

# **NPDES ANNUAL REPORT 2010**

## **VOLUME 2: WATER QUALITY**

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## **1.0 Introduction**

This volume of the Annual Water Quality Monitoring Summary report contains the results of water quality monitoring conducted in 2010 in accordance with the requirements of the National Pollutant Discharge Elimination System (NPDES) Permit for the Kensington Gold Project, near Juneau, Alaska (Permit No. AK-005057-1). A graphical presentation of water quality data collected at both discharge and receiving water monitoring stations, along with tabular summary statistics is included in this summary report. Construction of the Tailings Treatment Facility (TTF) and associated water treatment plant was completed in late August 2010. On December 4, 2010 the discharge of treated water commenced from Outfall 002.

## **2.0 Methods**

Monitoring of water quality at Outfall 001 (treated mine outflow discharge) occurred during 2010 as required by the NPDES permit. Outfall 003 (Kensington Camp domestic waste water discharge) was not discharging during 2010; therefore no monitoring occurred at this site. Outfall 002 (Tailings Treatment Facility) began discharging in December 2010. In addition to outfall sampling, monitoring was conducted at four receiving water streams (Johnson, Slate, Sherman and Ophir Creeks) for ambient upstream and downstream water quality. The following list describes the sampling activities at these outfalls and receiving water stations:

### **2.1 Monitoring Currently Active**

- Continuous monitoring of flow and pH at Outfall 001 effluent; daily samples from the influent and effluent of Outfall 001 for total suspended solids (TSS) analysis; weekly water sampling at Outfall 001 influent and effluent for analysis of field, general and trace parameters; quarterly sampling of the effluent for TDS anions and cations; monthly sampling of the effluent for whole effluent toxicity testing.
- Continuous monitoring of flow and pH commenced in December at Outfall 002 effluent along with; daily samples from the effluent of Outfall 002 for total suspended solids (TSS)

analysis; weekly water sampling at Outfall 002 effluent for analysis of field, general and trace parameters; monthly sampling of the effluent for whole effluent toxicity testing.

- Monthly receiving water field, general and trace parameters from stations MLA, SLB, SLC on Slate Creek; stations SH113, SH105, SH109 on Sherman; stations JS2, JS4, JS5 on Johnson Creek.
- Stations SH111 and SH103 on OphirCreek were sampled under a new schedule as of June 2009 according to the Residual Disposal Management Plan for the Mine Water Treatment Plant, which states that samples be collected from these sites only in the months of May, July, September and November.

## **2.2 Monitoring Currently Suspended**

- Weekly monitoring of flow, pH, TSS, biochemical oxygen demand (BOD 5 day test) and fecal coliform at Outfall 003 (effluent from the Kensington domestic waste water treatment plant); quarterly monitoring of Outfall 003 influent for BOD and TSS.

## **2.3 Monitoring Currently Planned**

- Quarterly sampling of Outfall 002 effluent for TDS, anions and cations.
- The frequency of monitoring at sample site SH113 is planned to be increased from monthly to once every two weeks.
- Monitoring at sample site #5 on East Fork Slate Creek is planned to occur mid-way between monthly sampling times at sample site SLB.

## **2.4 Changes during 2010 Monitoring**

The new tailings water treatment plant at Slate Creek was commissioned in 2010 with discharge initiated from Outfall 002 in December 2010. Monitoring that commenced in December 2010 therefore included:



- Continuous monitoring of flow and pH at Outfall 002 effluent; daily samples from Outfall 002 effluent for total suspended solids (TSS) analysis; weekly water sampling at Outfall 002 effluent for analysis of field, general and trace parameters; monthly sampling of the effluent for whole effluent toxicity testing.

### **3.0 QC Summary**

#### **3.1 Plan QC**

Coeur Alaska has complied with the approved quality assurance plan for the 2010 water quality data. At least ten percent of all lab reports are reviewed for issues pertinent to the five categories of quality control:

- Precision
- Accuracy
- Comparability
- Representativeness
- Completeness

Based on the results of this review, lab reports, individual samples, or individual parameters within samples may be qualified on a variety of issues as;

- Accepted
- Estimated
- Rejected

No data were rejected from the 2010 dataset, but some parameters within individual samples were flagged as estimated within the database when one or more of the quality controls were not met. During 2008, Coeur implemented the practice of completing the QA/QC review of all data gathered for the NPDES permit on a monthly basis in conjunction with preparation of the monthly Discharge Monitoring Report. This was continued through 2010 to allow for timely

resolution of any issues identified during the QA/QC review with the contract laboratory or field personnel.

### **3.1.1 Precision- Field Blind Duplicate Comparison**

Precision is a qualitative measure of the reproducibility of a measurement under a given set of conditions. Precision in the analytical results of laboratory analysis is determined by laboratory quality control measures such as duplicate matrix spikes and sample duplicates. The plan criterion for laboratory precision is a relative percent difference between duplicate samples of less than or equal to 20%. In addition, field blind duplicate sample pairs, which are collected throughout the year, are also used as a quality control for precision in the laboratory results.

Receiving water sample field duplicates are selected and collected on a random basis. The total number of receiving water field duplicates collected during 2010 was 34, up from 26 in 2009. Blind duplicates were normally performed on three sites per month in 2010. The relative percent difference (RPD) was calculated for each duplicated parameter. Only 9% of all duplicated parameter results were greater than 20% RPD and therefore did not pass the precision criteria. This was similar to previous years with 6% failure of precision in 2009, 7% in 2008 and 11.7% in 2007. The parameters that most frequently showed greater than 20% difference in 2010 were turbidity and TDS followed by aluminum, manganese and zinc. These same parameters also showed the greatest RPD between field duplicate samples together with nitrate, sulfate and chloride. Turbidity showed more than 20% difference in over half the blind duplicates. No field blind duplicates were collected from the influent or effluent sampling sites of Outfall 001 in 2010. Most of the parameters tested in blind duplicates at 001 Outfall in 2008 passed the 20% difference test. The results of comparisons between duplicate sets are tabulated in **Appendix A**.

### **3.1.2 Accuracy**

Accuracy in the analytical results of laboratory analysis is determined by percent recovery of laboratory quality control measures such as matrix spikes, control samples and method blanks. The criterion for accuracy in most analytical procedures is a percent recovery between 85 and 115 percent. Less than 1 % of all sample results typically fail this criterion and are qualified

appropriately in the database. Accuracy in field measurements is controlled and verified by using calibrated instruments. Field meters were always calibrated prior to their use during 2010 monitoring.

