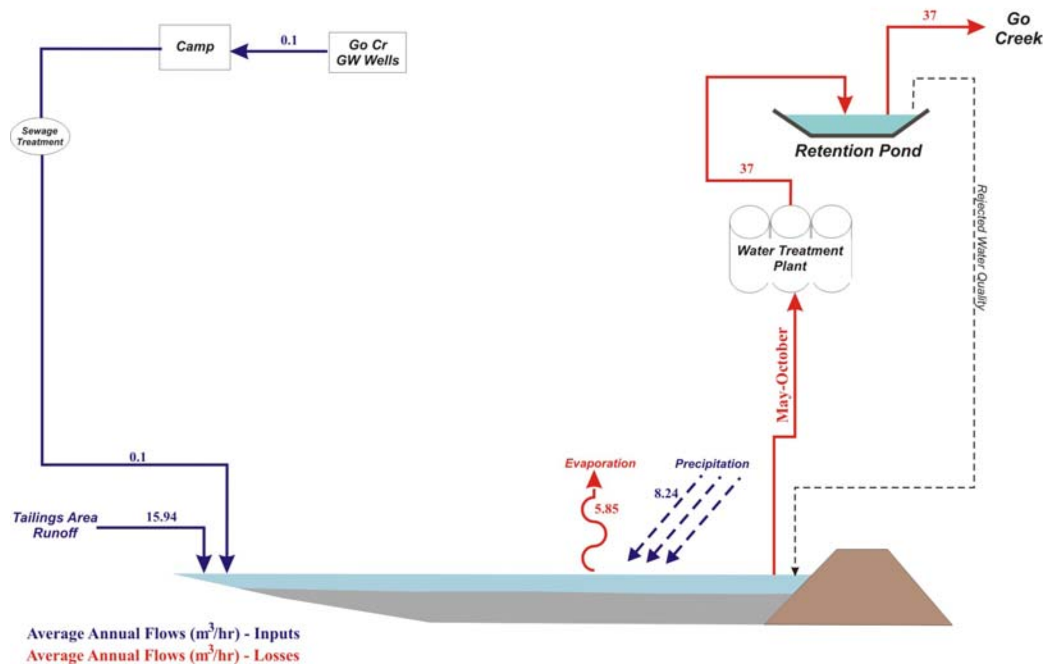

Figure 9-5 Schematic of Closure Water Balance for Average Year Flows During the First 3 Years Following Cessation of Operations

During post-closure, the dominant inflow to the water balance is runoff originating from the tailings area (15.94 m^3/L). Precipitation and evaporation rates also increase owing to the larger surface area of the impoundment pond. During the initial 3 years following closure, excess tailings water will be treated through the water treatment plant and water levels in the impoundment will be maintained below the spillway elevation of 1313.7 m. Because of the higher influx of fresh water, the discharge volume increases over that during operations to 37 m^3/h. The 3-year post-closure treatment phase is dictated by the time required to flush tailings-affected water, and the resultant impoundment water quality being below discharge limits (see Section 9.4).

Immediately prior to closure, the volume of tailings water in the impoundment will be approximately 80,000 m^3. Upon removal of the diversion ditches, annual inflows of runoff and precipitation to the facility are expected to be on the order of 158,000 m^3 (Figure 9-7). As such, roughly two tailings water volume replacements are expected to occur for each year. Because the tailings are to be covered with approximately 1 m of coarse DMS float (see Section 7.10), diffusion of tailings porewater to the overlying water column will be greatly attenuated. By the end of year-3 post-closure, approximately 5 to 6 complete volume replacements would have occurred with clean runoff water. After these flushings, impoundment water quality is expected to be of sufficient quality to allow passive discharge through the tailings spillway. With passive discharge, annual discharges can occur and average flows of 18 m^3/L (~5 L/s) to Go Creek are expected (Figure 9-8).

