Deloitte & Touche

Faro Mine Complex
AMP Event #4 Response: 2008 Status Report

FINAL

Prepared for

Deloitte and Touche Inc.

On behalf of

Faro Mine Closure Planning Office

Prepared by

SRK Consulting
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AMP Event #4 Response:
2008 Status Report

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Executive Summary

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Objectives and Primary Findings:

This report provides an update on the 2008 field activities and monitoring results relating to Adaptive Management Plan (AMP) Event #4 (*"Degraded Seepage Quality from the Grum Rock Dump"*) and compares the current year's results with results from previous monitoring.

Results of 2008 dump toe seepage surveys indicate that zinc concentrations in dump seepage have not stabilized, with the highest observed dissolved zinc concentrations occurring at several toe seepage stations in 2008.

It appears that partial diversion of water from station V15 to station V2A via the Grum Creek diversion has been successful in controlling the amount of zinc reporting to station V2, however it appears as though concentrations at Station V2A in Grum Creek have increased in corresponding fashion.

Downgradient monitoring stations indicate that zinc loading from Grum Dump to Vangorda Creek continues to be minimal (~5 kg/yr, as estimated from the water and load balance) and that significant attenuation is occurring along surface and shallow subsurface flowpaths.

Future Work Recommendations:

It is recommended that waste rock and seepage monitoring be continued at the same level as carried out since 2004. Grum Creek weir flow-monitoring instrumentation should be reinstalled.

1 Introduction

As required under Water Licence QZ03-059, an Adaptive Management Plan (AMP) for the Anvil Range Mine was submitted to the Yukon Territory Water Board on June 30, 2004 (GLL, 2004). The AMP outlines the short-term mine management strategies that have been instituted to ensure environmental protection during the period leading up to the implementation of a Final Closure and Reclamation Plan.

Event #4, *"Degraded Seepage Quality from the Grum Rock Dump"*, addresses the potential for increased contaminant loadings from Grum Dump to levels which could have an adverse impact on the receiving environment in Vangorda Creek. The initial trigger for the implementation of the AMP was a sustained and statistically significant increase in concentrations of sulphate, copper or zinc in seepage from the Grum Dump.

The trigger established for sulphate was exceeded on the date of AMP implementation (July 1, 2004). In response, a plan detailing additional monitoring efforts and further investigations was developed to obtain a better understanding of hydrological and geochemical conditions downgradient of the Grum Dump, and to assess the level of environmental impact of Grum Dump loadings on Vangorda Creek. The response plan (SRK 2004) was initiated in the fall of 2004, with ongoing monitoring continuing since that time. The 2004 through 2007 activities are documented in a series of annual status reports (SRK 2005, SRK 2006, SRK 2007 and SRK 2008).

This report provides an update on the 2008 field activities and monitoring results. The document is organized as follows:

- Summary of 2008 field activities that were completed as part of AMP response and other programs relevant to Grum Dump seepage;
- Discussion of 2008 monitoring activity results, review of historical water quality at selected stations, and conclusions from 2008 water quality monitoring;
- Summary of 2008 Response Plan activities, and
- Recommendations for further activities.

2 Summary of 2008 Field Activities

2.1 Water Quality Monitoring

2.1.1 Reference Water Quality Stations

Monitoring of the nine Reference Water Quality Stations (RWQSs) (Figure 1) identified in the AMP and in subsequent follow-up work was carried out by site environmental staff or by Gartner Lee Limited (GLL) during 2008. Table 1 provides a description of each of these stations.

Table 1: Locations of Reference Water Quality Stations

Station Name	Location	Frequency
V15	Outlet of the Tributary A sedimentation pond.	Biweekly (year round)
V2	Main stem of Grum Creek, below Tributary A.	Biweekly (May to Oct.)
P96-9A and BH05-9b	Adjacent to Tributary A, downgradient from V15.	Semi-annual (spring/fall)
V2A	Culvert outfall of the ditch that presently diverts Grum Creek into Moose Pond.	Biweekly (May to Oct.)
Moose Seep	Between Moose Pond and Vangorda Creek.	Biweekly (May to Oct.)
Moose Well 2	Between Moose Pond and Vangorda Creek.	Biweekly (year round)
V14	Grum Dump Toe Access Road downgradient of SRK-GD05. This station appears to have changed locations over the course of the monitoring period, and may also have been monitored on the road upgradient of Sheep Creek, and upstream of V15 at the dump toe.	Semi-annual
V16	Ditch adjacent to the Grum Toe Access Road between V15 and Grum Creek.	Semi-annual (spring/fall)

2.1.2 Waste Rock Seepage Survey

Seepage from the toe of the Grum waste rock dump has been monitored as part of the semi-annual seepage survey that has been carried out since 2002. Seepage from the southern toe of the dump is monitored at stations SRK-GD1, SRK-GD4, SRK-GD5, SRK-GD6, SRK-GD-16 and SRK-GD21 (Figure 1).

Monitoring results are discussed in the Results section of this report. A broader discussion of waste rock dump seepage will be included in the 2008 Waste Rock and Seepage Monitoring Report (SRK, in progress).

2.1.3 Downgradient Pathways Survey

Selected seepage monitoring stations downgradient of the Grum waste rock dump (GD05 d/s, Sweet Creek, Sheep Creek) have been monitored on a spring/ fall basis since 2003. Two additional stations were added to the program starting in 2004 (WGD01 and WTA-02). Station locations are shown in Figure 1.

Monitoring results are discussed in Section 3.1.3.

2.1.4 Additional Groundwater Monitoring

Five additional groundwater monitoring wells that are not included in the list of reference water quality stations were installed in 2004 and 2005. These five wells (SRK04-5A, SRK04-5B, SRK05-5C, SRK05-07, and SRK05-08) are located adjacent to the Grum Dump Toe Access Road, as shown in Figure 1.

2.1.5 Quality Assurance and Quality Control

For the waste rock seepage survey and downgradient pathways survey, duplicates and field blanks were collected as a check on the quality of the field methods and laboratory results.

Ion balances were calculated for all samples to ensure total anions were in balance with total cations in solution. During evaluation of September 2008 water analyses, it was found that ion balances were very poor when they were calculated using reported sulphate concentrations. The balances were greatly improved when sulphate was calculated from total dissolved sulphur concentrations; therefore, reported sulphate concentrations were replaced with calculated sulphate values for the September 2008 sampling round.

2.2 Flow Monitoring at the Grum Creek Weir

A 90° V-notch weir was installed on Grum Creek at the upstream end of the Grum Creek Diversion in September 2004. In 2005, the water level was recorded using a Thalimedes water level monitoring instrument, with a built-in data logger. The Thalimedes required removal prior to winter freeze-up and reinstallation prior to spring freshet if peak flows were to be recorded. However, due to variable timing of spring melt, it was found to be difficult to schedule the spring reinstallation exercise. The Thalimedes was removed in September 2005 for data recovery and over-winter storage, and was replaced in 2006 with a vented pressure transducer (model INW PT2X, manufactured by Instrumentation Northwest) with an integrated data logger that was intended to withstand winter conditions.

The data downloaded in 2007 indicated that freezing conditions had occurred around the sensor which resulted in erroneous pressure readings over the period October 27, 2006 to June 13, 2007. Once water temperatures rose above zero in mid June, 2007, readings returned to normal. However, it appeared that the snow pack had caused the transducer to shift vertically. The 2007 readings were then re-calibrated using water level and spot flow measurements collected in September 2007.

The data logger was not accessible in May 2008 due to snowpack. When the logger was checked during the September AMP sampling round it was found to be non-functional and it was removed and sent for servicing. Data was recovered from the logger up to September 15, 2008.

The data downloaded in 2008 indicated that freezing conditions had occurred which resulted in erroneous pressure readings over the period October 22, 2007 to May 31, 2008. The 2008 readings were re-calibrated using water level and spot flow measurements collected in September 2008 to account for vertical shifts due to snow pack.

2.3 Diversion of Seepage from Station V15

In 2006, increasing concentrations of zinc were observed at the outlet of the V15 sedimentation pond upstream of Tributary A. In response to this finding, Deloitte and Touche Inc. (D&T) installed an interim collection system to divert this seepage into an existing ditch below the V-Notch weir on Grum Creek, which routes water from Grum Creek to Moose Pond at Station V2A. The interim system consisted of a pump and pipeline to convey water from the sedimentation pond into the existing ditch.

No water was pumped in 2006. However, D&T began pumping on January 28, 2007. They ran the pump on Mondays and Thursdays for a couple of hours each day to lower the pond level so as to avoid any spill.

This system was upgraded to a diversion ditch in August, 2007. A conceptual design for the diversion ditch was presented as Appendix B in SRK 2008. Photos taken during the construction of the diversion ditches are presented in Appendix A of the 2007 Vangorda Geotechnical Inspection Report.

3 Results of 2008 Monitoring, Field Activities, and Data Review

3.1 Water Quality Monitoring

3.1.1 Reference Water Quality Stations

Station V15

Station V15 is located at the outlet of the Tributary A sedimentation pond, upstream of Station V2 (Figure 1), and has been a reliable sampling point since pond construction in 1995. The V15 sedimentation pond is thought to be directly downgradient from the Grum sulphide cell via a groundwater pathway, and water chemistry at this location is expected to be a good indicator of the arrival and loading of oxidation products from the sulphide cell. Sulphate and total and dissolved zinc concentrations measured at V15 is shown in Figure 2.

Sulphate concentrations at V15 steadily increased over the 1995 through 2001 period. From 2001 through early 2004, sulphate concentrations at V15 were within a stable range (700 to 1050 mg/L). This stable period was followed by a period of increasing concentrations from around 1000 mg/L to around 2000 mg/L by June 2005, with a single high result of 2990 mg/L recorded in February 2005. Samples collected since June 2005 have indicated relatively stable sulphate concentrations in the range of 1300 to 2100 mg/L. Future monitoring will be necessary to verify the observation of a stable trend.

Dissolved and total zinc concentrations at V15 were high variably from 1995 to 2002, typically in the range of 0.01 to 0.1 mg/L, with occasional values as high as 1 mg/L. This variability was the result of operational and post-operational water management, as discussed below for Station V2. Following the implementation of dump runoff control in 2002, zinc concentrations were lower and more uniform, ranging between 0.006 and 0.05 mg/L. Starting in 2006, there was a dramatic trend of increasing zinc concentrations from 0.07 mg/L in January 2006 to 0.68 mg/L in October 2006. Zinc concentrations then levelled off over the winter months and decreased to approximately 0.4 mg/L during the 2007 spring freshet. During the summer of 2007, the concentrations started to increase again, reaching 1.2 mg/L by October 2007 and remaining at approximately 1 mg/L throughout 2008. The pattern of increasing zinc concentrations appears to be a textbook case of breakthrough of an attenuated chemical species. Future monitoring at V15 is critical for understanding retardation factors and evolution of water chemistry downgradient of Grum Dump.

Historical pH values were in the neutral to slightly alkaline range (7.1 to 8.5) from 2000 to mid-2007. From May 2007 to April 2008, pHs were somewhat lower (typically between 6.7 and 7.2), with a minimum pH of 6.3 recorded in September 2007. Since May 2008, pHs have increased again to between 7 and 7.8.

Station V2

Sulphate and zinc concentrations measured at Station V2 are shown in Figure 3.

Sulphate concentrations at V2 showed a consistent increase from the initial pre-mining period through to mid-2004, and were responsible for triggering Event #4 of the Adaptive Management Plan. From mid-2004 until mid-2007, sulphate concentrations stabilized within a seasonably-variable range of 900 to 1100 mg/L. Since mid-2007, sulphate concentrations have decreased to stable concentrations of approximately 700 mg/L.

Total and dissolved zinc concentrations were highly variable during mining operations, and runoff and erosion from the Grum Dump led to continued variable and elevated zinc concentrations at V2 during the period from the cessation of mining through 2002. Improved runoff management since 2002 resulted in total and dissolved zinc concentrations within a much narrower range at V2. Zinc concentrations have demonstrated a slight increasing trend since 2004 but total and dissolved zinc concentrations have generally remained below 0.06 and 0.05 mg/L, respectively indicating that the partial diversion of flows from the V15 sedimentation pond to Moose Pond in 2007 was successful in maintaining zinc concentrations at V2 well below the discharge limit of 0.5 mg/L.

Water at V2 continues to show slightly alkaline pH conditions.

Station V2A

Zinc and sulphate concentrations at Station V2A are shown in Figure 4.

Sulphate concentrations at V2A increased steadily between 1997 and 2005, and more gradually from 2005 to 2008, reaching a maximum concentration of 1050 mg/L in June and September 2008.

Zinc concentrations were generally within the range of 0.05 to 2 mg/L over the period of 2001 through 2007, demonstrating a slightly decreasing trend since 2004 to concentrations generally below 0.2 mg/L since mid-2006. Since June 2008 however, dissolved zinc concentrations have increased to between 1 and 2 mg/L. A maximum total zinc concentration of 2.8 mg/L was recorded in June 2008. These results reflect the partial diversion of the flows from Station V15 into Moose Pond.

Water at Station V2A continues to show slightly alkaline pH conditions.

Station V14 and V16

Stations V14 and V16 have been historically monitored on a sporadic basis, from 1989 in the case of V14 and from 1995 in the case of V16. Station V16 has been monitored on a more consistent basis since 2004. There is no data from V14 for 2007 or 2008. Sulphate and zinc data for Stations V14 and V16 are shown in Figure 5.

The 2008 sulphate and zinc concentrations from V16 were within previously observed ranges.

Moose Seep

Moose Seep is located below Moose Pond approximately 25 m upslope from Vangorda Creek just upstream of Grum Creek (Figure 1), and has been monitored since Fall 2003. Monitoring frequency increased from twice-yearly to twice-monthly in 2005 as part of the AMP Event #4 Response.

Zinc and sulphate concentrations measured at Moose Seep are shown in Figure 6.

Sulphate concentrations ranged between about 400 to 800 mg/L until June 2008 when concentrations increased to between 800 and 1000 mg/L. Strong seasonal variations have been evident since 2006, with the lowest concentrations occurring during spring freshet, and maximum concentrations occurring in the late fall. The observed 2008 increase may be the result of diversion of water from V15 into Moose Pond.

Zinc concentrations have ranged from less than detection (0.005 mg/L) to a maximum of 0.026 mg/L (recorded in June 2008).

Moose Seep had neutral to slightly alkaline pH during all monitoring rounds.

Moose Well

Moose Well 2 was installed in September 2005, and has been sampled regularly since that time. Results are presented in Figure 6.

Sulphate concentrations have shown a cyclical pattern, with peak concentrations occurring in the late summer and fall, and minimum concentrations occurring in the early spring. The seasonal variation in sulphate concentrations was similar to the pattern observed upgradient at V2A (the point of Grum Creek discharge into Moose Pond), and support the assumption that infiltration into Moose Pond reports to Vangorda Creek via a diffuse shallow groundwater pathway.

Dissolved zinc concentrations varied from less than detection (0.005 mg/L) to 0.015 mg/L with one outlier of 0.07 mg/L. Unlike sulphate, there were no strong seasonal trends. These results suggest that there is significant attenuation along the seepage pathway between Moose Pond and Moose Well 2.

Field pHs have been between 7 and 8.

Station P96-9A and P96-9B/BH05-9B

Groundwater was historically monitored via one shallow (P96-9A) and one deeper piezometer (P96-9B) located adjacent to Tributary A, immediately downstream of the Grum Dump toe access road (Figure 1). These wells were intended to monitor the early arrival of oxidation products from the Grum sulphide cell in groundwater, in the same way that V15 was intended to monitor surface seepage. P96-9B became non-functional in 2001 and no samples have been collected from the deeper well since that time. In 2005, BH05-9B was installed to replace the damaged P96-9B.

Sulphate concentrations in the shallow unconfined aquifer at P96-9A show an increasing trend over the 1996-2001 period (Figure 7), and then show a period of stable concentrations with seasonal variations (950 to 1800 mg/L) from 2001 through 2008. Field pHs have varied between 5.9 and 7.7 since installation. Dissolved iron concentrations have been somewhat variable, but have remained below 0.2 mg/L since 2001. Zinc concentrations have remained low (less than 0.1 mg/L). Concentrations were somewhat higher in 2006 and 2007 in comparison to the 1999 through 2005 data. The increase in concentrations coincides with the increase in zinc concentrations observed in surface seepage at the upgradient station V15 in 2006 and it was thought that a breakthrough in zinc concentrations may be starting in the shallow groundwater in this area; however, zinc concentrations decreased again in 2008 to less than 0.02 mg/L (although this may be an artefact of diverting water from V15 to Moose Pond).

Sulphate concentrations in the deeper confined aquifer (P96-9B), which experienced flowing artesian conditions, were between 100 and 200 mg/L from 1996 through 2001, (with one outlier of 320 mg/L), and were similar in the replacement well BH-05-09B (Figure 8). From 1996 through 2001, dissolved iron concentrations varied from 0.01 mg/L to 0.31 mg/L, and dissolved zinc concentrations ranged from below the detection limit of 0.01 mg/L to 0.04 mg/L. Dissolved iron values from the replacement well have been higher, with values ranging from 0.5 to 0.8 mg/L, while dissolved zinc concentrations have been at or near the detection limit.