### **3.1.3 Representativeness**

Representativeness is controlled by sampling plan design, sampling techniques and sample handling procedures.

### **3.1.4 Comparability**

Comparability is maintained by using consistent sampling and analytical methods as well as consistent units of measurement. Colombia Analytical Services located in Kelso, Washington has conducted all NPDES water quality analyses since March 2008. This has helped maintain comparability within data sets. In addition, the sample and data management process is streamlined.

### **3.1.5 Completeness**

As stated in the quality assurance plan for the Kensington Gold Project, the completeness criterion goal for monitoring data is 90% due to the extreme conditions observed on site. Overall data capture was close to 100% for 2010. Two field measurements were missed at Outfall 001 and one measurement lost at JS-2. For all sites where monitoring was physically possible, data collection was very close to 100% complete. No water quality samples were missed during 2010.

## **3.2 Detection**

The laboratory Practical Quantitation Limit (PQL) remained consistent for each analytical method during 2010 water quality monitoring. Arsenic, chromium, lead, selenium and silver were not detected in any samples collected from the receiving water stations on Slate, Sherman, Ophir and Johnson Creeks. Cadmium was only detected at Slate Creek, exceeding the water quality standard on one occasion while remaining undetected most of the year. Iron and nickel were not detected at Johnson and Ophir Creeks. Slate Creek had low levels of iron, but Sherman exceeded the water quality standard on one occasion. Aluminum was present in all Slate Creek samples. Manganese was present in all MLA and SLB. Manganese was barely detected in background

Sherman samples, but was present in all downstream samples. Copper was found in four Sherman background samples and in downstream samples during five months. Zinc was present in one Sherman background sample and downstream during four months. Aluminum was the only metal detected in all samples collected from Sherman Creek and Ophir Creek stations. Of the four sample pairs collected from Ophir, only one pair contained copper, one upstream sample contained zinc and two downstream samples contained manganese. Nine other metals were undetected at Ophir sites. Most metals in Johnson Creek samples were either detected in a fraction of samples or none at all. Johnson Creek contained aluminum throughout the year while all downstream samples contained detectable levels of manganese. Copper was detected in March and November along with zinc, which was also above the PQL at one site in December. The number of undetected metals per site between the three receiving water streams was highest in Johnson Creek samples, then Sherman Creek and then Slate Creek.

As expected, sulfate, TDS and hardness parameters were detected in all samples collected from all stations on each of the three receiving water creeks. TDS and conductivity were highest in downstream samples from Sherman Creek. TDS and conductivity also showed an increase in downstream samples from Slate Creek in December. Conductivity was low in upstream Johnson samples but showed some increase downstream. Hardness was lowest in Johnson Creek, followed by Sherman Creek and then Slate Creek.

Ultra low detection limits, provided through the use of method 1631, were used to determine mercury concentrations in the receiving waters. Mercury was detected in Johnson Creek at JS-5 during three months of the year. At Sherman Creek, mercury was detected once at SH109 and was detected in three samples from SH113 and four samples from SH105. All samples collected from Ophir Creek remained below the detection limit. In the case of Slate Creek, mercury was detected on most sampling occasions at both upstream and downstream sites.

### **3.3 Outlier(s)**

A variance analysis was conducted on each monthly set of monitoring data. Variance analysis reports compare sample results to historical results for the same parameters at the same sampling stations. Those results that exceeded the threshold level of two standard deviations are

listed in the table for the appropriate month in **Appendix B**. Other field measurements or analytical results were identified as potential outliers by data time series plots. Tables 3 and 3A contain potential outliers in effluent and receiving water monitoring data determined using a combination of trend and statistical analysis. Total recoverable and dissolved manganese outliers are summarized in a separate table (Table 3A) due to the large number of apparent outliers compared to previous data. Outliers are identified by large variance from the mean, although the frequency of high manganese concentrations began to increase the average. Parameters, which occasionally varied widely from the average included copper, aluminum, iron, manganese ammonia, nitrate, sulfate, TSS, TDS, conductivity and dissolved oxygen. Outliers were observed at the effluent throughout 2010. Several outliers were observed at SLB and SLC on 12/6.

#### **4.0 General Major Chemistry**

Area waters generally:

- Have peak water temperature in August or September
- Are at or near oxygen saturation
- Have mildly basic pH
- Seasonal fluctuation of conductivity with peak in winter (excluding Slate Creek, but observed December 2010)
- Contain low levels of sulfate (<10ppm, excluding Sherman Creek)
- Are generally soft (in most cases <100ppm hardness, excluding SH103)
- Have low concentrations of dissolved metals

#### **5.0 Summary Statistics**

Summary statistics were calculated for all parameters at each discharge and receiving water station. The calculations include the minimum, maximum, arithmetic mean and standard deviations for each monitoring station contained in the 2010 data set. The results are presented in Tables 4 through 15. Also included in the summary tables are the total number of samples collected, total number of non-detect results and the percentage of non-detects.

## **6.0 Watersheds**

Upstream/downstream receiving water monitoring stations are present on Johnson, Slate, Ophir and Sherman Creeks. A comparison of the chemistry between these station pairs is discussed below. Tables 1 and 2 contain the monitoring parameters that remained undetected for the entire year at each station.

### **6.1 Receiving Waters- Johnson Creek**

#### **Monitoring Sites**

- JS2- Johnson Creek upstream of disturbance
- JS5- Johnson Creek downstream of mill process area and Bridge 2
- JS4- Johnson Creek downstream of Bridge 1

#### **6.1.1 Major Chemistry**

Water quality monitoring on Johnson Creek was intended to identify potential impacts from mill facility construction and operation. The water sampling sites are somewhat confusingly labeled since JS-5 lies downstream of Bridge 2, which is in between JS-2 (background, upstream site) and JS-4 (downstream of Bridge 1). Water quality at Johnson Creek shows some seasonal trends for temperature, TDS, nitrate, pH, and sulfate. Some elevation of conductivity, turbidity, TDS, sulfate, hardness, and color is also seen from upstream to downstream, particularly in winter months (Figures 6a, 6b). Upstream temperature was higher than downstream sites in December and lower in January, May and June. The highest temperature was recorded at JS-4 in September (7.2°C) and lowest at JS-2 in January and February (0.4°C). Nitrate was present at similar concentrations at all sites except for JS-4, which was higher (only up to 0.6mg/L) from April through June. JS-5 had slightly higher nitrate from July through October and December. The pH tended to be higher at the middle site, JS-5, except for June, October and November when JS-4 was higher. There was some elevation of pH (over 8 s.u.) at JS-2 and JS-5 from July through September. JS-4 had lower pH in January and December.