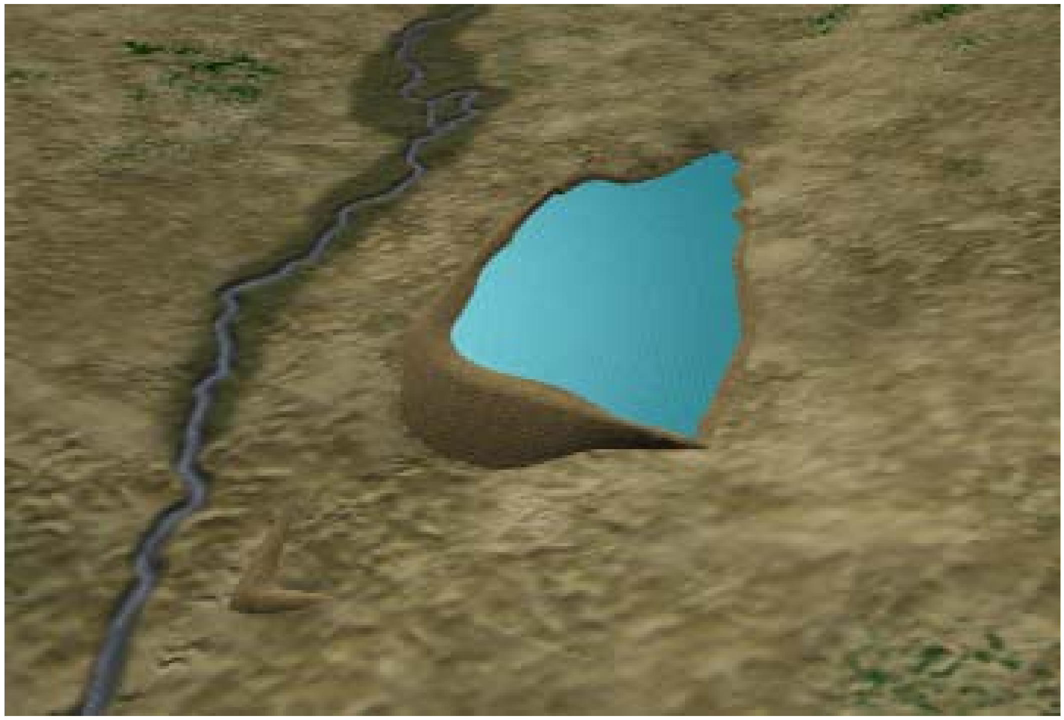

Figure 9-6 3-Dimensional Rendering of Post-Closure Tailings Facility

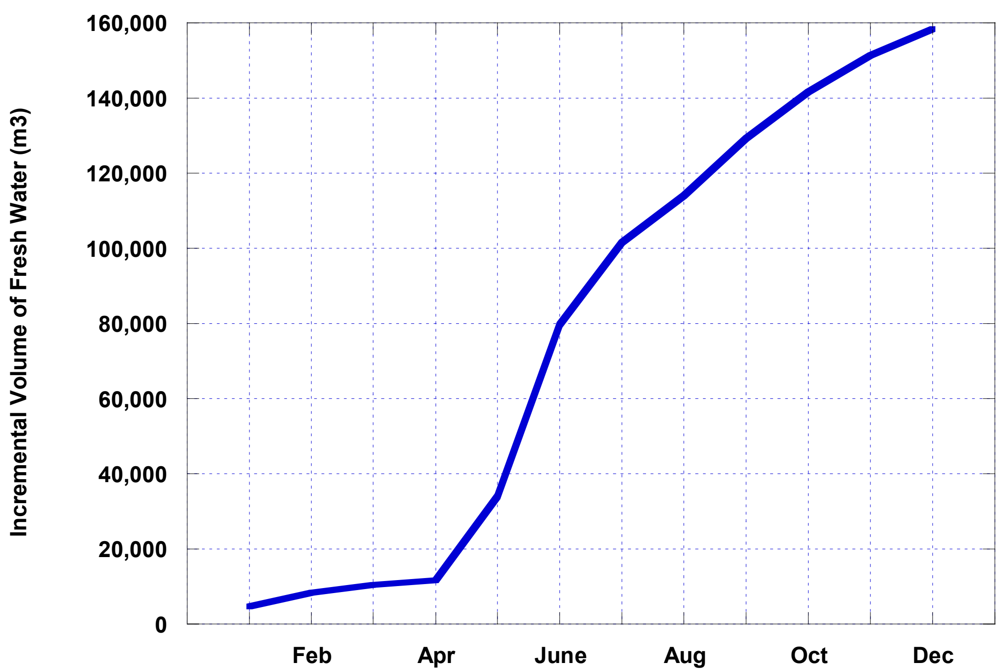

Figure 9-7 Annual Fresh Water Inflows to the Tailings Impoundment for Average Year Post-Closure without Diversions