Field pH reported ranged from 7.1 to 8.3 standard pH units, and showed no discernable trend.

3.1.2 Grum Dump Toe Seeps

SRK-GD01

SRK-GD01 is located where the main stem of Grum Creek emerges from the toe of Grum Dump (Figure 1). This is the largest surface flow identified at the toe of Grum Dump, and is considered to be the most important source of surface flows originating from the dump. Sulphate and zinc concentrations at SRK-GD01 are summarized in Figure 9. Complete results are provided in Appendix A1.

Sulphate concentrations have ranged between 890 and 1686 mg/L over the monitoring period (2002 through 2008), with the lowest observed sulphate concentration occurring in May 2008 and the highest occurring in September 2008. Dissolved zinc have typically varied between 2.5 to 4 mg/L over this period, with isolated peaks of 17 and 11 mg/L recorded during the 2004 and 2005 freshet surveys, respectively, and a high value of 6.7 mg/L in September 2008.

Circum-neutral pH conditions were observed during all sampling rounds.

SRK-GD05

Station SRK-GD05 is located at the dump toe directly upgradient of the swale shown on Figure 1 as No Fork Creek, and has been monitored on a semi-annual basis since 2002. Sulphate and dissolved zinc data are summarized in Figure 10.

The results indicate slightly alkaline pHs during all sampling rounds. Sulphate concentrations increased from approximately 1100 mg/L in 2002 to stabilize within the range of 1400 to 1800 mg/L since 2004. The sample collected in September 2008 had a slightly higher sulphate concentration of 2034 mg/L. Zinc concentrations ranged from 1.7 to 5.9 mg/L, with the highest concentrations measured in September 2008.

Flows at SRK-GD05 are low compared to flows in Grum Creek, but have been observed consistently during all sampling rounds. The seepage infiltrates into the ground within a few metres of the dump toe. However, emergent seepage is observed topographically downgradient in No Fork Creek at station GD05 d/s, with seepage volumes that exceed those observed at the toe on the basis of visual observation and crude field measurements. It is inferred that subsurface flow is more significant than surface flow at SRK-GD05, and that the No Fork Creek drainage is a preferred groundwater flowpath from Grum Dump to Vangorda Creek. Sampling results from No Fork Creek are discussed under station GD05 d/s.

SRK-GD16

SRK-GD16 is located at the toe of Grum Dump topographically upgradient from the linear depression shown on Figure 1 as Sweet Creek. Flows were observed during only four of fourteen sampling rounds. Results for this station are provided in Appendix A1.

The results indicate pHs ranging from 7.3 to 7.5, sulphate concentrations of 1680 to 4100 mg/L, and highly variable dissolved zinc concentrations ranging from 10.4 to 139 mg/L. The sample with the highest zinc and sulphate concentrations was collected in May 2008, and represents the highest sulphate and zinc concentrations observed from any external toe seep from Grum Dump.

SRK-GD04 and SRK-GD21

SRK-GD04 and SRK-GD21 are located immediately upgradient of V15 and Tributary A (Figure 1) at a minor topographic low along the dump toe. Surface flows in this area were observed during only seven of fourteen sampling rounds. Field pH values have been circum-neutral at these stations ranging from 6.8 to 8.1. Sulphate concentrations have ranged from 1350 to 2500 mg/L and zinc concentrations have ranged from 1.1 to 6.6 mg/L. The lowest field pH and highest sulphate and zinc concentrations were reported for SRK-GD21B in Fall 2008, however an increasing trend has not been observed. Complete results for this station are provided in Appendix A1.

3.1.3 Downgradient Pathways Survey

GD05 d/s

Station GD05 d/s is located in the topographic depression shown as No Fork Creek, downgradient from the toe seep station SRK-GD05 (Figure 1). This station has been monitored on a semi-annual basis since fall of 2003. Results for sulphate and zinc are shown in Figure 11, with complete results provided in Appendix A2.

The 2008 monitoring results were generally consistent with results from previous monitoring, with field pHs in the range of 6.9 to 8.2, sulphate concentrations of 834 to 1360 mg/L, and dissolved zinc concentrations near or less than the detection limit (previously 0.005 mg/L, lowered in 2008 to 0.0005 mg/L). The one exception was the spring 2008 sample, which had a zinc concentration of 0.026 mg/L. The Fall 2008 sample, however, had a zinc concentration of 0.0014 mg/L.

Sweet Creek

Sweet Creek, located downgradient of dump toe seepage station SRK-GD16, has been monitored on a semi-annual basis since September 2004. Sulphate and dissolved zinc concentrations are shown in Figure 12. Complete results are provided in Appendix A2.

Monitoring results from this station have typically had field pHs in the range of 7.7 to 8.3, sulphate concentrations of 847 to 1260 mg/L, and dissolved zinc concentrations generally less than the detection limit of 0.005 mg/L. Zinc concentrations in May 2007 and 2008 indicated low but detectable dissolved zinc concentrations of 0.006 and 0.0075 mg/L, respectively. The sulphate concentration in September 2008 was higher than previously recorded at 1563 mg/L.

Sheep Creek

Sheep Creek has been monitored on a semi-annual basis since fall 2003. Sulphate and dissolved zinc concentrations are shown in Figure 13. Complete results are provided in Appendix A2.

The results indicated consistently neutral to slightly alkaline pHs in all of the samples. Sulphate concentrations have demonstrated an increasing trend from 43 mg/L in the spring 2004 sample to 99 mg/L in the Fall 2008 sample. Dissolved zinc concentrations have ranged from less than detection limit (0.005 mg/L) to 0.007 mg/L. No clear trends in zinc concentrations have been observed.

WTA02

Station WTA02 represents seepage ponded on the roadway of the Grum Dump toe access road near the upper end of Sheep Creek (Figure 1). This station has been monitored at least once per year since 2004. Results are provided in Appendix A2.

The 2008 monitoring results were in the range of previous results at this station, with field pHs ranging from 7.6 and 8.3, sulphate concentrations ranging from 18 to 286 mg/L, and dissolved zinc concentrations typically at or near the detection limit of 0.005 mg/L. A single outlier of 0.038 mg/L was recorded in September 2006.

The cause, and significance, of detectable zinc at this station in 2006 is not presently known. Based on topographic considerations, it appears unlikely that this location is influenced by seepage from the Grum dump.

WGD01

Station WGD01 is located above Sheep Creek west of Grum Dump (Figure 1). This station has been measured at least annually since 2004.

Results of the 2008 monitoring are generally consistent with those from previous years, with field pH ranging from 7.6 to 8.2, sulphate concentrations ranging from 252 to 384 mg/L, and dissolved zinc concentrations typically in the range of the detection limit (0.005 mg/L). One exception was the sulphate concentration recorded in September 2008 which was an order of magnitude higher than previously recorded concentrations at 2955 mg/L. Complete monitoring results are provided in Appendix A2.

3.1.4 Additional Groundwater Monitoring

Most groundwater monitoring wells downgradient of Grum Dump are Reference Water Quality Stations, and results for these stations have already been discussed. The following discussion is limited to groundwater monitoring results from wells installed in 2004 and 2005. Complete results for these stations are provided in Appendix A3.

SRK04-05a and -05b

SRK04-05a and b are nested wells that were installed adjacent to Grum Creek and the Grum Dump Toe Access Road in 2004 (Figure 1). Flowing artesian conditions were encountered at a depth of 12.5 m. The deep monitoring well (SRK04-05a) was completed in weathered bedrock and the shallow piezometer was completed immediately below the inferred aquitard (SRK 2005). It is therefore likely that the two wells are hydraulically connected.

Samples were not collected at either of these locations in 2007 or 2008.

SRK05-05c

Installation of SRK05-05c was completed in August, 2005, and has been monitored annually since that time.

The 2008 results indicated sulphate concentrations of 340 to 410 mg/L and zinc concentrations of 0.006 to 0.007 mg/L. These were within the range previously observed at this station.

Although Grum Creek is within 10 m of SRK05-05c and is slightly topographically upgradient, the much higher sulphate and zinc concentrations in the creek (~900 mg/L sulphate and 0.1 to 0.2 mg/L Zn at V2A) suggest that the shallow groundwater at SRK05-05c has a significant component of the flow that originates from some other source that is isolated from the creek.

SRK05-07

SRK05-07 was installed in shallow bedrock on the south side of the Grum Dump Toe Access Road, downgradient of the dump toe seep location SRK-GD16 and upgradient of the Sweet Creek sample station (Figure 1).

2008 monitoring results indicated neutral pH conditions, sulphate concentrations in the range of 1140 to 1600 mg/L, and zinc concentrations between 0.028 and 0.029 mg/L. The 2008 sulphate concentrations were slightly higher than 2006 and 2007 concentrations.

SRK05-08

SRK05-08 was installed in shallow bedrock on the south side of the Grum Dump Toe Access Road, at the intersection of the road and a ridge that runs perpendicular from the dump toe to Vangorda Creek (Figure 1).

Monitoring of results from 2005 to 2008 indicated sulphate concentrations ranging from 458 to 780 mg/L, and dissolved zinc concentrations ranging from <0.005 to 0.052 mg/L. Sulphate concentrations have demonstrated an increasing trend over the monitoring period.

3.1.5 Summary of Water Quality Monitoring Results

Results of 2008 dump toe seepage surveys indicate that zinc concentrations in dump seepage have not stabilized, with the highest observed dissolved zinc concentrations occurring at several toe seepage stations (SRK-GD05, SRK-GD06, SRK-GD16 and SRK-GD21) in 2008.

The dramatic and consistent rise in dissolved zinc concentration observed at V15 in 2006 and 2007 remains noteworthy. The data appear to show a classic case of breakthrough of attenuated chemical species. Zinc concentrations reached a maximum value of 1.2 mg/L in Oct. 2007 before appearing to stabilize at approximately 1 mg/L throughout 2008. The 2008 monitoring results suggest that Zn concentrations have stabilized around 1 mg/L.

Despite the increase in zinc concentrations observed at Station V15, zinc concentrations at Station V2, downstream of this location, have remained very low throughout the monitoring period. Sulphate concentrations at Station V2 remain in excess of the initial trigger established in the AMP.

It appears that partial diversion of water from station V15 to station V2A via the Grum Creek diversion has been successful in controlling the amount of zinc reporting to station V2, however it appears as though concentrations at Station V2A in Grum Creek have increased in corresponding fashion. In 2006 through early 2008, dissolved zinc concentrations at V2A have typically been below 0.2 mg/L, but since June 2008, zinc concentrations have increased dramatically to between 1 and 2 mg/L. Zinc concentrations are currently attenuated between Moose Pond and Vangorda Creek, and are not having a measurable impact on Vangorda Creek.

Downgradient monitoring stations east of V2 below Moose Pond and west of V2 near Vangorda Creek show elevated sulphate concentrations, but zinc concentrations are typically at or near detection levels (0.005 mg/L). The monitoring data thus shows that zinc loading from Grum Dump to Vangorda Creek continues to be minimal (~5 kg/yr, as estimated from the water and load balance) and that significant attenuation is occurring along surface and shallow subsurface flowpaths.

3.2 Grum Creek Flow Monitoring

As mentioned previously, results of the 2008 flow monitoring at the Grum Creek weir were complicated by problems with the instrumentation and staff gauge over the winter months. Data from October 21, 2007 to May 31, 2008 were removed from the database due to erroneous pressure readings resulting from freezing conditions. Data from June 1, 2007 to September 15, 2007 was calibrated to match a spot flow measurement collected in September 2008.

The calibrated flows are shown in Figure 14.

Peak 2008 flows ranged from approximately 15 L/s during spring freshet to 8 L/s during the early fall; however, unlike other years, maximum flows up to 30 L/s were recorded during mid-July. Flows were similar in magnitude to results of the 2005 monitoring, and somewhat higher than results of 2006 and 2007 monitoring. Annual flow rates are correlated to precipitation rates. Precipitation recorded over the 2008 monitoring period was nearly twice as much as was recorded over the same period in 2007 (www.theweathernetwork.com).

The 2008 measurements of Grum Creek discharge are somewhat lower than the estimates of runoff from the upgradient catchment that were incorporated into the water and load balance (average annual runoff at the weir (Catchments 1+2) was estimated to be 6.3 L/s (SRK 2005)). The discharge data will be used to calibrate the runoff model at a later date, along with precipitation records from the station installed on the Grum Dump near toe seep station SRK-GD01, when revisions to the Grum Dump water and load balance are required.

3.3 Diversion of Seepage from Station V15

As mentioned previously, flows from the V15 sedimentation pond were pumped to the existing diversion ditch from Grum Creek to Moose pond starting in January 28, 2007 to minimize the potential for impacts to water quality at Station V2.

Upgrades to the interim seepage collection system used to divert flows from the Station V15 sedimentation pond were implemented in August, 2007, and flows were regularly diverted starting August 27, 2007.

The conceptual design for the diversion ditch was presented as Appendix B in SRK 2008.

4 Summary and Conclusions

4.1 Final Implementation of AMP Event #4 Response Plan

The final components of the AMP Response Plan were implemented in 2005. The following summary addresses the points raised in "*Section 5: Recommendation*", in the 2007 AMP Event #4 Status Report (SRK 2008), and the actions taken in 2008 to address these commitments.

Recommendation #1: Continue monitoring of Reference Water Quality Stations, as required under the AMP

Response actions in 2008:

- Continued monitoring all of the Reference Water Quality Stations as flow conditions permitted.
- Reviewed monitoring data and included monitoring results as part of the regular monthly report to the Water Board.

Recommendation #2: Continue to divert seepage from station V15 to station V2A in 2008, as a pro-active short-term mitigation strategy to minimize zinc concentrations at Station V2 until a final closure plan can be implemented.

Response actions in 2008:

- Continued diversion from Station V15 to Station V2A.

Recommendation #3: Collection and transfer of water to Vangorda Pit if zinc concentrations exceed acceptable levels at station V2, at Moose Seep, or at Moose Well 2.

Response actions in 2008:

- Monitored the water quality stations discussed above. Monitoring results showed that all of the drainage downgradient from the Grum Dump was fit for discharge, and that no collection and transfer of water was necessary.

Recommendation #4: Continue Spring/Fall downgradient pathway and dump toe seepage surveys

Response actions in 2008:

- Carried out May and September monitoring of Grum Dump toe seeps and previously-identified downgradient stations between Grum Dump and Vangorda Creek.

Recommendation #5: Continue monitoring and maintenance of the Grum Creek weir flow monitoring instrumentation

Response actions in 2008:

- Data logger was removed for servicing in September 2008 as the instrument was no longer able to be downloaded. The manufacturer retrieved the 2008 water level data, repaired the instrument's communication capabilities and replaced the batteries.

Recommendation #6: Review monitoring data on an ongoing basis and report Reference Water Quality Station monitoring data in the regular monthly report to the Water Board

Response actions in 2008:

- D&T reported results of 2008 monitoring activities to Water Board in regular monthly report.

- Prepared this report to document 2008 response activities in detail.

Recommendation #7: Present 2008 monitoring results in an annual AMP Event #4 Status report to be included with the annual AMP report prepared by GLL

Response actions in 2008:

- Results from this report will be included in the AMP report.

5 Recommendations

The following points summarize recommendations for continued monitoring of water quality downgradient of Grum Dump, and for implementation of additional water management if zinc concentrations exceed acceptable levels.

1. Continue monitoring Reference Water Quality Stations, as required under the AMP, by site environmental staff on a twice-monthly basis.

2. Continue to divert seepage from station V15 (the sedimentation pond) towards station V2A as a short term mitigation strategy to minimize zinc concentrations at station V2 until a final closure plan can be implemented.

3. Implement collection and transfer of water to Vangorda Pit or Little Creek Pond if zinc concentrations exceed acceptable levels at station V2, at Moose Seep, or at Moose Well.

    a. In the absence of site specific water quality objectives, the discharge water quality criteria of 0.5 mg/L zinc will be used as an interim threshold for implementation of water collection activities. Surface water collection and transfer would be implemented if three consecutive samples either at Station V2, at Moose Seep, or at Moose Well 2 exceed 0.5 mg/L zinc.

    b. Once a site-specific water quality objective has been developed for Vangorda Creek, the threshold for implementation of contingency measures should be re-evaluated to ensure that loading from this flow pathway is within acceptable limits.

    c. In the event that the interim threshold is exceeded, notification will be sent to the Water Board within 30 days.

4. Continue Spring/Fall downgradient pathway and dump toe seepage surveys.

5. Reinstall Grum Creek weir flow-monitoring instrumentation.

6. Review monitoring data on an ongoing basis. Results of the Reference Water Quality Station monitoring data should continue to be included as part of the regular monthly report to the Water Board.