Sulfate showed fairly consistent increases downstream through the year with all sites being higher in winter and lower in summer. The highest sulfate level was 11.4mg/L at JS-4 in March.

Dissolved oxygen was very similar at all sites throughout 2010 except for JS-2 appearing much higher in December. Conductivity measurements were much higher downstream than upstream in winter months. Values ranged from around 90 to 120umhos/cm from January through April and December at JS4 and JS5, but were less than 50umhos/cm throughout the year at JS2. From May to October, downstream sites ranged round 50 to 75umhos/cm, while JS2 was less than 40umhos/cm. Turbidity was less than 2ntu at all sites throughout the year with the exception of JS-4 in March (2.2ntu). Turbidity was 0.1ntu at JS-2 and 1.8ntu at JS-5 in March showing slight elevation in turbidity downstream.

Total dissolved solids typically increased from upstream to downstream with the exception of a high TDS value at JS-2 in June of 318mg/L that was not matched by high conductivity. All other samples collected at the upstream site were less than or equal to 35mg/L. The highest TDS level downstream was 72mg/L recorded in February. Hardness showed consistent increases downstream during 2010. Hardness did not vary much throughout the year at JS-2, with a low of 11.1mg/L in August and high of 18.9mg/L in April. The downstream sites were markedly higher in winter, with JS-5 ranging from 35 to 40mg/L from January to April and December. JS-4 was slightly higher at 40 to 53mg/L during winter months. All sites were less than 30mg/L from May through September. Color was not detected at JS-2 during 2010, but was detected at JS-5 in March, May, August and September and at JS-4 in January through April, and August through November. The highest color recorded was 15cu in January and March at JS-4.

Ammonia mostly remained undetected at Johnson Creek throughout 2010 with the exception of JS-5 in June and July when levels were recorded at the detection level. Chloride was not detected at JS-2 in 2010 and was only present at JS-5 at the detection level from January through April and at JS-4 from January through May. TSS was not detected at JS-2 in 2010 and was only detected at low levels in November at JS-5 and October and November at JS-4.

### **6.1.2 Trace Chemistry**

The majority of dissolved metals (8 out of 13) tested at Johnson Creek were not detected at any sites at any time of the year. These included arsenic, cadmium, chromium, iron, lead, nickel, selenium and silver. Concentrations of aluminum and manganese were higher at downstream sites

(JS-4 and JS-5) than the upstream site (JS-2) throughout 2010, although all values were within water quality standards (Figure 6c). The highest aluminum level recorded in Johnson Creek in 2010 was 52.4ug/L at JS-4 in November. Manganese was also elevated at JS-4 in January (8ug/L), March (6ug/L), September (8ug/L) and November (10ug/L) while levels never exceeded 1.6ug/L at JS-2.

Copper was not detected at any sites except in November when it was present at just over the detection level with the highest concentration at JS-4 (1.5ug/L), which was still just within the hardness-based WQS. Dissolved mercury was only detected in Johnson Creek in November, with concentrations increasing downstream to reach 0.0023ug/L at JS-4 in November and 0.001ug/L in September. Dissolved zinc was not detected at the upstream site in 2010 and was only detected at JS-4 in March (7.5ug/L) and December (2.8ug/L) and at JS-5 in November (4.1ug/L). The highest level was still well below the most stringent water quality standard.

Comparison with 2006 to 2009 data shows that Johnson Creek pH was slightly higher than previous years at JS-2 and JS-5 in summer, approaching 8.5 s.u. Turbidity in 2010 was similar to previous years where occasional peaks around 3ntu have been observed during higher spring or fall flows (eg. April 2007, 2009, November 2010). Total suspended solids were detected in October and November 2010, August and September 2009 and once in 2008, whereas 2006 and 2007 showed more frequent and higher detection levels. Mercury was detected on three occasions in 2010, twice in 2009 and once in 2008, whereas 2006 and 2007 showed much more frequent occurrences of mercury. Manganese levels showed some elevation at JS-4 in 2010, but levels did not get as high as they were in 2006 when they exceeded 70ug/L on three occasions. Copper was not detected from 2006 to 2009, but did appear in November 2010 when JS-4 reached 1.5ug/L, which was still below the hardness-based limit of 2.7ug/L. Nickel has not been detected in Johnson Creek since September of 2007.

Nitrate levels showed a similar pattern to previous years except the peak in May was only observed at JS-4, whereas previous years showed a peak at all sites in May. Sulfate levels also showed a similar pattern to previous years, being lowest in June and July and increasing from August with a slightly earlier peak in March than previously (11mg/L). Ammonia was only detected twice at very low level in 2010 and was previously detected at the end of 2006 and 2007 and in January 2008.



## **6.2 Receiving Waters - Slate Creek**

### **Monitoring Sites**

- MLA- Middle Lake Slate Creek upstream of disturbance
- SLB – East Fork Slate Creek upstream of confluence with West Fork Slate Creek
- SLC- Slate Creek downstream of confluence with West Fork Slate Creek

### **6.2.1 Major Chemistry**

Water quality monitoring on Slate Creek in 2010 was intended to identify potential impacts from the Tailings Treatment Facility (TTF). Figures 7a through 7b are graphical presentations of analytical results gathered throughout the year. As with the other receiving waters, Slate Creek's monitoring data exhibited some trends in accordance with expected seasonal changes, increasing in summer and decreasing in winter. Compared to the other streams, Slate Creek was the warmest, most likely due to the presence of lakes in the system that warm up in summer due to their large surface area. Only Upper Slate Lake contributes to this warming affect now as Lower Slate Lake is bypassed by a diversion pipe. MLA is the sampling site upstream of the tailings treatment area, SLB is approximately 1 mile downstream of the tailings treatment area and SLC is a further 10m downstream and receives water from both east and west forks of Slate Creek. Temperatures at SLB and SLC appeared cooler in summer 2010 than previous years as the highest temperature recorded at SLB was only 10°C, whereas 17°C was recorded here in 2009 and 15°C in 2008. The maximum water temperature recorded at MLA was 12.5°C in June compared to 18.2°C in July of 2009. The time of day that the grab samples are taken might affect the maximum temperature recorded since there can be a large diurnal temperature range.