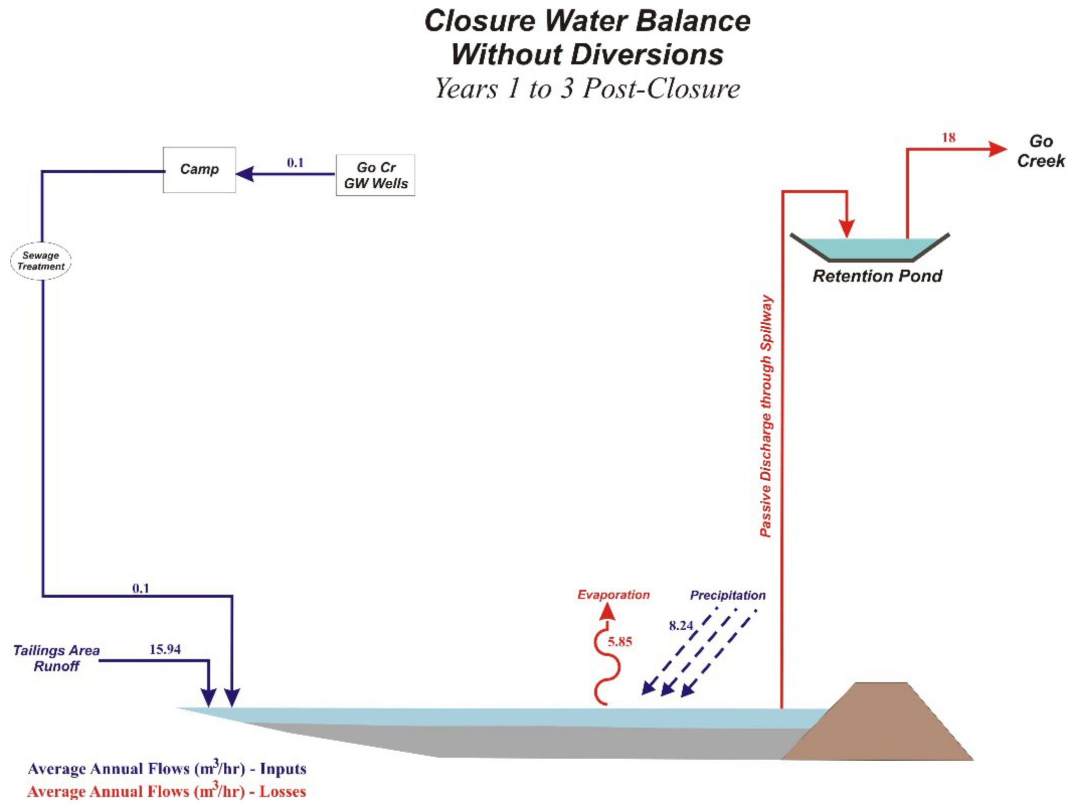

Figure 9-8 Post-Closure Water Balance for Passive Discharge to Go Creek

9.4 Water Treatment

Treatment of excess tailings impoundment water will be required in order to prevent impacts to the receiving environment in Go Creek during operations and for an estimated three-year period immediately following closure of the mine. The following sections describe the nature of the tailings water and include the most recent lock-cycle results from pilot process metallurgical testing. Aging test results are not provided in the present response document owing to the high recycle/reclaim rate, and thus a departure from the EAR submission. Following the discussion on tailings chemistry, the required treatment levels and proposed discharge limits for the water treatment plant are presented. Limits have been established to ensure that receiving water quality objectives presented in Section 9.1.4 are consistently achieved at the compliance point in Go Creek.

Predictions of water quality at the compliance point in Go Creek throughout the discharge period of May to October are also described.

Finally, a discussion of the treatment process proposed for the Wolverine Project is presented and reference to similar facilities and performance examples are outlined.