7. Present 2009 monitoring results in an annual AMP Event #4 Status report.

This report, **"AMP Event #4 Response: 2008 Status Report-final"**, has been prepared by SRK Consulting (Canada) Inc.

Prepared by:

Madeleine Corriveau, EIT/GIT (BC)

Dylan MacGregor, GIT (BC)

Reviewed by:

Peter Healey, P.Eng.

6 References

Gartner Lee Limited 2004. Anvil Range Mine Adaptive Management Plan Implementation Protocol, June 25, 2004. Report # GLL 40302.

SRK Consulting 2004b. Letter to Tony Polyck, Manager: Water Inspections Section, Department of Environment, Government of Yukon, RE: AMP Event #4, Seepage Water Quality from Grum Rock Dump, Anvil Range Mine, Yukon. August 16, 2004.

SRK Consulting 2005. AMP Event #4: Status Report. Prepared for Deloitte & Touche, May 2005.

SRK Consulting, 2006. AMP Event #4 Response: 2005 Status Report. Prepared for Deloitte & Touche, October 2006.

SRK Consulting, 2007. AMP Event #4 Response: 2006 Status Report. Prepared for Deloitte & Touche, January 2007.

SRK Consulting, 2008. AMP Event #4 Response: 2007 Status Report. Prepared for Deloitte & Touche, January 2008.

SRK Consulting, in progress. 2008 Waste Rock and Seepage Monitoring Report. In preparation for Deloitte & Touche, on behalf of the Faro Mine Closure Planning Office.

Figures

J:\01_SITES\FARO\1000_Deloitte_from GE_Projects\Acad-Vangorda-Grum\2006 Acad Drawings\site_plan_2006-Photo.dwg

Legend
- Reference Water Quality Stations
- Dump Toe Seeps
- Downgradient Monitoring Stations
- Groundwater Monitoring Well

Note:

Sulphide cell outline from as-built drawing, Feb. 1996, as reported in Figure 1, Anvil Range Mining Corporation, May 1996.

0 50 100 150 200 250 300 Metres

Scale 1:5000

Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

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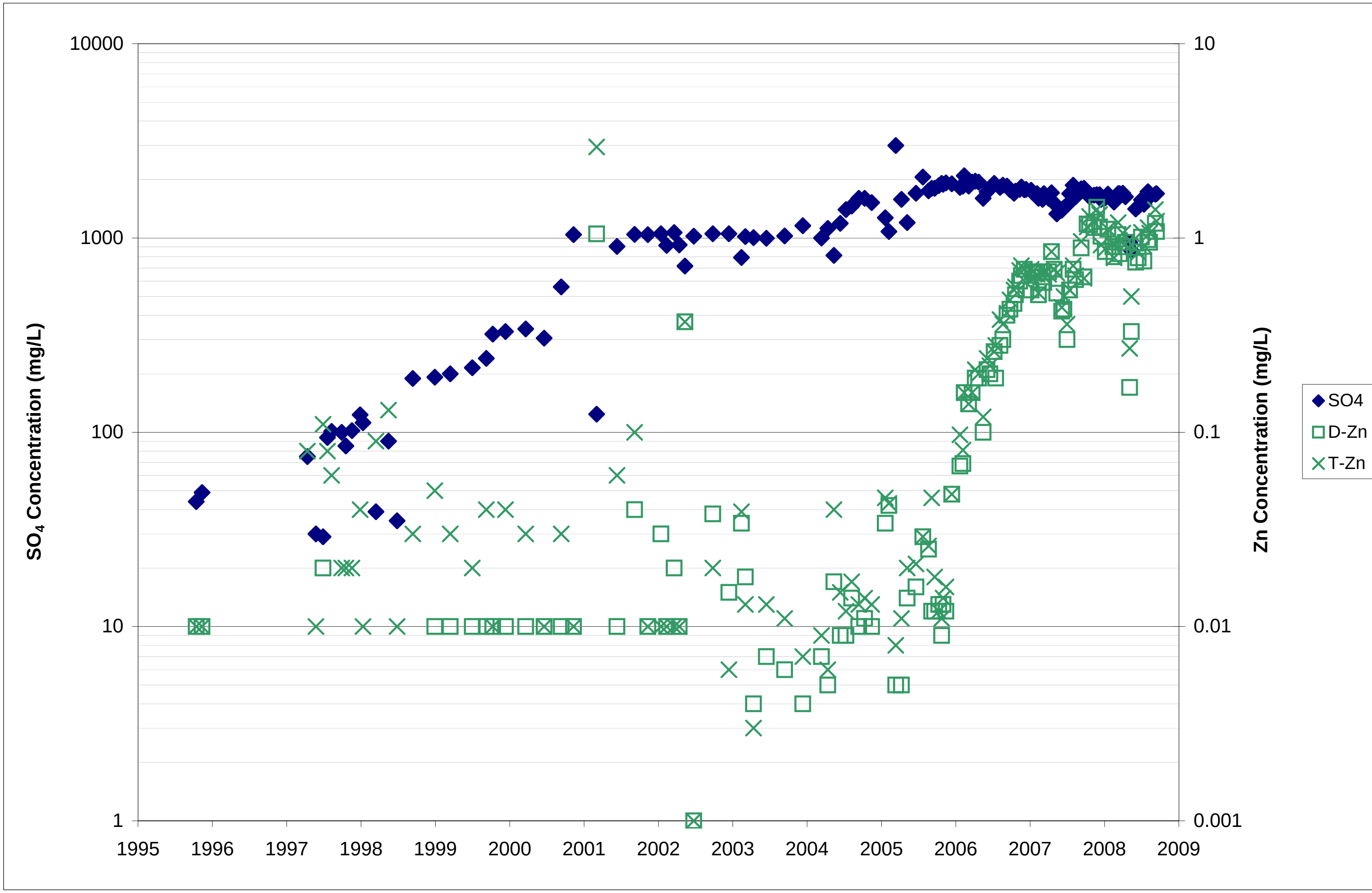
2008 AMP Event #4 Response: Status Report

2008 Borehole and Water Sampling Stations

SRK JOB NO.:	1CD003.110	Anvil Range Mining Complex	DATE: Dec. 2008	APPROVED: M.C.C.	FIGURE: 1
FILENAME:	site_plan_2006-Photo.dwg				



Note: Dissolved zinc concentrations are plotted at the detection limit where values were reported as less than detection.

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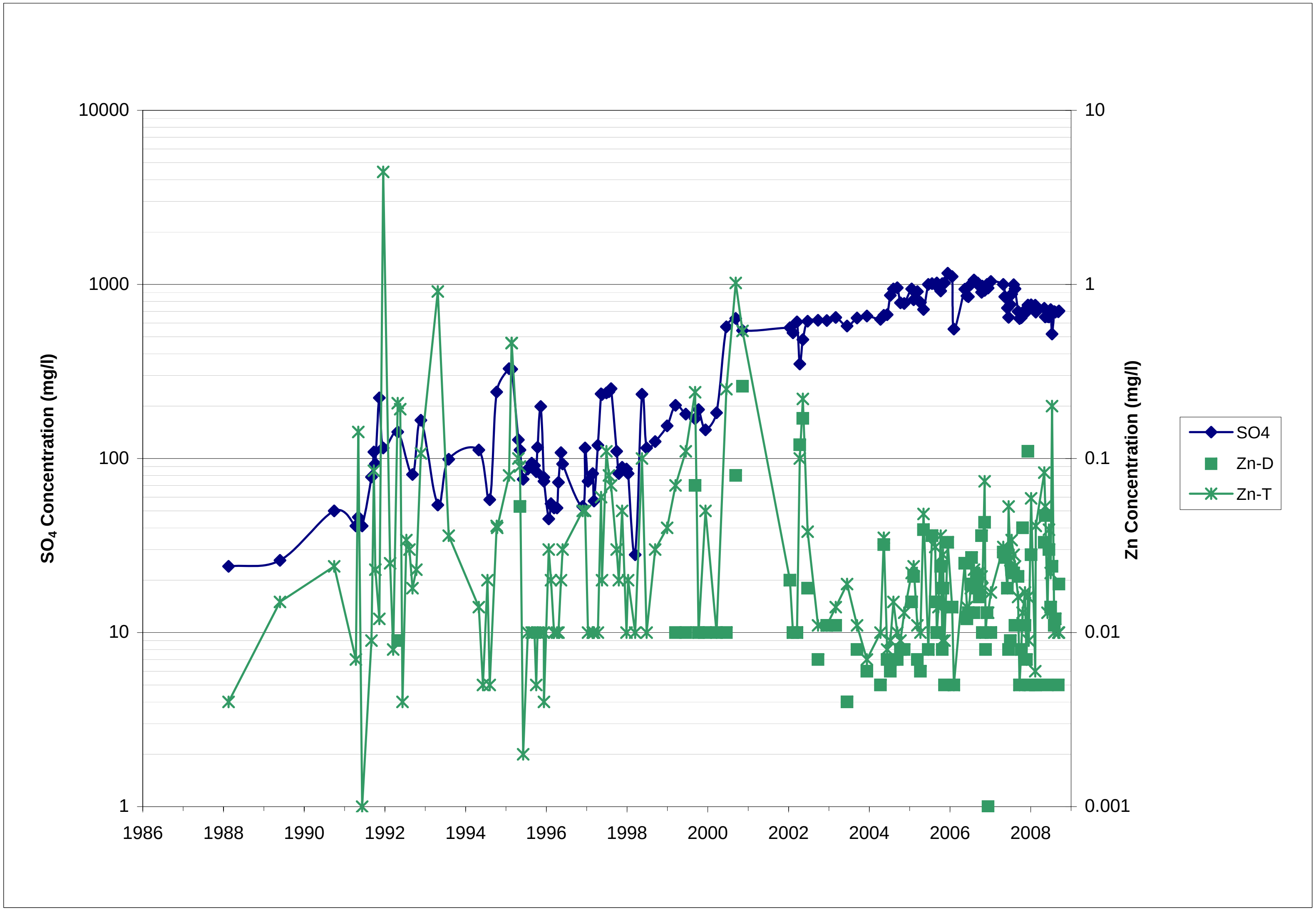
2008 AMP Event #4 Response: Status Report

Zinc and Sulphate Concentrations at V15

Job No: 1CD003.110
File: 2008 AMP Water Quality Figures

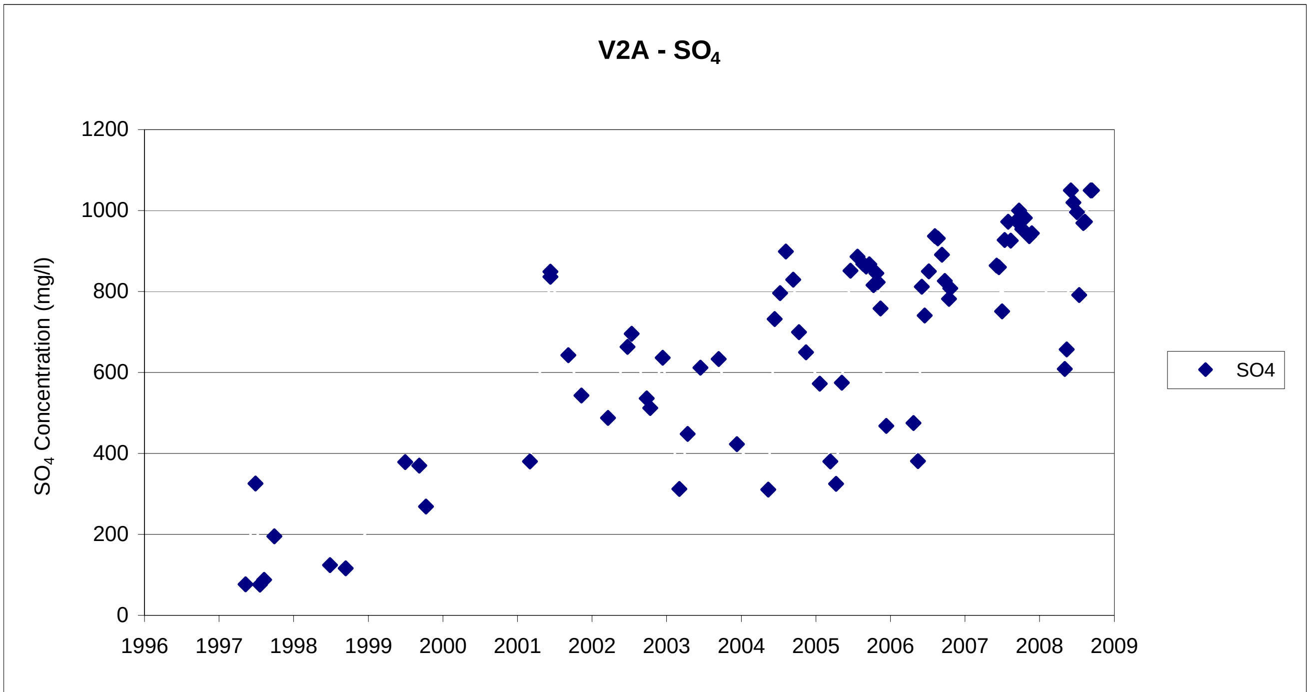
Faro Mine Complex

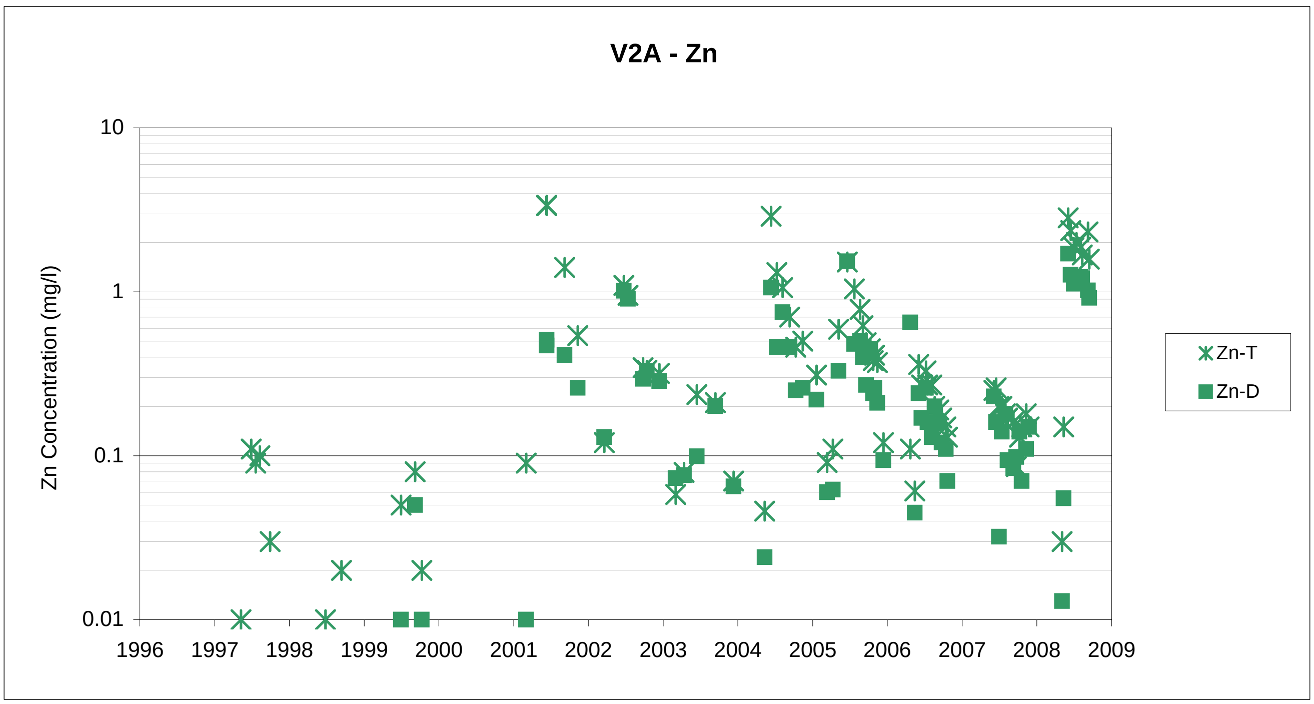
Date:	Approved:	Figure:
December 2008	MCC	2



Note: Dissolved zinc concentrations are plotted at the detection limit where values were reported as less than detection.