Some increase of pH, DO and chloride was evident from upstream to downstream (Figures 7a, 7b). An exception to this trend is pH, which was slightly higher at SLB than SLC in January (7.9), May (7.8), June (8.3), August (8.0), September (8.2) and November (7.7). MLA had typically lower pH except in February and July with the lowest overall pH of 7.04 in May.

Dissolved oxygen measured at Slate Creek stations showed a seasonal trend similar to those of the other receiving water streams in being slightly higher in winter months. MLA had lower DO measurements than the downstream sites from October to December as well as February and May. Dissolved oxygen measurements at SLB and SLC were often similar except for April when SLC was much lower than SLB. The lowest DO was observed at MLA in September at 9mg/L. Dissolved oxygen increases as temperature decreases and is likely to be lower in the lake (near MLA) than downstream where several cascades help to mix oxygen into the water. Chloride results in Slate Creek samples were higher than results from Johnson Creek throughout the year, but still well within water quality standards. Chloride was normally highest at SLC (2-4mg/L) with MLA typically being around 1mg/L and SLB between 1 and 2mg/L except for May (8mg/L) indicating a possible difference in chloride levels between East and West Fork Slate Creek.

Conductivity was also higher at all sites in Slate Creek than Johnson Creek and was highest at SLB in December (358umho/cm). Background conductivity was 105umhos/cm at this time. Site SLC was 235umho/cm at the same time. During the rest of the year, conductivity typically ranged from around 100 to 140umho/cm at all sites. Sulfate showed a similar pattern with all sites below 20mg/L throughout the year, but a spike of 85mg/L at SLB and 43mg/L at SLC in December. Sulfate at MLA remained at 2.5mg/L or less throughout the year. Turbidity was low (usually less than 1ntu) at MLA throughout the year, but SLB reached 21ntu and SLC reached 13ntu in March. Turbidity was also slightly elevated 4.5ntu and 3.4ntu respectively but remained below 2ntu from June to December at all sites. Ammonia was detected at low levels at MLA in July and August and at SLB and SLC in December. Nitrate was not detected at all at MLA in 2010, but was detected at low levels downstream in December (0.36mg/L at SLB). Nitrate results for Slate Creek were by far the lowest of all the streams until December 2010, but the level recorded in December was well below the WQS.

Hardness followed a similar pattern throughout the year at all three stations remaining below 70mg/L until December when SLB increased to 138mg/L. Background hardness in December was 47mg/L. TDS was higher at SLB than SLC or MLA during most of 2010 except for August and November. TDS remained similar at all sites throughout most of January through June (roughly 50 to 100mg/L). SLB showed elevated levels of TDS in July (114mg/L), October (146mg/L) and December (225mg/L). March also showed divergent results with 90mg/L at SLB

compared to 42mg/L at MLA. TSS was below detection limits at all three stations for all of 2010 except for March when SLB had 8mg/L and SLC had 5mg/L. Color appeared to decrease from upstream to downstream, and was lowest at all sites during lower flows in the summer (15 to 25cu). Some color is attributable to tannins in the water associated with vegetation die-off in the lakes. The West Fork has no lakes so would be expected to have less color and have a dilution effect on SLC. The highest level reached was 80cu in November at both MLA and SLB, diluted to 45cu at SLC.

### **6.2.2 Trace Chemistry**

Trace metals not detected in Slate Creek during 2010 were arsenic, chromium, lead, selenium and silver. All three sampling stations on Slate Creek showed seasonal increases in spring and fall for aluminum, iron and mercury, while cadmium, copper and nickel only showed increases in spring. Manganese was higher in spring and in December (Figure 7c). Aluminum tended to be higher at the background site MLA reaching 214ug/L in December while downstream sites remained below the WQS. SLB exceeded the aluminum WQS in January (92ug/L) and April (101ug/L). However this may be attributed to naturally elevated levels of aluminum. The aluminum concentrations at the background site MLA were 67.3ug/L in January and 101ug/L in April. SLC had the lowest aluminum levels throughout the year, although all sites were low in summer. Cadmium was not detected at MLA at any time during 2010. The WQS for cadmium for SLB and SLC varied with hardness from 0.12ug/L to 0.34ug/L. Cadmium levels at SLB exceeded this standard in March at 0.2mg/L when the WQS was 0.18mg/L. SLC only reached 0.1mg/L in March, which did not exceed the WQS and cadmium was not detected after April at any sites. Cadmium was not detected at SLB from June through December.

Copper was not detected at MLA, but was present at low level from January through May at SLB and January through April at SLC. The highest copper level was 2.5ug/L at SLB in March. Iron levels were generally similar at SLB and MLA, which were both slightly higher than SLC. SLB showed slightly elevated levels of iron in March (0.23mg/L) and May (0.25mg/L). All samples were well below the iron WQS of 1mg/L. Elevated levels of manganese were observed at

SLB in January (55ug/L), March (228ug/L), May (54ug/L) and December (56ug/L). MLA showed slightly elevated concentrations of manganese during the same period. SLC also reached 138ug/L in March, while background levels at MLA only reached 15.7ug/L.

Nickel was not detected at MLA during any month, was not detected at SLB from June through December and was only detected at SLC at low level in March. Zinc was present at MLA in March April, July and August with the level in March approaching, but not exceeding the WQS. Slightly elevated levels were observed at SLB from January through April with a maximum of 13.7ug/L in April. SLC showed elevated zinc levels in March and April, but levels were around half those at SLB. Zinc levels were lower than 2009 levels, which exceeded 40ug/L on four occasions. Mercury was detected at very low levels in the majority of samples collected from all Slate Creek monitoring stations. No mercury was detected at any site in January or June. There was a wide range in values of mercury between sites in March, April and May, but all sites had very similar levels from July through December. Slightly elevated levels of mercury were found at MLA in March (0.0024ug/L) and MLA and SLB in November (0.0026ug/L). Levels were generally not as high as those reached in 2009.