9.4.1 Tailings Supernatant Chemistry

As outlined in the operations water balance, tailings impoundment water will be dominated by process water with lesser contributions from underground mine water and clean runoff. For the purposes of the present evaluation, tailings impoundment water quality has been assumed to be equivalent to the poorest water quality observed during metallurgical lock-cycle testing. Recent data for water emanating from the test mine underground has indicated relatively good mine water quality and dilution of tailings water with this underground water has not been assumed. Table 9-4 presents a summary of representative tailings water chemistry generated from the selection of the poorest quality results for each parameter from two lock-cycle supernatant analyses.

Table 9-4 Summary of Expected Tailings Supernatant Quality

Parameter	Concentration (mg/L)
pH	8.5
Hardness	400.0
Ammonia-N	1.300
Nitrate	0.430
CN-total	0.030
SO_4	1500
Al	0.020
Sb	0.060
As	0.030
Cd	0.045
Cu	0.115
Fe	0.040
Pb	0.025
Hg	0.0001
Ni	0.018
Se	10.0
Ag	0.022
Zn	0.076

Tailings supernatant analyses indicate that the parameters most likely to be elevated in the impoundment during operations include: ammonia-N, Cd, Cu, Pb and Se. Of these parameters, Cd and Se present the most challenges with respect to successful treatment and this is discussed in more detail in section 9.4.4. The other parameters are routinely treated to acceptable environmental levels using conventional treatment technologies.

9.4.2 Treatment Requirements and Proposed Discharge Limits

Treatment requirements and proposed discharge limits for the Wolverine Project have been developed considering both the assimilative capacity of Go Creek and the water quality objectives proposed for the compliance point to ensure the protection of aquatic life. The development of proposed discharge limits for the project involved a two-step process that included:

1. A mass loading approach, using predicted excess water discharge volumes (31 m^3/L or 9 L/s), average low-flow volumes in Go Creek at the compliance point, baseline chemistry in Go Creek and proposed water quality objectives. This information was

used to back-calculate discharge concentrations that achieve water quality objectives at the compliance point in Go Creek;

2. Comparison of the calculated discharge concentrations to existing effluent discharge standards (e.g. MMER) and adjustment of the discharge concentrations to remain at or below such standards where warranted.

Table 9-5 provides a summary of the proposed discharge limits for the water treatment plant/retention pond system based on low-flows expected in October during the discharge period. As illustrated the proposed discharge limits for total ammonia-N, nitrate, Al, Fe and Ni have been adjusted downwards from their respective calculated allowable concentrations to be more aligned with authorized limits (MMER).

Table 9-5 Summary of Proposed Discharge Limits (mg/L) from the Water Treatment Plant/Retention Pond

	Baseline mg/L	Low Flow $Q_{(w80)}$ m^3/s	$Q_{(treatment)}$ m^3/s	*Site-Specific Water Quality Objective*	Maximum Allowable Discharge	*Proposed Discharge Limits*
Total Ammonia	0.02	0.149	0.009	1.0	18	***5.0***
Nitrate	0.008	0.149	0.009	1.3	23	***10***
Sulphate	10	0.149	0.009	100	1830	***1800***
CN(total)	0.00001	0.149	0.009	0.005	0.091	***0.05***
Al	0.01	0.149	0.009	0.1	1.66	***1.5***
Sb	0.0005	0.149	0.009	0.006	0.101	***0.1***
As	0.0005	0.149	0.009	0.005	0.083	***0.08***
Cd	0.000017	0.149	0.009	0.00015	0.0025	***0.0025***
Cu	0.001	0.149	0.009	0.002	0.019	***0.02***
Fe	0.05	0.149	0.009	0.3	4.6	***0.5***
Pb	0.0005	0.149	0.009	0.002	0.028	***0.025***
Hg	0.00002	0.149	0.009	0.000026	0.00013	***0.0001***
Ni	0.001	0.149	0.009	0.065	1.172	***0.5***
Se	0.0005	0.149	0.009	0.002	0.028	***0.025***
Ag	0.00002	0.149	0.009	0.0001	0.0015	***0.001***
Zn	0.005	0.149	0.009	0.03	0.463	***0.45***