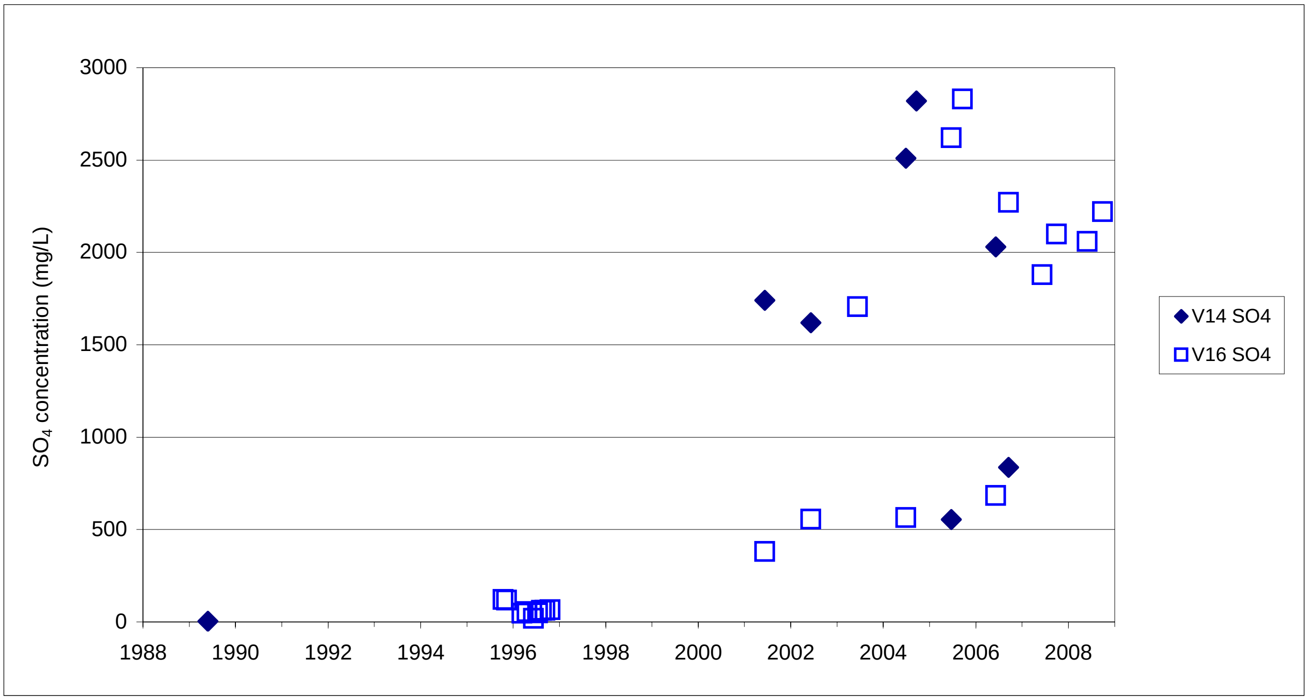
SRK Consulting Engineers and Scientists VANCOUVER	Deloitte & Touche	2008 AMP Event #4 Response: Status Report **Zinc and Sulphate Concentrations at V2**
Job No: 1CD003.110 File: 2008 AMP Water Quality Figures	Faro Mine Complex	Date: December 2008 · Approved: MCC · Figure: 3

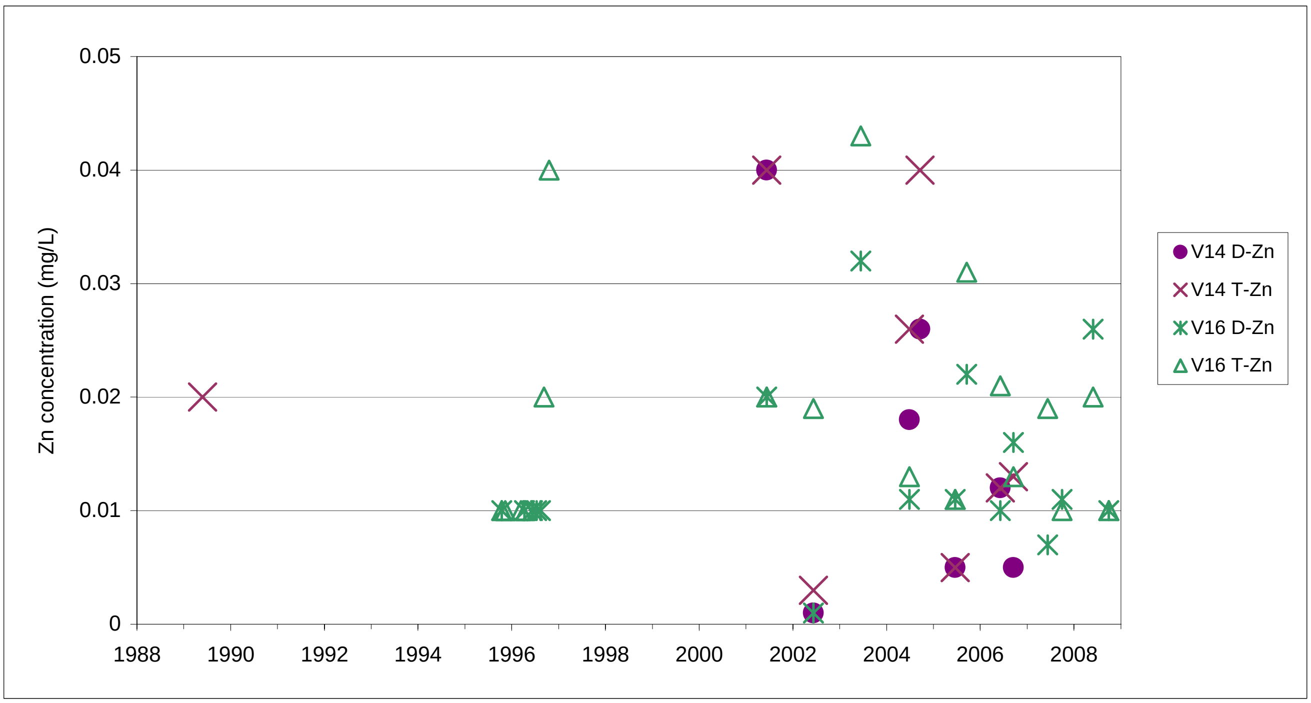




Note: Dissolved zinc concentrations are plotted at the detection limit where values were reported as less than detection.

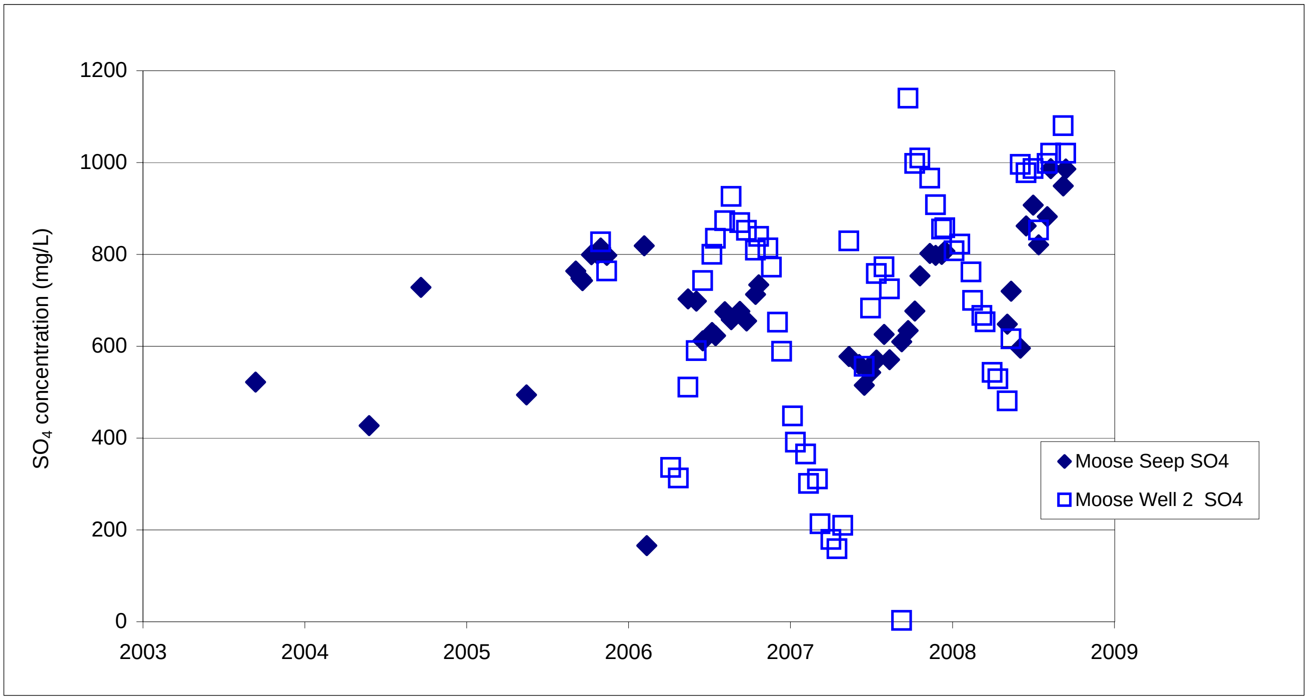
SRK Consulting Engineers and Scientists VANCOUVER	Deloitte & Touche	2008 AMP Event #4 Response: Status Report
		Zinc and Sulphate Concentrations at V2A
Job No: 1CD003.110 File:	Faro Mine Complex	Date: December 2008 | Approved: MCC | Figure: 4

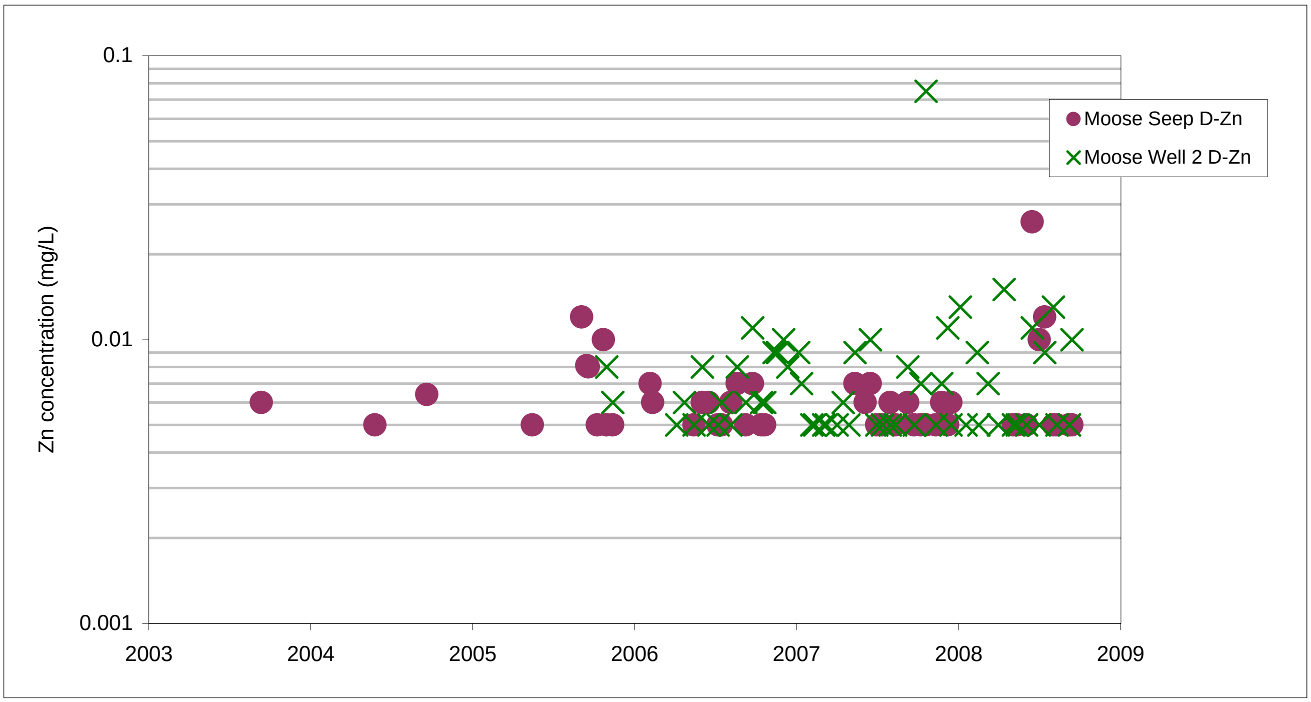




Note: Dissolved zinc concentrations are plotted at the detection limit where values were reported as less than detection.

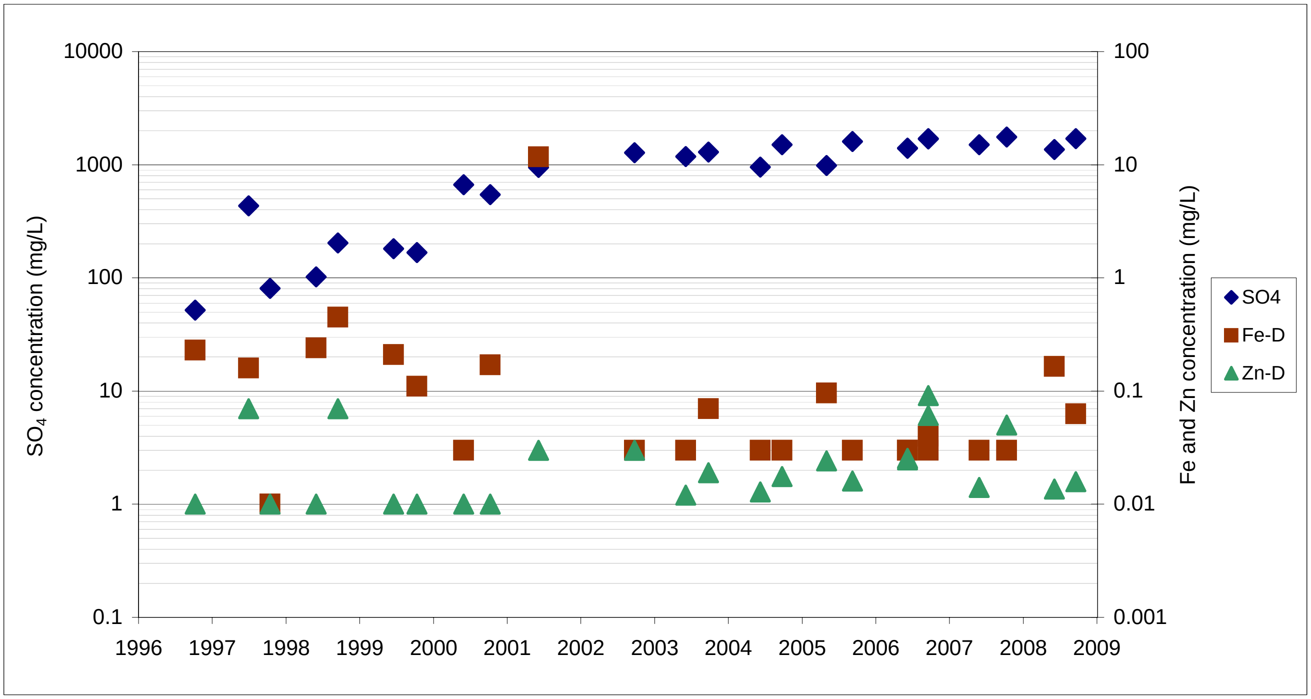
SRK Consulting Engineers and Scientists VANCOUVER	Deloitte & Touche	2008 AMP Event #4 Response: Status Report
		Zinc and Sulphate Concentrations at V14 and V16
Job No: 1CD003.110 File: 2008 AMP Water Quality Figures	Faro Mine Complex	Date: December 2008 / Approved: MCC / Figure: 5

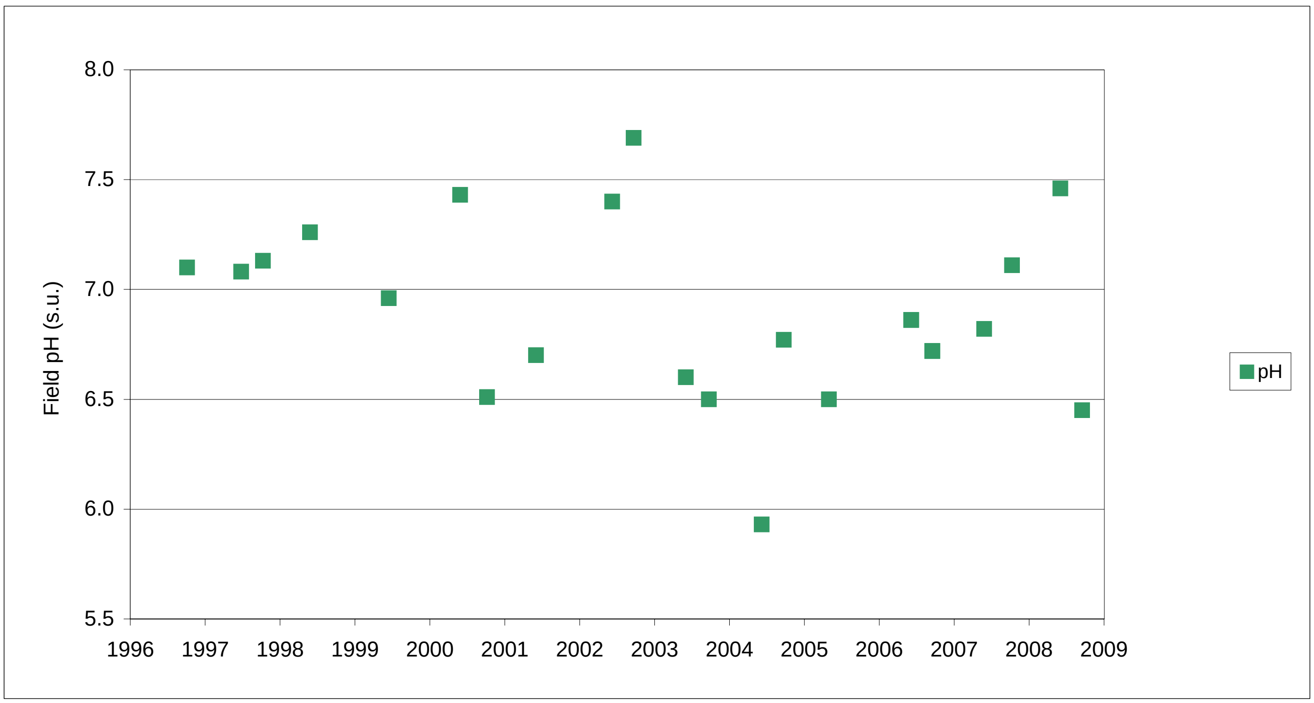




Note: Dissolved zinc concentrations are plotted at the detection limit where values were reported as less than detection.