A comparison of Slate Creek data with previous years shows that pH was slightly higher at MLA and SLB in summer of 2010, but still within acceptable levels. Sulfate was relatively low at all Slate Creek sites through 2006 and up to June 2007, remaining below 5mg/L. Sulfate increased at SLB and SLC from August 2007 to February 2008 and showed a peak of 16mg/L at SLB in April 2008. Levels dropped again in May 2008, but again increased to around 15mg/L in September 2008 with another peak in September 2009. Sulfate levels approached 17mg/L in March 2010, but the greatest increase was seen in December 2010 when sulfate reached 85mg/L. Nitrate was present at low levels (<0.2mg/L) during 2006 and occasionally in 2007 and early 2008. It was not detected between April 2008 and February 2009 but appeared again at all sites from March to June 2009 (around 0.35mg/L). This contrasted with 2010 when no nitrate was detected at MLA and only very low levels were present at SLB in March and May (<0.1mg/L) followed by an increase at SLB in December (0.36mg/L).

During most of 2010, conductivity typically ranged from around 100 to 140umho/cm at all sites. This was higher than May 2009 when conductivity ranged from 60 to 70umhos/cm. The

highest conductivity in Slate Creek was recorded in December 2010 at 358µmhos/cm. TDS typically fluctuated from 60 to 80mg/L among all Slate Creek sites in 2006, increasing slightly in August 2007 when MLA reached 100mg/L, SLB reached 110mg/L and SLC registered 710mg/L. MLA showed a peak of 180mg/L in November 2007, while downstream sites remained less than 100mg/L. TDS levels were mostly 60 to 100mg/L during 2008 with SLB reaching 129 in September 2008. TDS remained relatively stable in 2009 fluctuating between 30 and 85mg/L at all sites. This continued into 2010 until SLB increased to 114mg/L in July, 146mg/L in October and 225mg/L in December. In 2006, color was very similar at MLA and SLB remaining around 40cu through the first part of the year then increasing in October to 120cu at MLA and 130cu at SLC. MLA tended to show the highest color in 2007, 2008, and 2009 with color reaching a maximum of 210cu in September 2007. The highest color level for 2009 was 125cu in November at SLB. Color was lower in 2010 decreasing to 15cu in June and only reaching 80cu in November. Lower color is perhaps due to the presence of diversion pipe since the lower lake is no longer contributing color from decomposing plant material (tannins).

Cadmium was not consistently detected at SLB until August 2007, reaching a peak in April 2008 (1.9µg/L). The water quality standard for cadmium was exceeded on five occasions in 2009, but levels were lower than 2008. Cadmium was just above the WQS in March 2010 and has not been detected since June 2010. Copper has never been detected at MLA, and was first detected downstream at SLB in September 2006 (2µg/L). Low levels (1µg/L) were present on three occasions in 2007, then slightly higher levels (4µg/L) in October and November 2007 and again in April and September 2008. These levels came close to the hardness-based WQS, but did not exceed it. Copper did, however, exceed water quality standards in September 2009 when it reached 14.2µg/L at SLB. Copper was detected at low level during the first part of 2010, but has not been detected since May 2010. Iron levels were highest at MLA from January to April 2006 and March/April 2007, but were exceeded by SLB in July-December 2006 (peak of 0.43mg/L in July 2006), September-October 2007 and September 2008 (0.45mg/L). Iron levels were lower in 2009 and 2010, peaking at 0.252mg/L at MLA in November 2009 and 0.247mg/L at SLB in May 2010. All samples were well below the WQS of 1mg/L.

Aluminum has occasionally been present in background samples at concentrations exceeding the WQS of 87µg/L, but rarely the permit limit of 143µg/L eg. January 2006 (99µg/L),

October 2007 (90ug/L), April 2008 (106ug/L), October 2008 (89ug/L) and December 2008 (90ug/L), April 2010 (101ug/L), November 2010 (95ug/L), December 2010 (214ug/L). Levels downstream at SLB have also exceeded the WQS as follows: October 2006 (119ug/L), October 2007 (124ug/L,) April 2008 (134ug/L), September 2008 (145ug/L), December 2008 (90ug/L), January 2010 (92ug/L) and April 2010 (101ug/L). The background level was frequently responsible for the high aluminum recorded downstream. Aluminum at MLA was 82ug/L in February 2010, but this did not exceed the WQS. Aluminum levels at SLB and SLC were much lower than MLA in December 2010.

Mercury had a peak of almost 0.01ug/L at SLB in 2008, but only reached 0.003ug/L at SLB and 0.005ug/L at SLC in 2009. 2010 levels were similar to 2009, but only reached a maximum of 0.0026ug/L at MLA and SLB. Zinc was not detected during the first part of 2006, appearing at low level in both background and downstream sites in fall 2006. Zinc levels at SLB increased in May 2007 and exceeded the WQS in March 2008 (81.2ug/L), April 2008 (180ug/L), October 2008 (72.7ug/L), January 2009 (58.3ug/L), but values were much lower throughout the rest of 2009 and 2010, only reaching 13.7ug/L in April 2010.

Nickel was present at SLB and SLC at low level during 2006, increased in August 2007 and peaked in April 2008, but remained less than 5ug/L in 2009 and less than 2ug/L in 2010. Manganese was not detected at downstream sites during the first part of 2006, but showed elevated levels at SLB in September 2006 (90ug/L). Background manganese was above the WQS at this time (56ug/L) and again in December 2006, March, April, August, November and December 2007, November 2008 and October 2009. SLB exceeded the WQS for manganese in October and November 2007, March, April, October, November, December 2008, January and May 2009, and January, March, May and December 2010. The highest level recorded was 228ug/L in March 2010.