9.4.3 Predictions of Water Quality in Go Creek During Discharge

Discharge limits for the water treatment system have been proposed to ensure the protection of aquatic life throughout the six month discharge window. This was achieved by back-calculating minimum treatment requirements during low flow periods. As discussed in the Section 5.1 (hydrology), flows in Go-Creek are significantly higher during May, June and July as compared to October. Accordingly, water quality at the compliance point in Go Creek will be better than the proposed water quality objectives during most of the discharge period owing to the increased assimilative capacity at higher flows. Examples of this are provided in Tables 9-6 and 9-7, which show predicted concentrations of key parameters at the compliance point for June and July, assuming average flow conditions (see Appendix H1 for additional data). Accordingly, significant flexibility exists within the water management and discharge system to discharge higher or lower volumes of treated water, all the while achieving the principle objective of meeting water quality objectives for the protection of aquatic life.

Table 9-6 Summary of Predicted Concentrations (mg/L) of Key Parameters at the Compliance Point in Go Creek in June as Compared to Water Quality Objectives

June	Baseline mg/L	June $Q_{(w80)}$	$Q_{(treatment)}$ m^3/s	Discharge Concentration	Predicted Concentration at Compliance	*Water Quality Objective (mg/L)*
Hardness	65	0.400	0.009	400	72	
Total Ammonia	0.02	0.400	0.009	5.0	0.125	***1.0***
Nitrate	0.008	0.400	0.009	10	0.219	***1.3***
Sulphate	10	0.400	0.009	1800	48	***100***
CN(total)	0.00001	0.400	0.009	0.05	0.001	***0.005***
Al	0.01	0.400	0.009	1.5	0.041	***0.1***
Sb	0.0005	0.400	0.009	0.1	0.003	***0.006***
As	0.0005	0.400	0.009	0.08	0.002	***0.005***
Cd	0.000017	0.400	0.009	0.0025	0.00007	***0.00015***
Cu	0.001	0.400	0.009	0.02	0.0014	***0.002***
Fe	0.05	0.400	0.009	0.3	0.055	***0.3***
Pb	0.0005	0.400	0.009	0.025	0.001	***0.002***
Hg	0.00002	0.400	0.009	0.0001	0.00002	***0.000026***
Ni	0.001	0.400	0.009	0.5	0.012	***0.065***
Se	0.0005	0.400	0.009	0.025	0.0010	***0.002***
Ag	0.00002	0.400	0.009	0.001	0.00004	***0.0001***
Zn	0.005	0.400	0.009	0.45	0.014	***0.03***

Table 9-7 Summary of Predicted Concentrations (mg/L) of Key Parameters at the Compliance Point in Go Creek in July as Compared to Water Quality Objectives

July	Baseline mg/L	July $Q_{(w80)}$	$Q_{(treatment)}$ m^3/s	Discharge Concentration	Predicted Concentration at Compliance	*Water Quality Objective (mg/L)*
Hardness	70	0.290	0.009	400	80	
Total Ammonia	0.02	0.290	0.009	5.0	0.164	***1.0***
Nitrate	0.008	0.290	0.009	10	0.296	***1.3***
Sulphate	10	0.290	0.009	1800	62	***100***
CN(total)	0.00001	0.290	0.009	0.05	0.001	***0.005***
Al	0.01	0.290	0.009	1.5	0.053	***0.1***
Sb	0.0005	0.290	0.009	0.1	0.003	***0.006***
As	0.0005	0.290	0.009	0.08	0.003	***0.005***
Cd	0.000017	0.290	0.009	0.0025	0.00009	***0.00015***
Cu	0.001	0.290	0.009	0.02	0.0015	***0.002***
Fe	0.05	0.290	0.009	0.3	0.057	***0.3***
Pb	0.0005	0.290	0.009	0.025	0.001	***0.002***
Hg	0.00002	0.290	0.009	0.0001	0.00002	***0.000026***
Ni	0.001	0.290	0.009	0.5	0.015	***0.065***
Se	0.0005	0.290	0.009	0.025	0.0012	***0.002***
Ag	0.00002	0.290	0.009	0.001	0.00005	***0.0001***
Zn	0.005	0.290	0.009	0.45	0.018	***0.03***

9.4.4 Treatment Process

The proposed treatment process for the Wolverine Project was described previously in the EAR submission. A number of possible water treatment methods were considered including High Density Sludge (HDS), lime neutralization, reverse osmosis, activated silica gel, biological treatment and activated carbon. The HDS method was selected because it is robust, has minimal sludge production with near stable sludge quality and is easy to fine tune once constructed.