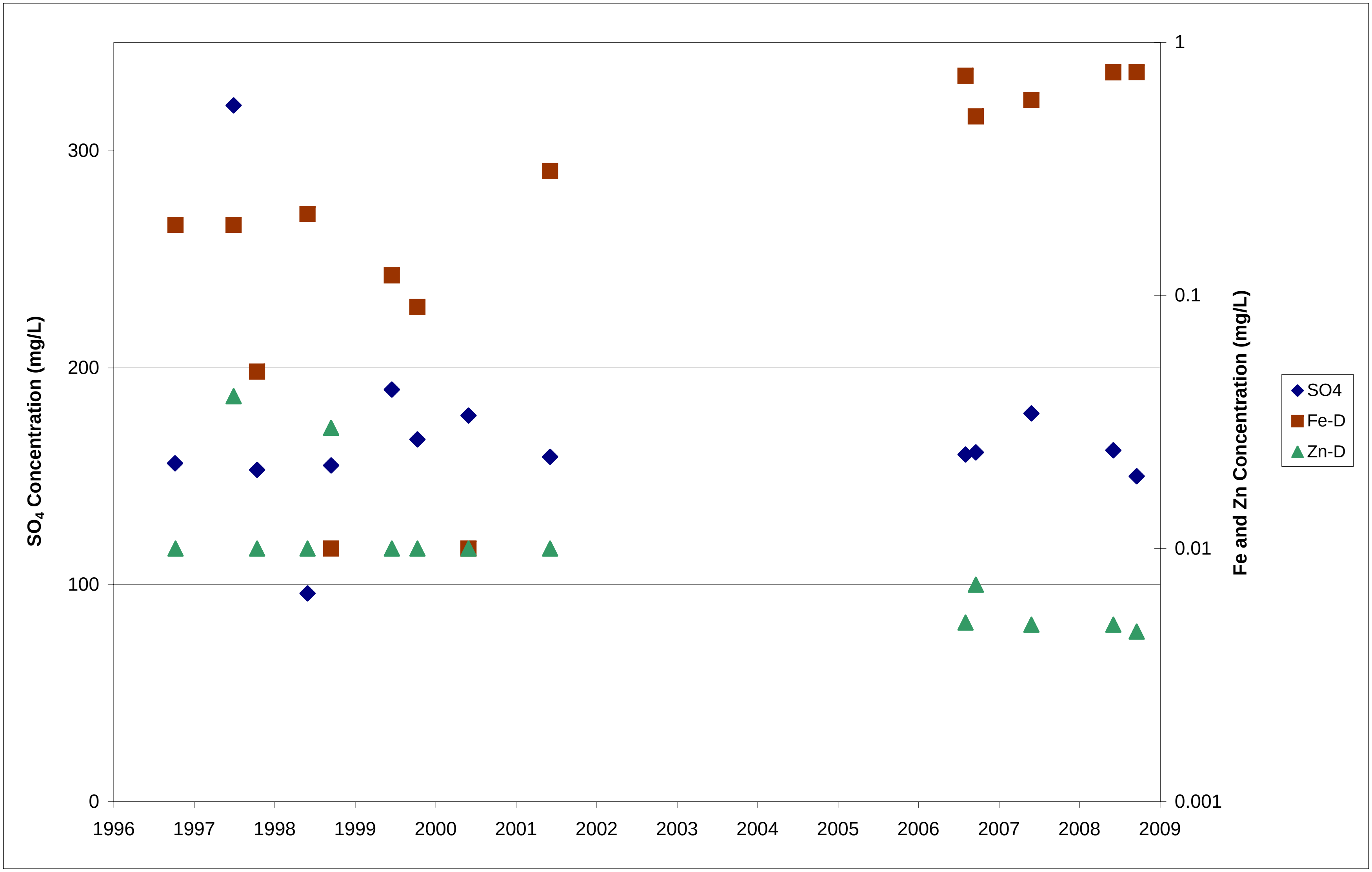
SRK Consulting Engineers and Scientists VANCOUVER	Deloitte & Touche	2008 AMP Event #4 Response: Status Report **Zinc and Sulphate Concentrations at Moose Seep and Moose Well**
Job No: 1CD003.110 File: 2008 AMP Water Quality Figures	Faro Mine Complex	Date: December 2008 / Approved: MCC / Figure: 6





Note: Dissolved zinc concentrations are plotted at the detection limit where values were reported as less than detection.

SRK Consulting Engineers and Scientists VANCOUVER	Deloitte & Touche	2008 AMP Event #4 Response: Status Report
		Zinc and Sulphate Concentrations and Field pH at P96-9a
Job No: 1CD003.110 File: 2008 AMP Water Quality Figures	Faro Mine Complex	Date: December 2008 · Approved: MCC · Figure: 7



Note: Dissolved zinc concentrations are plotted at the detection limit where values were reported as less than detection.

SRK Consulting Engineers and Scientists VANCOUVER	Deloitte & Touche	2008 AMP Event #4 Response: Status Report
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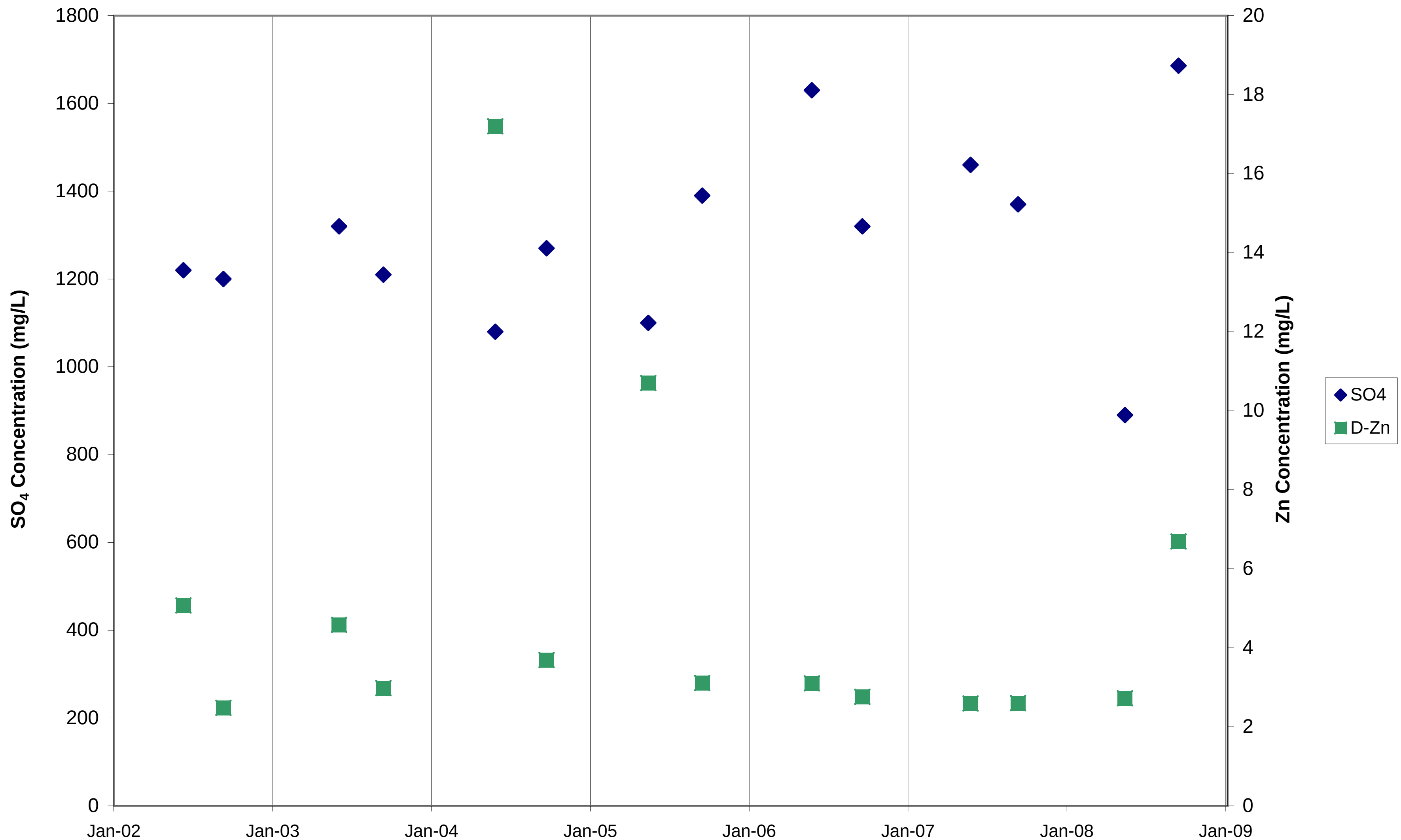
Job No: 1CD003.110 File: 2008 AMP Water Quality Figures	Faro Mine Complex	Date: December 2008 · Approved: MCC · Figure: 8



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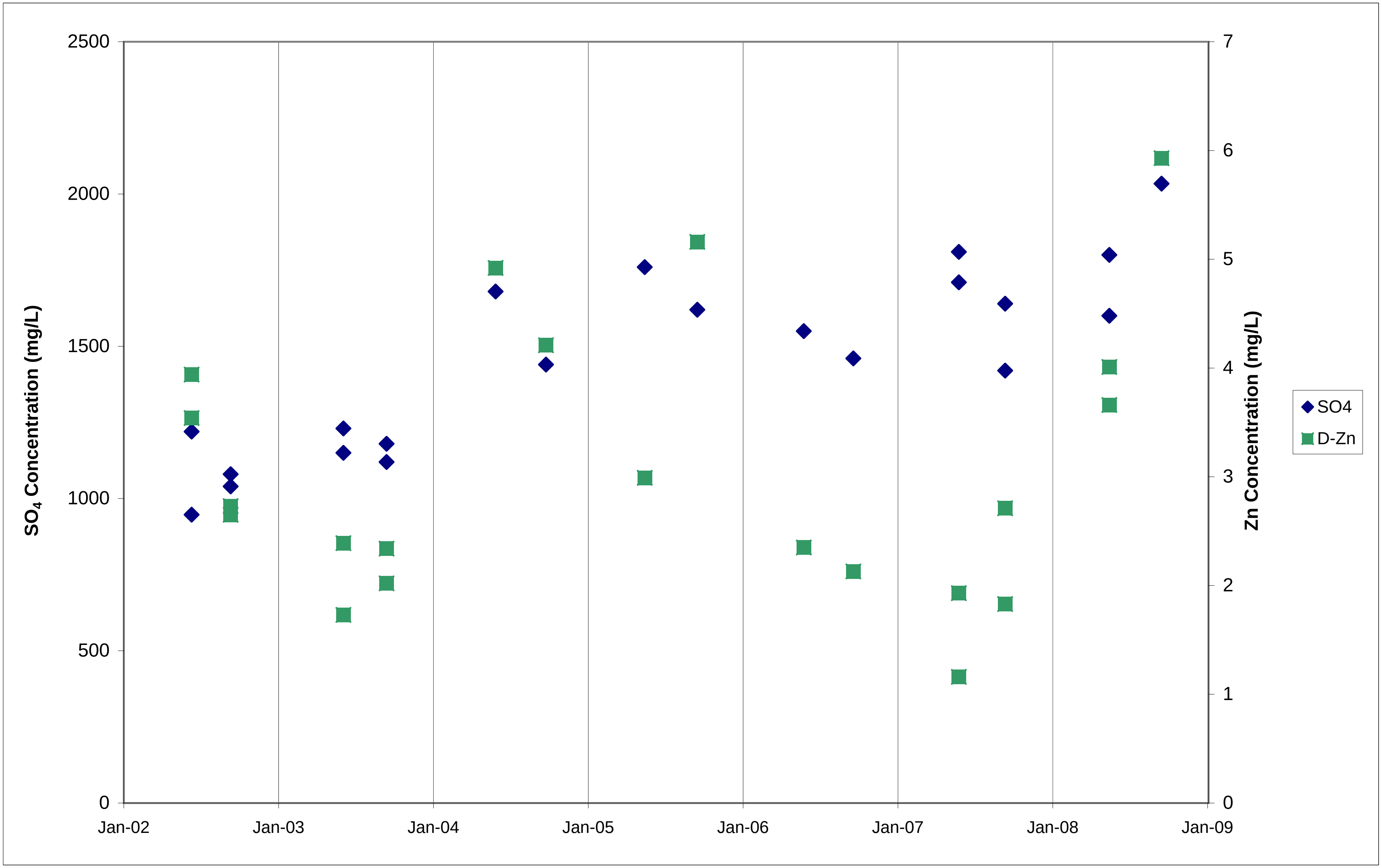
2008 AMP Event #4 Response:
Status Report

Zinc and Sulphate Concentrations at SRK-GD01

Job No: 1CD003.110
File: 2008 AMP Water Quality Figures

Faro Mine Complex

Date:	Approved:	Figure:
December 2008	MCC	9



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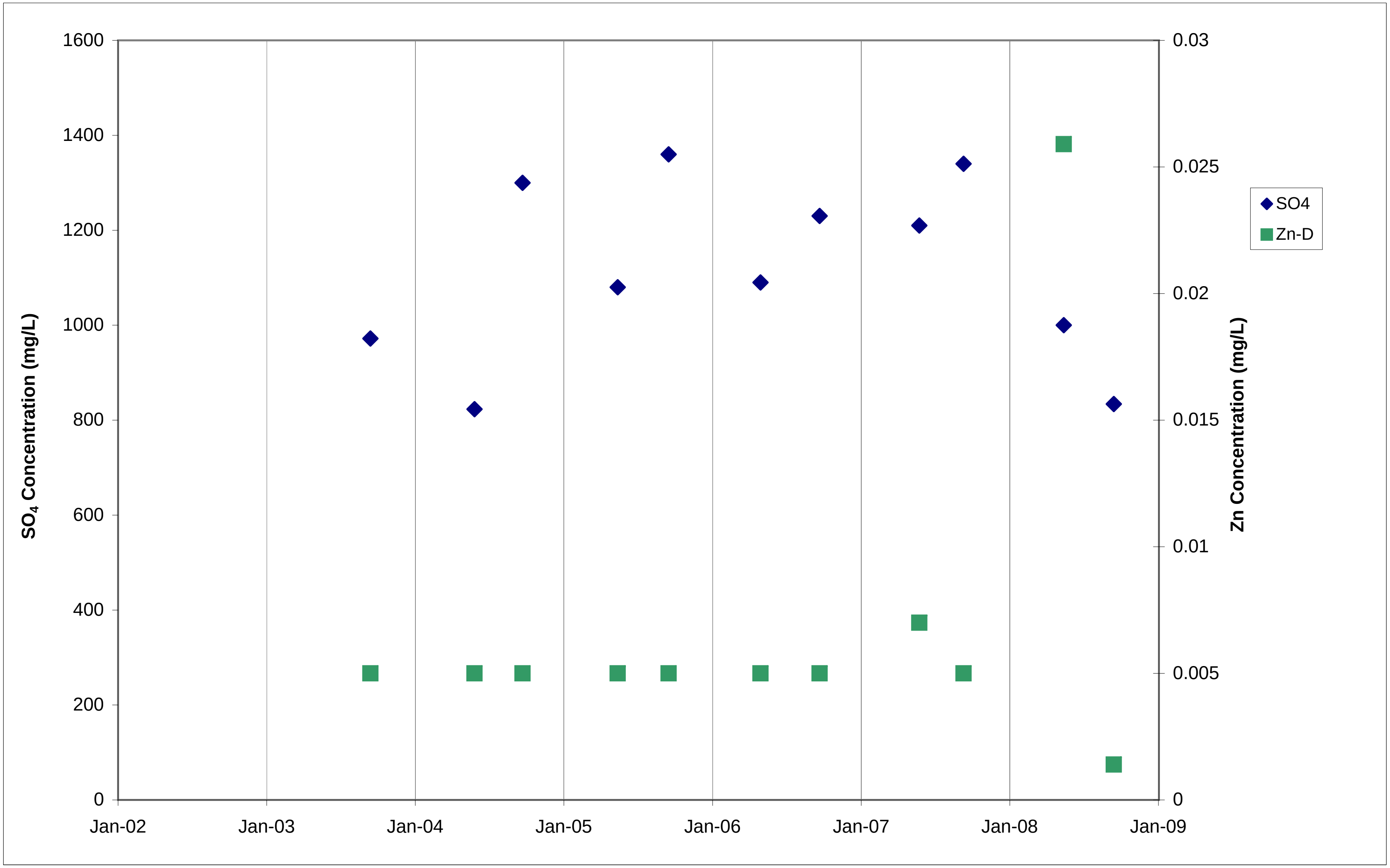
2008 AMP Event #4 Response: Status Report