### **6.3 Receiving Waters- Sherman Creek**

#### **Monitoring Sites**

- SH109- Upper Sherman Creek upstream of disturbance
- SH113- Sherman Creek downstream of Outfall 001

- SH105- Sherman Creek downstream at mouth of creek

### 6.3.1 Major Chemistry

Water monitoring on Sherman Creek was intended to help identify any potential impacts from underground mine activities as all drainage from the mine flows to the Sherman Creek drainage (Figures 8a, 8b). Temperature was typically highest at SH113 just downstream from the 001 effluent and coolest at SH109 upstream of the effluent during 2010 with the exception of January to March when SH109 was warmer. The difference between these two sites was greatest in August/September (SH113 was 1.3°C higher), and December (SH113 was 3.1°C warmer). There was little difference in temperature between these sites in March and from May through July. In November, SH105 was 0.6°C warmer than SH113 and 1.4°C warmer than SH109. Dissolved oxygen was similar at upstream and downstream sites throughout the year except for January and December when SH105 was higher and March when SH109 was lower, perhaps due to changes in flow. Measurements of DO tended to be slightly lower in summer as water temperature increased and higher in winter. Measurements of pH appeared to decrease from upstream to downstream except for August when pH at SH109 dipped to 6.57 s.u. while remaining around 7.4 s.u. at SH105 and SH113. The highest pH was 8.02 at SH109 in June. Monitoring station SH109 had the greatest range in pH values of all the Sherman Creek sites.

Conductivity was highest at site SH113 (middle site) and lowest at SH109 (upper site) throughout the year, except for December when SH105 had the lowest conductivity of 20umhos/cm. All three sites showed lowest conductivity in May/June and October/November and higher levels in February and April, with SH113 highest in September (285umhos/cm) and December (316umhos/cm). Turbidity was less than 1 NTU throughout the year at all sites with the exceptions of April, May and November at SH105, May, June, October, November at SH113 and May, June and November at SH109. Turbidity was 5.47 NTU at SH113 in November, but the background level was 2.6 NTUs. Total dissolved solids tended to increase from upstream to downstream and were higher during winter months, particularly at SH113 and SH105. TDS was highest at SH105 (470mg/L) in September and lowest at SH105 (<10mg/L) in August.

Ammonia was detected in four of twelve samples at SH113, ranging from 0.1mg/L to 0.55mg/L. At the other sites ammonia was only present at or below the detection level. The nitrate level at the upstream site was highest in March at 0.32mg/L and lowest in summer months. Site SH113 showed a highest level in December at .0.77mg/L while SH105 downstream reached 0.37mg/L in December. All reported measurements were below the WQS of 10mg/L. Sulfate, chloride and hardness tended to be highest at SH113 and lowest at SH109. Sulfate tended to be higher at SH113 than other sites, though less so in March, May, June, October and November, which tended to have higher flow. The highest sulfate was found at SH113 in December (53.3mg/L). The lowest sulfate level recorded at SH113 was 9.2mg/L in June. Sulfate was less than 30mg/L at SH105 throughout the year and less than 10mg/L at SH109. Chloride was not detected at the upstream site in 2010 except in January when it was present at the detection level. Chloride reached 14mg/L at SH113 in August while SH105 reached 3mg/L at the same time. These concentrations were well below the water quality standard of 230mg/L. Hardness was relatively high (>75mg/L) at SH113 in January, February, April, August, September and December. Hardness remained below 75mg/L at SH109 and SH105 throughout the year and was lowest in summer months. Hardness levels at SH105 downstream were very similar to the background site SH109 particularly from May through October.

Total suspended solids were not detected at any sites from January through April, nor from June to September or December. TSS was present at the background site in October and November though was higher in concentration at SH113 at this time (<15mg/L). SH105 only had detectable levels close to SH113 in November. Color generally increased from upstream to downstream when it was detected, although a high of 70cu was recorded at SH109 in August. Color had lower peaks (up to 40cu) at all sites in March and again in November.

### **6.3.2 Trace Chemistry**

Trace metals not detected in Sherman Creek during 2010 were arsenic, cadmium, chromium, lead, selenium and silver. Aluminum was higher at SH105 near the stream mouth than both SH109 and SH113 from January through May and August through December, similar to 2009. This suggests there is some source of aluminum downstream that is not associated with the



001 effluent. Aluminum at SH105 reached 72ug/L in March and 55ug/L in November. Peaks were observed at upstream sites during these months, but levels were lower than SH105. Aluminum was low at all sites in summer. Copper was not detected at any sites in February, June through September and December. Low levels were found at all sites in March, October and November. Manganese was not detected in most samples from SH109, but at least 15ug/L were found at SH113, with concentrations reaching 151ug/L in August and 112ug/L in September. Low-level mercury was only detected at SH113 on three occasions, March, October, and November. SH105 had a higher level in March than SH113 and also had mercury present in August at low concentration. Mercury was detected at SH109 in November at a concentration of 0.0016ug/L, but was undetected at all other sampling events. Nickel was not detected at SH109 and only found at low levels at SH113 in February, September and December. Only one sample collected at SH105 had detectable levels of nickel (1.2ug/L in February). Zinc was only detected at SH109 at just above the detection level in May. Zinc was found at SH113 in low concentrations in January, February, April, August and December and at SH105 in March, April and December. Iron was only detected once at SH113 in November at a concentration of 0.052ug/L and at slightly higher concentration downstream at SH105 on the same day. Iron was also present at low concentration at SH105 in March. Iron was not found in concentrations above the detection limit in any samples from SH109.

A comparison with previous data shows that Sherman Creek appeared to have slightly lower pH in the latter half of 2008 than previous years, but remained at normal levels in 2009 and 2010. The pH at the background site SH109 was lower than usual in August 2010. Turbidity appeared slightly higher in 2010 than 2009, but this was partly due to higher background turbidity. Ammonia was present at a low level in late 2006 and early 2007, spring of 2007 and December 2007, then it remained undetected until June and August 2009 and July-September and December 2010. Chloride appeared to have an increasing trend from July 2007 to March 2008, but was present at much lower levels (less than 4mg/L) from May 2008 and remained below 6mg/L during 2009 and the first half of 2010. Slightly higher chloride levels (8-14mg/L) were observed in August, September and December 2010, but these levels are well below the 230mg/L WQS.

Nickel seems to have declined since July 2007. It was not detected between June 2008 and November 2009 and most of 2010 (only detected in February, September, December at low level).

Manganese was low until July 2007, increasing at SH113 at high flow in fall of 2007 and spring and fall of 2008. Manganese levels at SH113 never exceeded 26ug/L in 2009, but in 2010 3 samples exceeded 50ug/L. Iron was detected at SH105 in previous years (twice in 2006 and twice in 2007). Iron was not detected in 2008 and appeared only once at SH113 in 2009 (January) and once in 2010 (November) at low levels.