The HDS process has many advantages over other lime precipitation systems. The most important of these is a substantial reduction in sludge volume resulting from an increase in sludge density. Typical HDS plants can densify the influent from 2 to 30% solids resulting in reduction of the volume of sludge produced by over 95% compared to conventional neutralization plants. In addition to reduced sludge volume and superior sludge density, there is an increase in sludge stability, both chemically and physically. The sludge produced by a HDS process can be co-deposited with tailings. Other advantages of the HDS process include:

- a high quality effluent is produced
- the process is easily automated
- HDS is a proven technology

The effective removal of base metals in a chemically stable form in the HDS process is primarily the result of the formation of co-precipitates with iron on the surfaces of the recycled sludge particles. A high iron to total metals ratio in the treatment plant feed is sought to provide for chemical stability of the precipitates.

Examples of effective HDS treatment of mine water from plants operating in other areas of the world including Canada are provided in Table 9-8 below.

Table 9-8 Effluent Quality from Different HDS Plants (mg/L)

Elements	Chile		Dominican Republic		Australia		Central BC Canada	
	Feed	Effluent	Feed	Effluent	Feed	Effluent	Feed	Effluent pH ~8.0
Aluminum	2090	1.6	1210	8.24	928	2.12	586.7	6.9
Arsenic	0.76	<0.04	43.6	0.0113	-	-	1.9	<0.2
Cadmium	0.43	<0.01	8.44	0.00068	0.008	<0.001	0.58	<0.01
Cobalt	10.5	<0.01	0.98	<0.0050	3.87	<0.001	3.36	<0.01
Copper	286	<0.01	2.51	<0.0010	165	0.008	54.42	<0.01
Chromium	0.53	<0.01	162	<0.0010	0.075	0.005	-	-
Phosphorus	62.5	<0.5	14.7	<0.30	-	-	18.6	0.4
Iron	864	<0.05	7030	<0.030	822	<0.02	729.19	<0.03
Manganese	297	0.07	7.34	0.00165	126	0.217	115.41	4.01
Mercury	-	-	0.0018	<0.000050	-	-	<0.05	<0.05
Molybdenum	0.5	0.24	<0.30	0.0117	-	-	0.05	0.08
Nickel	5.93	<0.01	1.29	<0.0050	0.479	0.002	7.09	<0.02
Lead	<0.02	<0.02	<0.50	<0.00050	0.057	0.001	0.13	<0.05
Selenium	0.11	<0.05	<2.0	0.021	-	-	-	-
Silver	<0.004	<0.004	<0.10	<0.00010	-	-	<0.02	<0.02
Sulfates	26100	2160	24470	1748	12500	1700	-	-
Zinc	103	<0.01	1230	0.011	10.4	0.004	107.16	0.02

The examples of HDS performance at other mining operations indicate that the proposed discharge limits for the Wolverine Project should be readily achievable utilizing this treatment technology. Pilot plant water treatment plant testwork is continuing at the time of writing and updates on expected plant performance will be provided on a regular and as-needed basis.

9.5 Potential Effects on Aquatic Communities of Go Creek

Effluent discharged from the water treatment plant to Go Creek 200 m downstream of W16 will be treated to reduce levels of metals and other constituents (TSS, pH, ammonia, nitrate) so they meet CCME or site-specific objectives in Go Creek in fish-bearing waters (W80 as compliance point) throughout the year for all parameters (Appendix H1). As a result, the discharge of metals to Go Creek is not expected to have an adverse effect on water quality, benthic invertebrate or periphyton communities downstream of W80.