Zinc and Sulphate Concentrations at SRK-GD05

Job No: 1CD003.110
File: 2008 AMP Water Quality Figures

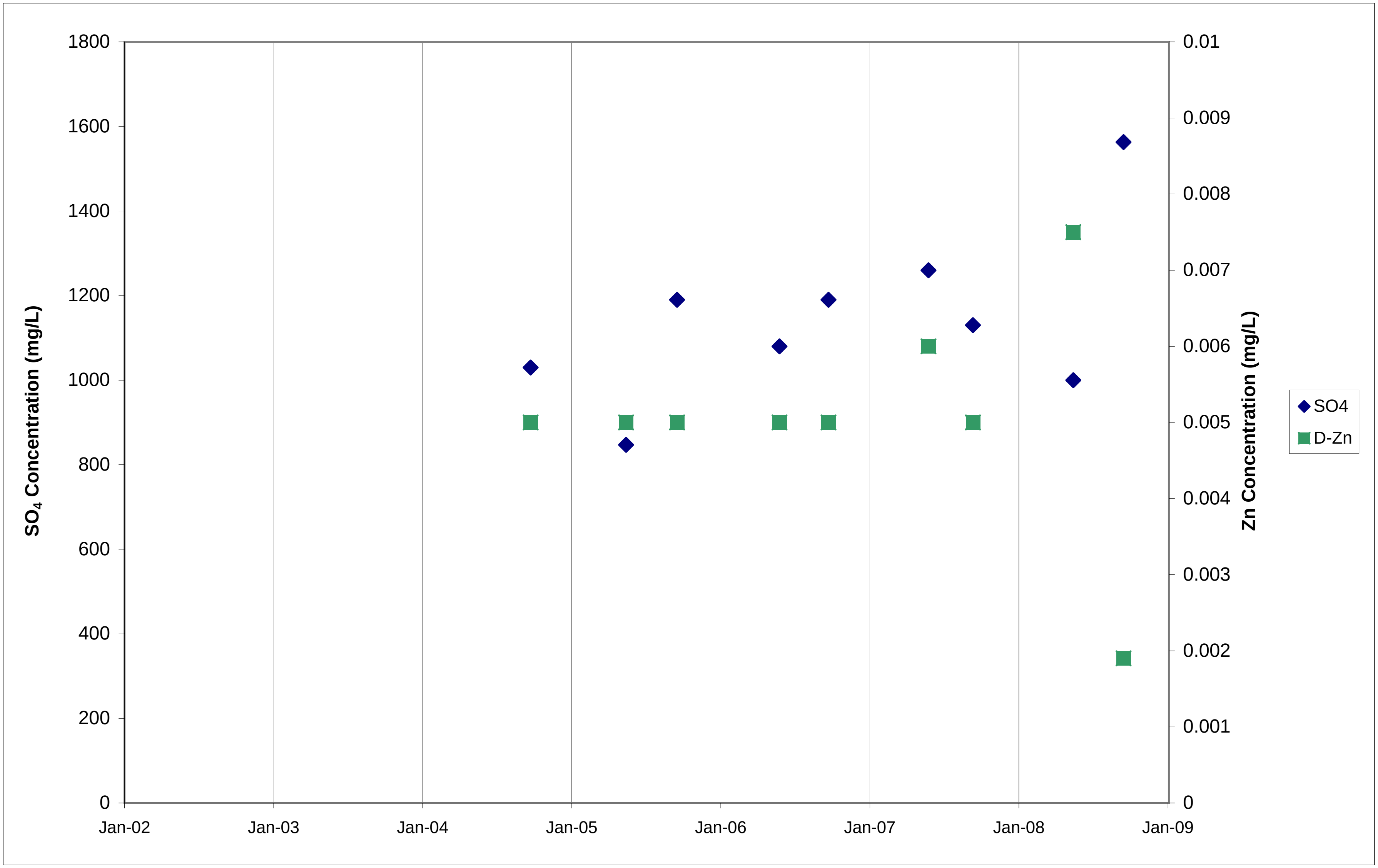
Faro Mine Complex

Date:	Approved:	Figure:
December 2008	MCC	10



Note: Dissolved zinc concentrations are plotted at the detection limit where values were reported as less than detection.

SRK Consulting Engineers and Scientists VANCOUVER	Deloitte & Touche	2008 AMP Event #4 Response: Status Report **Zinc and Sulphate Concentrations at SRK-GD05 d/s**
Job No: 1CD003.110 File: 2008 AMP Water Quality Figures	Faro Mine Complex	Date: December 2008 / Approved: MCC / Figure: **11**



Note: Dissolved zinc concentrations are plotted at the detection limit where values were reported as less than detection.

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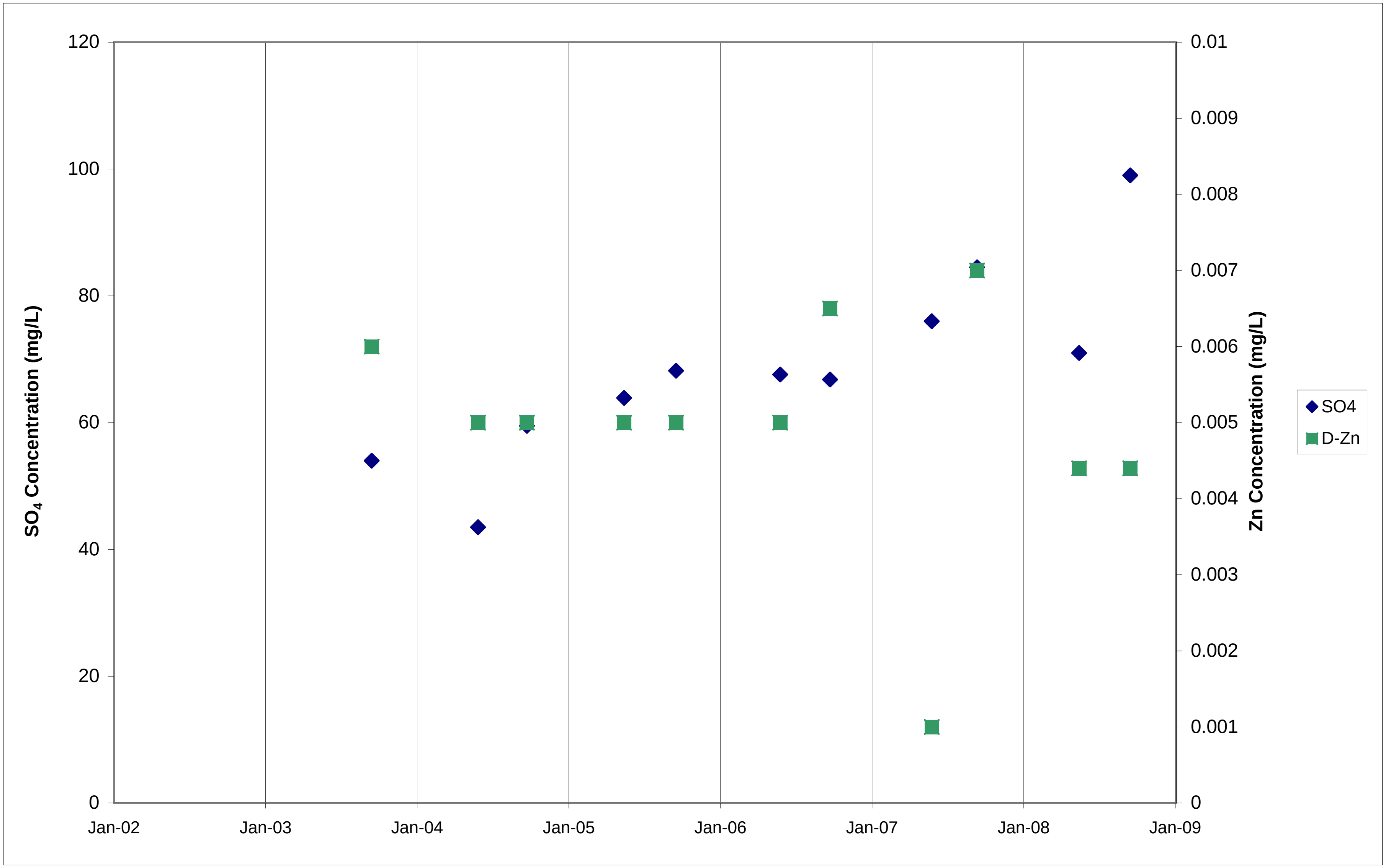
2008 AMP Event #4 Response: Status Report

Zinc and Sulphate Concentrations at Sweet Creek

Job No: 1CD003.110
File: 2008 AMP Water Quality Figures

Faro Mine Complex

Date:	Approved:	Figure:
December 2008	MCC	12



Note: Dissolved zinc concentrations are plotted at the detection limit where values were reported as less than detection.

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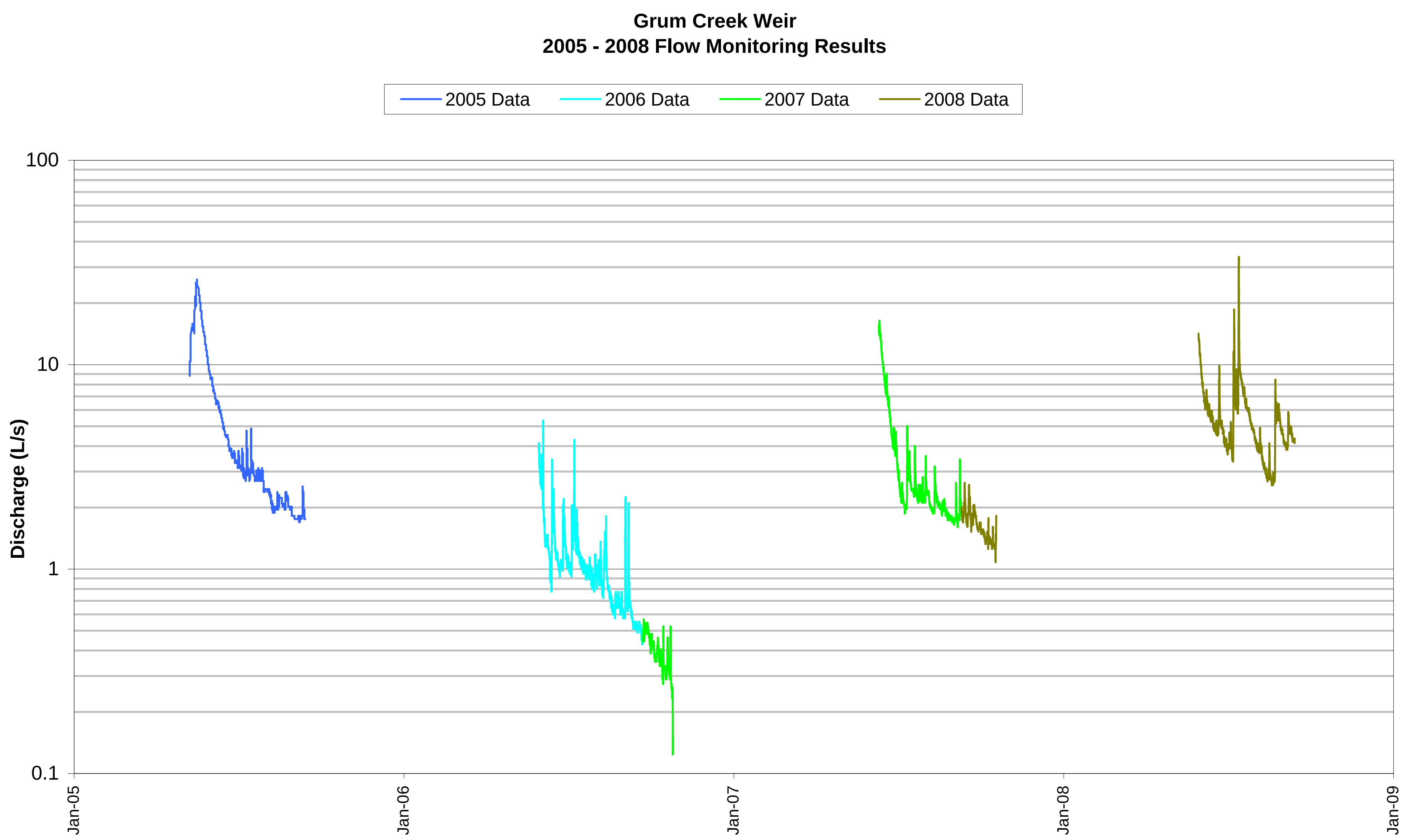
2008 AMP Event #4 Response: Status Report

Zinc and Sulphate Concentrations at Sheep Creek

Job No: 1CD003.110
File: 2008 AMP Water Quality Figures

Faro Mine Complex

Date:	Approved:	Figure:
December 2008	MCC	13



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2008 AMP Event #4 Response:
Status Report