Sulfate, TDS and conductivity tend to follow hardness patterns, peaking at SH113 in February 2008, March 2009, and February 2010. Conductivity has typically been higher at SH113 than upstream or downstream sites and was also high in August and December 2010 whereas TDS peaked in September and November 2010. Conductivity during the historical peak months of January through April was lower in 2010 as compared to 2008, but was slightly higher than 2009 during the same period. Sulfate has demonstrated a downward trend since 2008 with a peak value of 82.9mg/L in February as compared to February's peak value in 2010 of 40.7mg/L. Similarly TDS has exhibited a downward trend since 2008. TDS in February of 2008 was greater than 200mg/L whereas TDS in February of 2010 was less than 150mg/L. The same pattern holds for hardness with a peak value greater than 150mg/L in 2008 and a peak value less than 125mg/L in 2010.

Nitrate has been observed at low levels in Sherman Creek. It showed a slight increase in February, May, October and November 2007 and in February 2008 then remained low until April to June of 2009 when levels were similar to November 2007. Nitrate levels in 2010 appeared slightly lower than 2009.

## **6.4 Receiving Waters- Ophir Creek**

### **Monitoring Sites**

- SH111- Ophir Creek upstream of Comet Development Rock Stockpile
- SH103- Ophir Creek downstream of Comet Development Rock Stockpile

#### **6.4.1 Major Chemistry**

Water monitoring on Ophir Creek was intended to help identify any potential impacts from mine construction and development activities associated with the Comet Development Rock Stockpile. Figures 9a through 9c are graphical presentations of analytical results gathered throughout 2010. Monitoring station SH111 is often unavailable for sampling during low flow periods and frozen conditions in winter. Monitoring is now only required at SH111 and SH103 once every other month between May and November. Data was collected in May, July, October and November in 2010.

As with the other receiving waters, Ophir Creek's monitoring data exhibited many trends in accordance with expected seasonal changes, increasing in summer and decreasing in winter. However, unlike the other receiving waters, dissolved oxygen at SH111 and SH103 was not necessarily lowest during the summer months, but exhibited lowest DO in October 2010. DO was very similar at both sites each time measurements were made. Measured conductivity at SH103 has often been the highest of all 11 monitoring sites on the project receiving waters, reaching 650umhos/cm from January to April 2009 and 495umhos/cm in November 2009. No samples were collected during this period in 2010. The highest recorded conductivity in 2010 was 165umhos/cm in November with 161umhos/cm recorded in October. Background conductivity at this time was 50-60umhos/cm.

Total dissolved solids were present at similar concentrations at both sites in May (less than 40mg/L) and increased at SH103 in July reaching a peak in October (111mg/L). In November the background site had a higher concentration (125mg/L) than SH103 (69mg/L). This may have been due to an increase in flow in November. Sulfate at SH111 was around 2mg/L on each sampling occasion, but sulfate at SH103 increased from around 7mg/L in May and July to 34mg/L in October and 41mg/L in November. Hardness showed a similar pattern with the concentration remaining around 20mg/L at SH111, but increasing to over 60mg/L in fall samples. In the past chloride tended to be higher in winter than summer and was not detected at all in 2010 May-November samples. Nitrate levels were low at both sites and higher in May and November than July and October.

As in previous years, samples collected at SH103 had a slightly lower pH than the samples collected upstream at SH111, while all samples collected on Ophir Creek remained between 7.23 and 7.94 pH units. Ammonia was not detected in any Ophir Creek samples in 2010. Total suspended solids were only detected at low level at SH103 in October (4.8mg/L). Color was only detected at the detection level at both sites in November.

#### **6.4.2 Trace Chemistry**

Non-detected metals for both SH111 and SH103 included arsenic, cadmium, chromium, iron, lead, mercury, nickel, selenium and silver. Copper was only detected in November at the same concentration at both sites (1.6ug/L). Zinc was present at the detection level in May, but was undetected in all other samples. Manganese was not detected at the background site, but was present in fall at 2.1ug/L in October and 3.2ug/L in November.

Low levels of aluminum were measured in all samples collected at both Ophir Creek sites during 2010 with little difference between the sites except for May when the upstream site was higher. SH111 and SH103 had by far the lowest concentrations of aluminum of all the receiving waters, as was the case in 2008 and 2009.

### **7.0 Discharges**

#### **7.1 Outfall 001**

The Comet water treatment plant (WTP) discharge (Outfall 001) was sampled weekly, resulting in at least four times the data compared to most receiving water stations. This larger group of sample results is a greater opportunity to identify trends (Figures 10a – 10d). Discharge Monitoring Reports containing results of required monitoring (Permit No. AK-005057-1) were submitted each month during 2010. The results can also be found in this annual report in **Appendix C**.

##### **7.1.1 Major Chemistry**

Dissolved oxygen (DO) in the effluent tended to be higher in winter (13-14mg/L) and lower during the summer season (11-12mg/L), with low levels recorded in January and August (7-

8mg/L). DO is typically negatively correlated with temperature, which was seen to increase from less than 3°C from January to early March to around 7°C in May, reaching a maximum of 10.6°C in mid-September, before declining to 4°C in December. Grab samples from the effluent and background station SH109 are collected weekly in conjunction with the influent/effluent composite samples. The difference between background turbidity and effluent turbidity remained low for most of the year (well under the limit of 5ntu). Background turbidity reached 32ntu in November during high flow, but effluent turbidity remained less than 2.5ntu.

Both TDS and sulfate (associated with calcium and magnesium) were well below permit limits in 2010. Throughout the year, major cations (represented by hardness) and anions (represented by sulfate), plus total dissolved solids showed differing trends. Effluent sulfate was higher from January to early April at 30 to 40mg/L, but remained less than 15mg/L the rest of the year. Effluent hardness was mostly 75 to 100mg/L from January to early April then dropped suddenly to 35mg/L in mid-April, slowly climbing over the summer to peak at 123 in September. Hardness showed a second sharp drop to 37mg/L in October before climbing again to 114mg/L in December. TDS ranged from 200-280mg/L from January to June then became more variable, dipping to 132 in mid-June and rising to 375 in August. October to December mostly ranged from 200 to 250mg/L, with two peaks over 300mg/L.

Daily samples were collected for TSS analysis. All samples collected between January 1 and July 31 contained non-detectable levels of total suspended solids with the exception of one sample collected on June 9, which contained 14mg/L of TSS. The second half of the year saw more frequent detection of suspended solids with 21 samples containing suspended solids. A sample collected in December 2010 contained 19.6mg/L, which is close to the permit limit for TSS. Only 7 samples had detectable levels in 2009 and all were well below the permit limit.