Between the discharge point and W80 (a distance of approximately 4.5 km), levels of a cadmium, selenium and zinc are predicted to be slightly higher than the site-specific water quality objectives as flows decrease after freshet. Given that levels will be only slightly higher than the objectives, in a localized area (i.e., close to the discharge point, given the 1.5 fold increase in stream flows and dilution downstream to W80), and that there is a wide margin of safety inherent in the objectives, a low magnitude adverse effect on benthic communities may be predicted for Go Creek upstream of W80. For perspective, Wolverine Creek maintains viable benthic communities in waters that naturally contain notably higher levels of zinc, cadmium and selenium than baseline conditions in Go Creek or immediately downstream of the effluent discharge to Go Creek

Selenium toxicity and bioaccumulation of selenium in fish and bird tissues (through consumption of contaminated insects) have been noted at sites of elevated selenium concentrations, as found downstream of some mines, particularly coal mines, and in streams draining arid seleniferous soils where agricultural practices include long-term irrigation (Outridge *et al*. 1999; Chapman 2000). Levels in Go Creek immediately downstream of the effluent discharge are expected to be a maximum of 0.0025 mg/L and to meet the BC water quality guideline of 0.002 mg/L in fish-bearing waters downstream of W80, so are not predicted to cause effects on fish and wildlife.

Issues associated with cadmium toxicity also tend to occur at levels considerably higher than will occur in Go Creek. Saiki *et al*. (2001) noted adverse effects on salmonids and aquatic insects in the upper Sacramento River, California, in an area classified as a Superfund site by the USEPA, where highly elevated levels of copper, cadmium and zinc are associated with historic mining practices and are considerably higher than levels predicted for Go Creek downstream of the discharge.

Benthic productivity may be stimulated by releases of nitrate, ammonia and perhaps phosphate in the effluent. Baseline nitrate levels range from below detection (0.005 mg/L) at W12 to 0.012 to 0.040 mg/L at W16. Total phosphate levels range from W16 0.003 to 0.004 mg/L at W16 to 0.006 to 0.007 mg/L at W12. Ammonia levels are below analytical detection limits (0.02 mg/L) at both sites. With discharge of treated effluent, nitrate levels will increase to 0.3 mg/L and ammonia will increase to 0.16 mg/L in Go Creek during July (Table 9-6) and to higher levels later in the growing season (Appendix H1). These levels will be well below water quality objectives for toxicity and may stimulate periphyton growth in Go Creek, which may lead to changes in benthic invertebrate communities.

Following closure of the mine, the discharge of metals into Go Creek is not expected to have an adverse effect on benthic communities, given the proposed methods of water treatment and monitoring.

9.6 Monitoring and Mitigation Plans

9.6.1 Go Creek

Successful operation of the water management/water treatment system depends upon the implementation of an integrated monitoring system that provides real-time information of hydrological conditions, flows from the retention pond and relatively rapid analysis of confirmatory water quality sampling at key points within the treatment-discharge system. Figure 9-9 highlights the key components of the Wolverine monitoring program for the water treatment system and compliance point that is designed to ensure that discharges from the water treatment plant/retention pond protect downstream aquatic life. Details of the system are described below.