Grum Creek Discharge

Job No: 1CD003.110
File: 2008 AMP Water Quality Figures.xls

Faro Mine Complex

Date:	Approved:	Figure:
December 2008	MCC	14

Appendices

Appendix A
Water Quality Monitoring Results

Appendix A1

2002-2008 Waste Rock Seepage Survey Results

		Field Parameters					Physical Tests		Dissolved Anions				Dissolved Metals																															
Sample ID	Date Sampled	pH (WTW)	Cond (uS/cm)	Temp (C)	ORP (mV)	Flow (L/min)	Cond (uS/cm)	Lab pH	Acidity (to pH 8.3) CaCO3	Alkalinity-Total CaCO3	Chloride Cl	Sulphate SO4	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni	P	K	Se	Si	Ag	Na	Sr	Tl	Sn	Ti	U	V	Zn
Min. detection level							2.0	0.010	1.0	1.0	0.50	0.50	0.20	0.20	0.20	0.010	0.0050	0.20	0.10	0.010	0.050	0.010	0.010	0.010	0.030	0.050	0.010	0.10	0.0050	0.030	0.050	0.30	2.0	0.20	0.050	0.010	2.0	0.0050	0.20	0.030	0.010		0.03	0.005
Units		s.u.	uS/cm	0C	mV	L/min	uS/cm	s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
SRKGD01	6/11/2002	6.69	2170	1.8	272	100	2080	7.66	38	337	1.7	1220	0.2	0.2	0.2	0.03	0.005	0.2	0.1	0.01	283	0.01	0.01	0.01	0.03	0.05	0.02	141	0.059	0.03	0.26	0.3	5	0.2	3.98	0.01	7	0.914	0.2	0.03	0.01		<0.03	5.07
SRKGD01	9/11/2002	6.91	2490	2.5	272	340	2460	7.27	69	497	1.5	1200	0.2	0.2	0.2	0.06	0.005	0.4	0.1	0.01	351	0.01	0.01	0.01	0.03	0.05	0.02	216	0.062	0.03	0.29	0.3	8	0.2	4.09	0.01	9	1.31	0.2	0.03	0.01		<0.03	2.48
SRKGD01	6/4/2003	6.93	2670	2.4	488	105	2530	7.82	25	534	2.2	1320	0.2	0.2	0.2	0.05	0.005	0.2	0.1	0.01	316	0.01	0.01	0.01	0.03	0.05	0.03	223	0.044	0.03	0.43	0.3	8	0.2	4.36	0.01	10	1.3	0.2	0.03	0.01		<0.03	4.58
SRKGD01	9/14/2003	7.26	2610	2.5	459	150	2530	8.09	16	559	2.4	1210	0.2	0.2	0.2	0.05	0.005	0.2	0.1	0.01	367	0.01	0.01	0.01	0.03	0.05	0.02	233	0.053	0.03	0.34	0.3	8	0.2	4.46	0.01	10	1.48	0.2	0.03	0.01		<0.03	2.98
SRKGD01	5/28/2004	7.71	2110	2.1	414	400	2030	7.44	44.2	255	1.17	1080	0.2	0.2	0.2	0.037	0.005	0.2	0.1	0.01	259	0.01	0.05	0.01	0.03	0.05	0.018	146	0.998	0.03	0.43	0.3	5.4	0.2	2.83	0.01	5	0.912	0.2	0.03	0.01		<0.03	17.2
SRKGD01	9/23/2004	7.06	2780	3.6	285	180	2700	7.77	23	583	5	1270	0.2	0.2	0.2	0.043	0.005	0.2	0.1	0.01	348	0.01	0.01	0.01	0.03	0.05	0.027	239	0.056	0.03	0.351	0.3	8.3	0.2	4.08	0.01	10.1	1.36	0.2	0.03	0.01		<0.03	3.69
SRKGD01	5/15/2005	7.06	2220	1.6	460	0	2170	7.69	21.8	290	5	1100	0.2	0.2	0.2	0.051	0.005	0.2	0.1	0.01	291	0.01	0.016	0.01	0.03	0.05	0.022	173	0.353	0.03	0.295	0.3	4.2	0.2	2.93	0.01	5.3	0.897	0.2	0.03	0.01		0.037	10.7
SRKGD01	9/16/2005	7.63	2540	2.9	402	100	2730	7.79	19.1	566	5	1390	0.2	0.2	0.2	0.035	0.005	0.2	0.1	0.01	332	0.01	0.01	0.01	0.03	0.05	0.022	248	0.0502	0.03	0.355	0.3	5.7	0.2	3.9	0.01	9.1	1.14	0.2	0.03	0.01		<0.050	3.11
SRKGD01	5/26/2006	6.76	2360	2.5	317	30	3130	7.85	34.9	588	5	1630	0.2	0.2	0.2	0.04	0.005	0.2	0.1	0.01	343	0.01	0.01	0.01	0.038	0.05	0.015	289	0.0828	0.03	0.336	0.3	8	0.2	3.23	0.01	11.1	1.19	0.2	0.03	0.01		<0.03	3.1
SRKGD01	9/19/2006	7.17	2420	3	187	30	2620	7.63	22.5	552	1.23	1320	0.2	0.2	0.2	0.043	0.005	0.2	0.1	0.01	317	0.01	0.01	0.01	0.03	0.05	0.03	253	0.0449	0.03	0.334	0.3	6.9	0.2	3.83	0.01	10	1.23	0.2	0.099	0.01		<0.030	2.76
SRKGD01	9/12/2007						2700	7.68	40.3	570	50	1370	0.005	1E-03	0.003	0.033	0.0025	0.003	0.05	0.0012	349	0.0025	0.0013	0.002	0.03	0.0015	0.027	274	0.0299	0.0009	0.278	0.3	7.5	0.005	4.16	5E-05	10.3	1.29	5E-04	0.0005	0.01		0.005	2.6
SRKGD01	5/26/2007	7.33	24	2.6	298	2	2880	7.61	65	535	1.28	1460	0.002	9E-04	0.003	0.033	0.0002	2E-04	0.01	0.0008	328	0.0002	0.0026	0.0033	0.77	0.0013	0.032	280	0.03	0.0012	0.337	0.03	7.18	0.003	4.57	5E-05	10.3	1.19	3E-04	0.0002	0.0005		0.0005	2.59
SRKGD01	5/15/2008	7.78	2100	2.1	72	20	2100	8.2	8.9	350	1.4	890	0.002	9E-04	0.003	0.032	ND	ND	ND	0.002	255	ND	0.0018	0.003	0.009	0.001	0.0245	182	0.0236	0.0013	0.213	ND	6.28	0.001	3.59	ND	6.99	0.908	3E-04	ND	ND	0.0287	ND	2.72
SRKGD01	9/15/2008	6.78	1988	3.6	187	300	2700	7.9	58.1	430	1.6	1686	0.003	0.001	0.003	0.028	ND	ND	ND	0.0021	355	ND	0.0047	0.0021	0.011	0.0013	0.03	286	0.0593	0.0012	0.411	ND	6.57	0.001	4.05	ND	9.26	1.23	3E-04	ND	0.003	0.0428	ND	6.69
SRKGD05	6/11/2002	7.74	2670	3.1	273	7.5	2570	8.14	13	527	2.2	1220	0.2	0.2	0.2	0.03	0.005	0.2	0.1	0.01	358	0.01	0.01	0.01	0.03	0.05	0.04	211	0.189	0.03	0.59	0.3	8	0.2	5.66	0.01	14	1.52	0.2	0.03	0.01		<0.03	3.54
SRKGD05	9/11/2002	7.45	2550	3.7	292	30	2470	7.88	28	600	1.9	1080	0.2	0.2	0.2	0.02	0.005	0.3	0.1	0.01	349	0.01	0.01	0.01	0.03	0.05	0.03	199	0.008	0.03	0.51	0.3	7	0.2	6.06	0.01	11	1.41	0.2	0.03	0.01		<0.03	2.65
SRKGD05B	6/4/2003	7.8	2550	3.9	421	20	2480	8.04	15	638	2.4	1230	0.2	0.2	0.2	0.03	0.005	0.2	0.1	0.01	312	0.01	0.01	0.01	0.03	0.05	0.03	199	0.007	0.03	0.38	0.3	7	0.2	5.51	0.01	12	1.36	0.2	0.03	0.01		<0.03	1.73
SRKGD05B	9/14/2003	7.84	2610	1.7	402	21	2510	8.11	14	627	2.8	1180	0.2	0.2	0.2	0.03	0.005	0.2	0.1	0.01	337	0.01	0.01	0.01	0.03	0.05	0.03	212	0.013	0.03	0.44	0.3	7	0.2	5.66	0.01	11	1.48	0.2	0.03	0.01		<0.03	2.02
SRKGD05	5/28/2004	7.83	3180	4.9	399	20	2960	8.03	19.9	583	2.09	1680	0.2	0.2	0.2	0.038	0.005	0.2	0.1	0.01	392	0.01	0.01	0.01	0.03	0.05	0.043	269	0.0931	0.03	0.644	0.3	7.8	0.2	5.48	0.01	12.8	1.68	0.2	0.033	0.01		<0.03	4.92
SRKGD05	9/24/2004	7.64	3010	4.7	577	10	2930	8.01	4.8	609	5	1440	0.2	0.2	0.2	0.034	0.0056	0.2	0.1	0.01	361	0.01	0.01	0.01	0.03	0.05	0.052	263	0.009	0.03	0.705	0.3	8.3	0.2	5.07	0.01	13.5	1.6	0.2	0.03	0.01		<0.03	4.21
SRKGD05	5/15/2005	7.96	2520	3.7	413	8	3240	8.14	10.3	541	0.5	1760	0.2	0.2	0.2	0.026	0.005	0.2	0.1	0.01	363	0.01	0.01	0.01	0.03	0.05	0.044	298	0.013	0.03	0.54	0.3	6.4	0.2	3.9	0.01	12.8	1.42	0.2	0.03	0.01		0.059	2.99
SRKGD05	9/16/2005	7.86	2550	6	386	3.6	3010	8.1	9.6	610	5	1620	0.2	0.2	0.2	0.029	0.005	0.2	0.1	0.01	477	0.01	0.01	0.01	0.03	0.05	0.056	341	0.0127	0.03	0.917	0.3	8.9	0.2	6.25	0.011	17.9	1.81	0.2	0.03	0.01		<0.07	5.16
SRKGD05	5/25/2006	7.71	2350	5.2	97	3.7	2950	8.07	22.3	586	2.5	1550	0.2	0.2	0.2	0.029	0.005	0.2	0.1	0.01	391	0.01	0.01	0.01	0.03	0.05	0.034	302	0.0064	0.03	0.493	0.3	7.5	0.2	4.74	0.01	16	1.7	0.2	0.03	0.01		<0.03	2.35
SRKGD05	9/19/2006	8.06	2420	4.7	174	4	2820	8	10.4	589	5	1460	0.2	0.2	0.2	0.017	0.005	0.2	0.1	0.01	310	0.01	0.01	0.01	0.03	0.05	0.034	234	0.005	0.03	0.448	0.3	5.5	0.2	4.29	0.01	11.2	1.17	0.2	0.092	0.01		<0.03	2.13
SRKGD05	5/26/2007	7.98	242	9.1	356	2	3730	7.89	39	538	2.08	1810	0.001	0.002	0.005	0.021	0.0002	2E-04	0.01	0.0003	433	0.0002	0.001	0.0027	0.8	0.0008	0.033	330	0.0048	0.0012	0.413	0.03	6.74	0.003	5.84	5E-05	13.5	1.59	4E-04	0.0002	0.0005		0.0006	1.16
SRKGD05	9/12/2007						2880	8.08	17	592	50	1640	0.005	0.002	0.005	0.017	0.0025	0.003	0.05	0.0006	375	0.0025	0.0006	0.0016	0.03	0.0015	0.038	284	0.00589	0.001	0.413	0.3	7	0.005	5.3	5E-05	13.3	1.48	5E-04	0.0005	0.01		0.005	1.83
GD05	5/15/2008	8.17	3200	4.4	65	1	3200	8.3	ND	460	1.8	1800	0.004	0.002	0.004	0.029	ND	ND	ND	0.0019	414	ND	0.0044	0.0024	0.028	0.0011	0.048	312	0.0347	0.0013	0.348	ND	7.3	0.002	4.1	ND	11.2	1.33	5E-04	ND	ND	0.0462	ND	3.66
GD05dup	9/15/2008	7.47	2595	4.1	182	7.2	3400	7.7	32.6	600	2.1	2034	ND	ND	0.008	0.03	ND	ND	ND	0.0025	432	ND	0.0024	ND	ND	0.0019	ND	354	0.131	ND	0.632	ND	8	ND	ND	ND	14	1.69	3E-04	ND	0.086	0.056	ND	5.93
SRKGD06	6/11/2002	7.62	2640	3.5	269	15	2540	8.1	17	557	2.5	947	0.2	0.2	0.2	0.03	0.005	0.3	0.1	0.01	361	0.01	0.01	0.01	0.03	0.05	0.04	209	0.23	0.03	0.52	0.3	9	0.2	5.87	0.01	14	1.56	0.2	0.04	0.01		<0.03	3.94
SRKGD06	9/11/2002	7.35	2540	3.1	314	30	2480	8	26	700	1.8	1040	0.2	0.2	0.2	0.03	0.005	0.3	0.1	0.01	348	0.01	0.01	0.01	0.03	0.05	0.02	196	0.008	0.03	0.42	0.3	7	0.2	6.07	0.01	11	1.39	0.2	0.03	0.01		<0.03	2.73
SRKGD06	6/4/2003	7.67	2510	3.1	473	0	2430	8.02	18	643	2.6	1150	0.2	0.2	0.2	0.03	0.005	0.2	0.1	0.01	337	0.01	0.01	0.01	0.03	0.05	0.03	214	0.011	0.03	0.38	0.3	7	0.2	6.15	0.01	13	1.49	0.2	0.03	0.01		<0.03	2.39
SRKGD06	9/14/2003	7.74	2540	3.1	486	15	2500	8.28	1	646	2.5	1120	0.2	0.2	0.2	0.03	0.005	0.2	0.1	0.01	325	0.01	0.01	0.01	0.03	0.05	0.03	199	0.008	0.03	0.41	0.3	7	0.2	5.64	0.01	11	1.41	0.2	0.03	0.01		<0.03	2.34
SRKGD06	5/26/2007	7.69	243	3.4	321	trace	3570	7.95	40	677	2.08	1710	0.001	0.001	0.005	0.026	0.0002	2E-04	0.01	0.0007	466	0.0002	0.0004	0.0021	0.71	0.0008	0.028	320	0.0016	0.0006	0.428	0.03	6.4	0.003	5.87	5E-05	12.3	1.63	3E-04	0.0002	0.0005		0.0008	1.93
SRKGD06	9/12/2007						2820	8.04	21.9	635	50	1420	0.005	0.001	0.004	0.019	0.0025	0.003	0.05	0.0015	385	0.0025	0.0005	0.002	0.03	0.001	0.035	272	0.00272	0.0005	0.449	0.3	6.8	0.005	5.52	5E-05	13.4	1.47	5E-04	0.0005	0.01		0.005	2.71
GD06	5/15/2008	7.86	3300	3.2	85	2	3100	8.3	1.8	610	2.4	1600	0.002	0.001	0.005	0.026	ND	ND	ND	0.002	469	ND	0.0014	0.0016	0.011	0.0016	0.038	293	0.0113	0.0006	0.547	ND	7.37	ND	5.42	ND	13.6	1.57	4E-04	ND	ND	0.0516	ND	4.01
SRK-GD16	5/28/2004	7.47	3280	3.4	504	30	3040	7.72	43	619	2.14	1680	<0.2	<0.2	<0.2	0.041	<0.005	<0.2	<0.1	<0.01	382	<0.01	0.03	<0.01	<0.03	<0.05	0.048	253	1.75	<0.03	0.701	<0.3	7	<0.2	4.59	<0.01	12	1.67	<0.2	<0.03	<0.01		<0.03	10.4
SRK-GD16	5/18/2005	7.28			439	2.1	3480	7.62	93.2	602	<5.0	2090	<0.20	<0.20	<0.20	0.032	<0.0050	<0.20	<0.10	0.089	416	<0.010	0.096	0.026	<0.030	<0.050	0.045	338	4.93	<0.030	0.501	<0.30	6.1	<0.20	6.71	<0.010	15.4	1.69	<0.20	<0.030	<0.010		<0.030	59.9
SRK-GD16	5/26/2007	7.6	24	3.6	322	trace	3710	7.67	92.0	659	2.6	1730	0.002	6E-04	0.005	0.027	-0.0002	-0	-0.01	0.008	461	-2E-04	0.008	0.004	0.86	0.0049	0.022	302	0.69	0.0008	0.214	-0.03	4.3	0.003	8.28	-5E-05	12.9	1.51	6E-04	-2E-04	0.0006		0.0007	16.5
GD16	5/15/2008	7.45	4300	2	160	trickle	5000	7.50	151.0	290	1	4100	0.003	9E-04	0.002	0.044	ND	ND	ND	0.045	462	ND	0.186	0.004	0.015	0.0073	0.087	570	1.73	0.0034	0.803	ND	7.0	0.009	3.99	ND	09.8	1.81	9E-04	ND	ND	0.0329	ND	139
SRK-GD04	6/11/2002	7.6	3260	2.5	248	1.5	3220	8.06	18	477	1.9	1350	<0.2	<0.2	<0.2	0.02	<0.005	<0.2	<0.1	<0.01	352	<0.01	0.03	<0.01	<0.03	<0.05	0.04	347	0.207	<0.03	0.42	<0.3	10	<0.2	3.65	<0.01	16	1.59	<0.2	<0.03	<0.01		<0.03	3.68
SRK-GD21	5/28/2004	7.47	3390	3.4	394	7.5	3140	7.86	27.6	393	1.26	1990	<0.2	<0.2	<0.2	0.036	<0.005	<0.2	<0.1	<0.01	315	<0.01	0.026	<0.01	<0.03	<0.05	0.066	403	0.271	<0.03	0.345	<0.3	12.3	<0.2	2.3	<0.01	14.9	1.53	<0.2	<0.03	<0.01		<0.03	2.52
SRK-GD21	9/24/2004	7.1	3860	4	536	Trace	3770	8.1	6.3	628	<5	2170	<0.2	<0.2	<0.2	0.016	<0.005	<0.2	<0.1	<0.01	365	<0.01	<0.01	<0.01	<0.03	<0.05	0.041	438	0.0619	<0.03	0.409	<0.3	10	<0.2	3.89	<0.01	17.1	1.63	<0.2	<0.03	<0.01		<0.03	1.82
SRK-GD21	5/15/2005	7.74	2490	2.7	438	6	2950	8.10	7.9	356	<5.0	1770	<0.20	<0.20	<0.20	0.025	<0.0050	<0.20	<0.10	<0.010	277	<0.010	0.012	<0.010	<0.030	<0.050	0.047	340	0.0983	<0.030	0.290	<0.30	8.2	<0.20	1.66	<0.010	11.4	1.16	<0.20	<0.030	<0.010		0.053	2.63
SRK-GD21	5/25/2006	7.85	2370	10.5	118	trace	2890	8.08	9.8	400	<2.5	1670	<0.2	<0.2	<0.2	0.018	<0.005	<0.2	<0.1	<0.01	287	<0.01	0.014	<0.01	<0.03	<0.05	0.043	342	0.0643	<0.03	0.330	<0.3	10.0	<0.2	2.18	<0.01	12.2	1.28	<0.2	<0.03	<0.01		<0.03	3.42
SRK-GD21	5/26/2007	8.14	242	11	364	trickle	3500	8.17	8.0	470	-2	1820	0.001	0.002	0.003	0.020	-0.0002	-0	-0.01	0.0008	346	-2E-04	0.006	0.0023	0.63	0.0008	0.034	362	0.0190	0.0033	0.253	-0.03	8.3	0.005	3.24	-5E-05	10.8	1.34	5E-04	-2E-04	0.0004		0.0006	1.08
GD21B	9/15/2008	6.83	3012	6.7	196	Trace	3600	8.00	37.9	340	0.9	2496	0.003	0.002	0.005	0.017	ND	ND	ND	0.0025	443	ND	0.001	0.0017	0.008	0.004	0.052	396	0.0839	0.0007	0.213	ND	10.6	0.001	3.44	ND	11.7	1.48	0.000	ND	0.003	0.0215	ND	6.58