Both nitrate and ammonia remained well below daily maximum permit limitations during the first part of the year, but began to increase in July with ammonia exceeding the limit on September 9 at 4.5mg/L. Nitrate followed the same peaks as ammonia reaching 7.26mg/L at this time. Nitrate and ammonia both declined in fall with ammonia remaining below 1mg/L and nitrate remaining below 2mg/L from mid-October to the end of the year.

### **7.1.2 Trace Chemistry**

Arsenic, chromium and silver were undetected in effluent samples during 2010. Cadmium, copper and lead were undetected in 2009, but present in 2010. Cadmium was only detected in two samples toward the end of the year at low level (0.1ug/L). Copper was present at 6ug/L in one sample collected on January 5 then remained undetected throughout most of the year until appearing at less than 2ug/L in three December samples. Lead was present in one sample collected in January (0.2ug/L) and two samples collected in December (0.4 and 0.5ug/L).

Aluminum remained at relatively low concentrations (less than 25ug/L) until December when a level of 113ug/L was recorded, followed by 52 and 73ug/L, before dropping back to 15ug/L. Iron showed a similar pattern, not being detected until July then occurring more frequently and showing a peak of 0.68mg/L in November and two peaks of 1.97mg/L and 1.64mg/L in December. The permit limit is 1.7mg/L so there was one exceedence of iron in December. Mercury was found in low concentrations in May, September, November and December, but was undetected throughout the rest of the year. Zinc concentrations varied slightly throughout the year but remained less than 10ug/L throughout the year. Nickel concentrations fluctuated throughout the year from undetectable to 3ug/L during the first part of the year and from 1 to 3.7ug/L from July through December, never exceeding the lowest hardness-based limit of 48ug/L. Selenium varied slightly throughout the year mostly ranging from 1-2ug/L and well below the limit of 8.2ug/L. Manganese concentrations for the effluent increased somewhat after July. The average manganese concentration for 2009 was 55ug/L, but this increased to 190ug/L for 2010. The average manganese concentration for August through November 2010 was 302ug/L with two samples exceeding 500ug/L and a further five samples in the 400 to 500ug/L range.

### **7.1.3 Whole Effluent Toxicity Testing**

Whole Effluent Toxicity (WET) Tests were conducted monthly on the 24-hour composite samples collected from Outfall 001 effluent. The following three tests were rotated throughout the year such that each test was conducted once a quarter:

- *Pimephales promelas* (fathead minnow)- static, renewal, larval survival and growth test.
- *Ceriodaphnia dubia* (water flea)- 7-day static, renewal, survival and reproduction test.

- *Selanastrum capricornutum* (green algae)- 4-day static, growth.

All monthly WET tests conducted on 001 discharge water in 2010 were within permit limits.

## **7.2 Outfall 002**

Outfall 002 discharge is from the tailing treatment facility, which began on December 4, 2010 after the new water treatment plant was commissioned. Daily reporting for total suspended solids from December 5 to 31 are included in this annual report for 2010 as well as weekly reporting for metals (Figures 11a – c). The Discharge Monitoring Report for December containing results of required monitoring (Permit No. AK-005057-1) was submitted for Outfall 002. The results can also be found in this annual report in **Appendix C**.

### **7.2.1 Major Chemistry**

Flow and pH meters were connected to the SCADA system on December 14 to collect continuous data on the effluent so there are only 18 days of continuous electronic data for 2010. Both flow and pH appeared to stabilize during the last week of December after some fluctuation earlier in the month. The average daily pH was 7.76 when first recorded then stabilized around 7.12. Average daily flow ranged from only 53gpm to 646gpm, but stabilized around 450gpm during the last week of the year. Dissolved oxygen (DO) in the tailings effluent ranged from 6.93mg/L on December 23 to 13.63mg/L on December 29. Temperature only varied from 5.6°C to 4.6°C on these dates with a wider range earlier in the month; a temperature of 8.6°C was recorded on December 7 and 2.1°C was recorded on December 18. Background samples for turbidity were collected weekly at MLA in conjunction with the influent/effluent composite samples. The difference between background turbidity and effluent turbidity remained low throughout December (under the limit of 5ntu). Background turbidity reached 1.25ntu in December, while effluent turbidity remained less than 0.9ntu.

Both TDS and sulfate approached permit limits in December with sulfate just exceeding the limit of 250mg/L in two out five sampling occasions. Dissolved solids ranged from 453mg/L to 484mg/L remaining below the limit of 500mg/L.

Effluent hardness ranged from 280 to 308mg/L in December weekly samples. This was somewhat higher than the background hardness of 47mg/L for December. Daily samples were collected for TSS analysis from December 5 onwards. No suspended solids were detected in any of the 17 samples collected in December. Both nitrate and ammonia remained well below daily maximum permit limitations during December. Nitrate was around 1mg/L, while ammonia was less than 1mg/L compared to the permit limit of 3.5mg/L.

### **7.2.2 Trace Chemistry**

Arsenic, cadmium, chromium, copper, lead, mercury, selenium and silver were undetected in Outfall 002 effluent samples during December 2010. Aluminum was present at concentrations between 4 and 8ug/L and well below the 143ug/L permit limit. Iron ranged from 0.27 to 0.48mg/L, well below the permit limit of 1.7mg/L. Nickel ranged from 2 to 3ug/L compared to the permit limit of 26ug/L and zinc ranged from 3 to 5ug/L compared to a permit limit of 37ug/L. All trace metals were either undetected or present at low levels, with the exception of manganese, which ranged from around 360 to just over 400ug/L. There is currently no permit limit for manganese.

### **7.2.3 Whole Effluent Toxicity Testing**

A whole Effluent Toxicity (WET) Test was conducted in December on the 24-hour composite sample collected from Outfall 002 effluent. A 7-day static, renewal, survival and reproduction test was carried out on *Ceriodaphnia dubia* (water flea) and results were within the permit limit.

## **7.3 Outfall 003**

Outfall 003 is the Comet Beach Camp sewage treatment plant with a marine discharge. The plant was decommissioned at the end of October 2007 as a result of the camp population



moving to the Jualin facilities. Since there was no longer any discharge from this outfall, monitoring ceased.