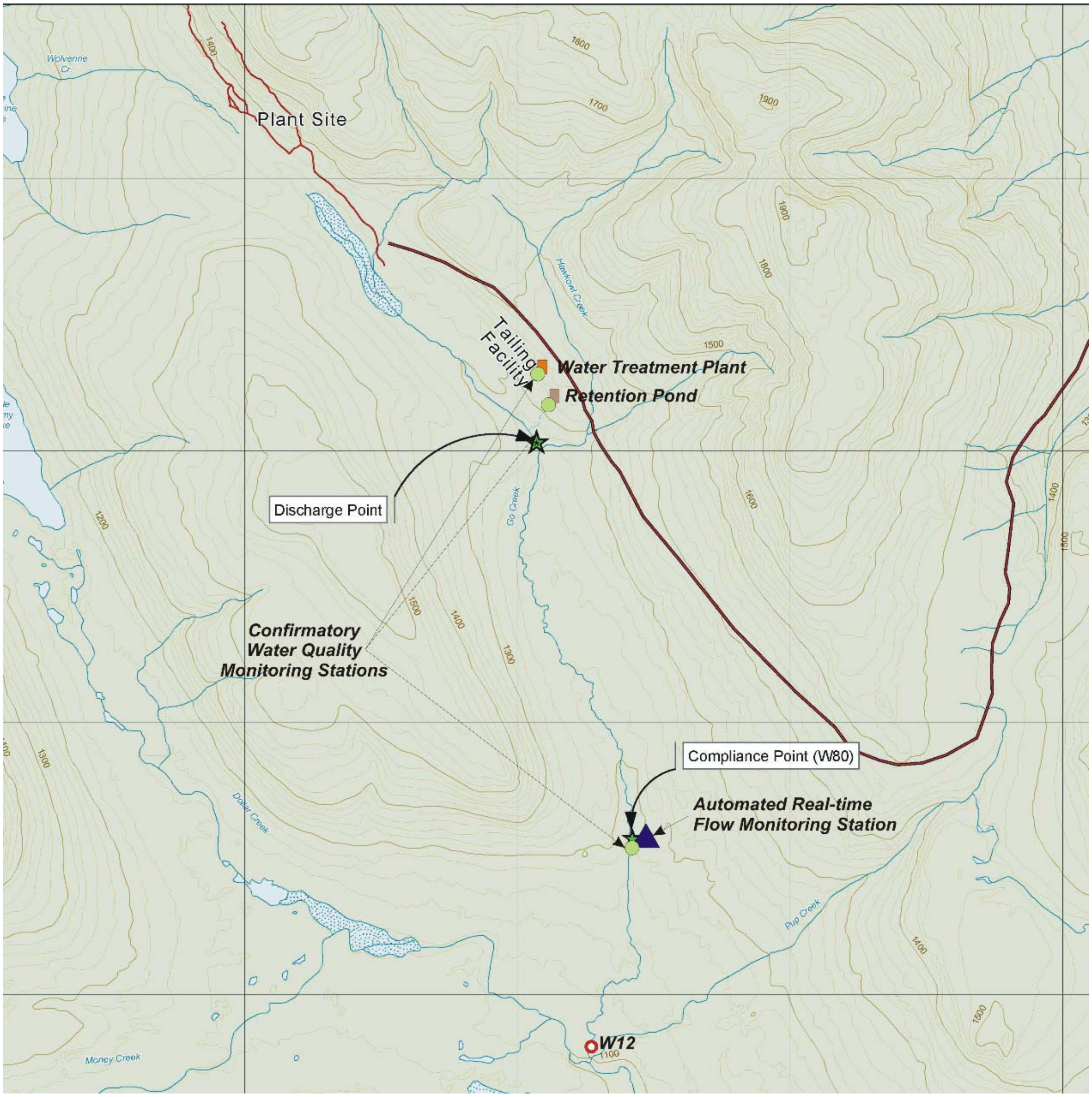

Figure 9-9 Key Features of the Water Treatment-Discharge Monitoring System for Go Creek

<u>Automated Real-Time Flow Monitoring of Compliance Point</u>

An automated, real-time flow monitoring station will be installed at the compliance point (W80) in Go Creek. Data from this station will be relayed back to environmental and engineering personnel at the water treatment plant. At the start of freshet, flow monitoring data will be evaluated closely and when flows at the compliance point consistently (e.g. two consecutive days) exceed 150 L/s (i.e. lower flow limit for safe discharge at proposed discharge limits) the water treatment plant will be activated and treatment of excess tailings water will commence.

Water Quality Monitoring of Treatment Plant and Retention Pond

Discharge volume and chemistry will be monitored closely during operation of the plant in conjunction with twice daily monitoring of the water quality in the retention pond located near the water treatment plant (Figure 9-9). The retention pond will be sized to hold approximately two days of water treatment production (i.e. ~1500 m^3). If water quality in the retention pond meets the proposed discharge limits, controlled flow release to Go Creek at the discharge location will commence. Should water quality not meet discharge standards, a portion or all of the volume in the retention pond will be pumped back to the tailings impoundment.

Discharge to Go Creek will continue at the proposed 31 m^3/h (9.0 L/s) discharge rate until flow in Go Creek reduces to approximately 160 L/s. At this stage, close monitoring of hydrological conditions in Go Creek will occur and the water treatment system will be shut down when flows in Go Creek diminish to 150 L/s at the compliance point.

In addition to monitoring of flow and discharge chemistry in the treated water, routine monitoring of water quality at the compliance point and station W12 will occur during discharge periods to ensure that water quality objectives are being met. The frequency of monitoring at these stations, as well as other sampling details, will be provided as part of the Type A Water License documentation.