Appendix A2
2003-2008 Downgradient Seepage Pathways South of Grum Dump

Appendix A2: Water Quality of Downgradient Seepage Pathways South of Grum Dump

Sample ID	Date Sampled	Field Parameters pH	Conducti	Temperat	ORP	Flow	Physical Tests Conductivity	pH	Dissolved Anions Acidity (	Alkalini	Cl	SO4	Dissolved Metals Al	Sb	As	Ba	Be	Bi	B	Cd	Ca
			uS/cm	°C	mV	L/min	uS/cm		mg CaC(	mg CaC	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
						Method Detection Limit:	2.0	0.010	1.0	1.0	0.50	0.50	0.20	0.20	0.20	0.010	0.0050	0.20	0.10	0.010	0.050
GD05 D/S	9/15/2003	7.66	2140	3.7	424	60	2070	8.11	15	421	2.4	972	0.2	0.2	0.2	0.06	0.005	0.2	0.1	0.01	277
GD05 D/S	5/28/2004	7.79	1884	2.9	190	30	1760	8.13	6.6	373	2.03	823	0.2	0.2	0.2	0.052	0.005	0.2	0.1	0.01	264
GD05 D/S	9/23/2004	6.9	2430	4.3	69	2.25	2390	8.07	8	434	5	1300	0.2	0.2	0.2	0.06	0.006	0.2	0.1	0.01	330
GD05 D/S	5/15/2005	7.94	2170	3.6	478	0	2200	8.1	7.5	406	5	1080	0.2	0.2	0.2	0.048	0.005	0.2	0.1	0.01	305
GD05 D/S	9/17/2005						2480	8.07	8.8	449	5	1360	0.2	0.2	0.2	0.057	0.005	0.2	0.1	0.01	340
GD05 D/S	5/1/2006	7.71	2350	5.2	97	3.7	2290	8.17	7.4	416	1.58	1090	0.2	0.2	0.2	0.034	0.005	0.2	0.1	0.01	332
GD05 D/S	9/23/2006	8.02	2480	4.3	0	1	2510	8.15	8.4	466	3.4	1230	0.2	0.2	0.2	0.043	0.005	0.2	0.1	0.01	301
GD05 D/S	5/26/2007	7.74	22	1.4	38	trace	2370	7.87	27	354	1.66	1210	0.001	2E-04	0.001	0.029	0.0002	2E-04	0.01	1E-05	309
GD05 D/S	9/12/2007						2630	8.05	14.7	484	2.03	1340	0.005	5E-04	0.001	0.0403	0.0025	0.003	0.05	0.0003	364
GD05 D/S	5/15/2008	8.24	2400	0.1	95	4	8.2	2200	9.5	390	2	1000	0.004	2E-04	0.001	0.0328	ND	ND	ND	4E-05	288
GD05 D/S	9/15/2008	7.9	5	2145	144	14	8.1	2800	15.4	480	2	834	0.002	1E-04	6E-04	0.0217	ND	ND	ND	ND	194
Moose Seep	9/15/2003	7.61	1310	3.4	406	1	1280	8.2	5	288	1.5	522	0.2	0.2	0.2	0.05	0.005	0.2	0.1	0.01	174
Moose Seep	5/28/2004	7.79	465	3.6	167	Trace	1120	8.08	5.2	236	1.52	427	0.2	0.2	0.2	0.057	0.005	0.2	0.1	0.01	157
Moose Seep	9/22/2004	7.32	1573	6.4	48	1	1540	8.08	5.4	296	5	728	0.2	0.2	0.2	0.078	0.006	0.2	0.1	0.01	235
Moose Seep	5/18/2005	7.7	0	0	415	0	1240	8.2	3	245	0.79	494	0.2	0.2	0.2	0.048	0.005	0.2	0.1	0.01	168
Moose Seep	9/17/2005						1590	8.05	6.8	320	5	748	0.2	0.2	0.2	0.087	0.005	0.2	0.1	0.01	293
Sheep Seep	9/15/2003	7.3	557	2.4	450	45	539	8.36	1	262	0.7	54	0.2	0.2	0.2	0.17	0.005	0.2	0.1	0.01	88.5
Sheep Seep	5/28/2004	7.51	458	1.9	208	270	420	8.24	1.6	205	0.72	43.5	0.2	0.2	0.2	0.135	0.005	0.2	0.1	0.01	72
Sheep Seep	9/23/2004	8.02	571	4.1	76	4.5	580	8.36	1	268	2.5	59.5	0.2	0.2	0.2	0.171	0.005	0.2	0.1	0.01	89
Sheep Creek	5/15/2005	8.34	576	2.4	434	0	581	8.34	1	269	0.5	63.9	0.2	0.2	0.2	0.176	0.005	0.2	0.1	0.01	96.2
Sheep Creek	9/17/2005						565	8.28	1	294	0.5	68.2	0.2	0.2	0.2	0.195	0.005	0.2	0.1	0.01	105
Sheep Creek	9/23/2006	8.35	589	3.4	0	3	561	8.23	3.5	254	0.5	66.8	0.2	0.2	0.2	0.197	0.005	0.2	0.1	0.01	101
Sheep Creek	5/26/2006	7.83	575	0.7	188	1	558	8.32	1	258	0.5	67.6	0.2	0.2	0.2	0.144	0.005	0.2	0.1	0.01	92.9
Sheep Creek	5/26/2007	7.86	567	1.6	47	2	512	8.15	4	247	0.4	76	0.001	2E-04	5E-04	0.109	0.0002	2E-04	0.01	1E-05	94.1
Sheep Creek	9/12/2007						582	8.24	1.5	265	0.5	84.5	0.0021	2E-04	3E-04	0.166	0.001	0.001	0.02	0.0001	101
Sheep Creek	5/15/2008	8.28	500	4	49	20	8.4	480	ND	190	0.7	71	0.003	1E-04	3E-04	0.128	ND	ND	ND	2E-05	77.5
Sheep Creek	9/15/2008	8	5.2	405	146	60	8.3	550	ND	220	0.9	99	0.004	1E-04	4E-04	0.13	ND	ND	ND	2E-05	98.9
Sweet Creek	9/23/2004	8.03	2260	4.3	114	90	2180	8.1	7.4	418	5	1030	0.2	0.2	0.2	0.071	0.005	0.2	0.1	0.01	336
Sweet Creek	5/15/2005	8.11	1935	3	474	0	1930	8.12	6.5	417	5	847	0.2	0.2	0.2	0.055	0.005	0.2	0.1	0.01	305
Sweet Creek	9/17/2005	0	0	0	0	0	2300	8.1	8	390	5	1190	0.2	0.2	0.2	0.065	0.005	0.2	0.1	0.01	349
Sweet Creek	5/26/2006	7.85	2230	4.3	141	39.25	2210	8.14	10.4	428	0.5	1080	0.2	0.2	0.2	0.043	0.005	0.2	0.1	0.01	329
Sweet Creek	9/23/2006	8.31	2450	3	0	40.8	2330	8.04	12.9	448	1.68	1190	0.2	0.2	0.2	0.055	0.005	0.2	0.1	0.01	351
Sweet Creek	5/26/2007	7.66	231	3.3	44	15	2440	7.9	20	438	2.25	1260	0.001	2E-04	8E-04	0.044	0.0002	2E-04	0.01	1E-05	365
Sweet Creek	9/12/2007						2490	8.11	12.1	483	2.17	1130	0.005	5E-04	5E-04	0.0444	0.0025	0.003	0.05	0.0003	380
Sweet Creek	5/15/2008	8.34	2200	1	41	50	8.2	2300	9.5	410	1.9	1000	0.002	3E-04	6E-04	0.0395	ND	ND	ND	ND	331
Sweet Creek	9/15/2008	8.19	4.5	2016	155	240	8.1	2700	11.4	480	2.1	1563	0.002	3E-04	6E-04	0.0557	ND	ND	ND	ND	418
WTA02	9/23/2004	8.05	450	5	69	1	447	8.39	1	232	2.5	18	0.2	0.2	0.2	0.093	0.005	0.2	0.1	0.01	81.3
WTA02	5/18/2005	7.55	0	0	389	0	931	8.2	3.3	258	0.55	286	0.2	0.2	0.2	0.126	0.005	0.2	0.1	0.01	152
WTA02	5/26/2006	8	413	13.8	160	trace	414	7.17	34.5	203	0.5	19.8	0.2	0.2	0.2	0.123	0.005	0.2	0.1	0.01	85.1
WTA02	9/24/2006	8.16	427	0.4	0	2	412	8.24	3	220	0.5	19.4	0.2	0.2	0.2	0.088	0.005	0.2	0.1	0.01	76.7
WTA02	5/26/2007	8.8	47	12.1	33	trickle	350	8.23	0.5	210	0.2	25.1	0.002	2E-04	4E-04	0.092	0.0002	2E-04	0.01	1E-05	77
WTA02	9/12/2007						452	7.99	7.2	236	0.5	23.3	0.001	1E-04	1E-04	0.092	0.0005	5E-04	0.01	5E-05	89.4
WTA02	5/15/2008	8.34	410	3.2	53	0.5	8.4	390	ND	180	ND	24	0.0058	2E-04	2E-04	0.0791	ND	ND	ND	ND	74.8
WTA02	9/15/2008	7.9	5.8	308	159	10	8.3	420	ND	220	ND	21	0.0017	1E-04	2E-04	0.0921	ND	ND	ND	5E-06	80.8
WGD01	9/23/2004	7.71	1115	6.8	64	2	1120	8.18	2.6	277	5	384	0.2	0.2	0.2	0.165	0.005	0.2	0.1	0.01	172
WGD01	9/16/2005						1100	8.13	3.8	286	0.82	380	0.2	0.2	0.2	0.173	0.005	0.2	0.1	0.01	186
WGD01	5/26/2006	7.62	1008	8.1	282	trace	1010	8.07	10.1	278	0.62	308	0.2	0.2	0.2	0.102	0.005	0.2	0.1	0.01	158
WGD01	9/23/2006	8.14	1144	4.5	0	2	1130	8.21	4.5	278	0.89	358	0.2	0.2	0.2	0.13	0.005	0.2	0.1	0.01	190
WGD01	5/26/2007	8.1	882	4.5	44	trickle	856	8.03	10	245	0.46	252	0.002	2E-04	4E-04	0.091	0.0002	2E-04	0.01	1E-05	144
WGD01	9/12/2007						1060	8.08	6	268	0.97	365	0.0037	2E-04	2E-04	0.0847	0.001	0.001	0.02	0.0001	171
WGD01	5/15/2008	8	1200	4.7	86	2	8.3	1000	ND	260	0.6	330	0.0033	2E-04	2E-04	0.163	ND	ND	ND	1E-05	173
WGD01	9/15/2008	7.73	7.9	984	173	3	8.1	1300	5.3	270	0.9	2955	0.0171	7E-04	0.001	0.946	0.00002	ND	ND	9E-05	1200

Sample ID	Date Sampled	Cr	Co	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni	P	K	Se	Si	Ag	Na	Sr	Tl	Sn	Ti	U	V	Zn
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Method Detection Limit:		0.010	0.010	0.010	0.030	0.050	0.010	0.10	0.0050	0.030	0.050	0.30	2.0	0.20	0.050	0.010	2.0	0.0050	0.20	0.030	0.010		0.030	0.0050
GD05 D/S	9/15/2003	0.01	0.01	0.01	0.03	0.05	0.01	166	0.005	0.03	0.05	0.3	3	0.2	5.84	0.01	10	1.04	0.2	0.03	0.01		0.03	0.005
GD05 D/S	5/28/2004	0.01	0.01	0.01	0.03	0.05	0.01	129	0.005	0.03	0.05	0.3	2.6	0.2	5.4	0.01	8.4	0.985	0.2	0.03	0.01		0.03	0.005
GD05 D/S	9/23/2004	0.01	0.01	0.01	0.03	0.05	0.013	192	0.005	0.03	0.05	0.3	2.6	0.3	6.06	0.02	11.7	1.21	0.2	0.03	0.01		0.03	0.005
GD05 D/S	5/15/2005	0.01	0.01	0.01	0.03	0.05	0.011	171	0.005	0.03	0.05	0.3	2.3	0.2	5	0.01	9.8	1.03	0.2	0.03	0.01		0.046	0.005
GD05 D/S	9/17/2005	0.01	0.01	0.01	0.03	0.05	0.015	217	0.005	0.03	0.05	0.3	2.9	0.2	5.94	0.01	12.3	1.17	0.2	0.03	0.01		0.055	0.005
GD05 D/S	5/1/2006	0.01	0.01	0.01	0.03	0.05	0.01	184	0.0056	0.03	0.05	0.3	3.5	0.2	5.43	0.01	11	0.978	0.2	0.03	0.01		0.03	0.005
GD05 D/S	9/23/2006	0.01	0.01	0.01	0.03	0.05	0.017	191	0.005	0.03	0.05	0.3	2.8	0.2	5.32	0.01	10.9	0.982	0.2	0.079	0.01		0.03	0.005
GD05 D/S	5/26/2007	0.0002	0.0002	0.0013	0.43	0.0002	0.009	216	0.0048	0.0005	0.0009	0.03	3.42	0.002	5.69	0.00005	9.07	0.975	0.00002	0.0002	0.0004	0.022	0.0005	0.007
GD05 D/S	9/12/2007	0.0025	0.0005	0.0007	0.03	0.00025	0.025	233	0.00049	0.0005	0.0025	0.3	3.7	0.005	6.3	0.00005	12.8	1.25	0.0005	0.0005	0.011	0.0366	0.005	0.005
GD05 D/S	5/15/2008	ND	0.0001	0.0009	0.02	0.00021	0.012	157	0.0014	ND	0.0007	ND	ND	4E-04	5.04	ND	8.69	1.05	ND	ND	ND	0.0313	ND	0.0259
GD05 D/S	9/15/2008	ND	ND	0.0005	0.005	0.0001	0.008	127	ND	ND	0.0005	ND	2.04	ND	3.15	ND	6.52	0.663	ND	ND	ND	0.0205	ND	0.0014
Moose Seep	9/15/2003	0.01	0.01	0.01	0.03	0.05	0.01	72.9	0.005	0.03	0.05	0.3	2	0.2	4.84	0.01	7	0.491	0.2	0.03	0.01		0.03	0.006
Moose Seep	5/28/2004	0.01	0.01	0.01	0.03	0.05	0.01	62.6	0.005	0.03	0.05	0.3	2.1	0.2	4.38	0.01	6.1	0.453	0.2	0.03	0.01		0.03	0.005
Moose Seep	9/22/2004	0.01	0.01	0.01	0.03	0.05	0.01	97.6	0.005	0.03	0.05	0.3	2.1	0.3	5.45	0.02	7.8	0.679	0.2	0.03	0.01		0.03	0.0064
Moose Seep	5/18/2005	0.01	0.01	0.01	0.03	0.05	0.01	69.2	0.005	0.03	0.05	0.3	2	0.2	3.81	0.01	5	0.433	0.2	0.03	0.01		0.03	0.005
Moose Seep	9/17/2005	0.01	0.01	0.01	0.03	0.05	0.01	117	0.0055	0.03	0.05	0.3	2.3	0.2	6.1	0.01	8.3	0.73	0.2	0.03	0.01		0.04	0.0081
Sheep Seep	9/15/2003	0.01	0.01	0.01	0.03	0.05	0.01	21	0.005	0.03	0.05	0.3	2	0.2	4.73	0.01	2	0.369	0.2	0.03	0.01		0.03	0.006
Sheep Seep	5/28/2004	0.01	0.01	0.01	0.03	0.05	0.01	15.9	0.005	0.03	0.05	0.3	2	0.2	4.48	0.01	2	0.297	0.2	0.03	0.01		0.03	0.005
Sheep Seep	9/23/2004	0.01	0.01	0.01	0.03	0.05	0.01	19.7	0.005	0.03	0.05	0.3	3	0.3	4.61	0.02	2.4	0.364	0.2	0.03	0.01		0.03	0.005
Sheep Creek	5/15/2005	0.01	0.01	0.01	0.03	0.05	0.01	23.3	0.005	0.03	0.05	0.3	2	0.2	3.77	0.01	2	0.394	0.2	0.03	0.01		0.03	0.005
Sheep Creek	9/17/2005	0.01	0.01	0.01	0.03	0.05	0.01	23.6	0.005	0.03	0.05	0.3	2	0.2	4.9	0.01	2.2	0.414	0.2	0.03	0.01		0.03	0.005
Sheep Creek	9/23/2006	0.01	0.01	0.01	0.03	0.05	0.01	22.8	0.005	0.03	0.05	0.3	2	0.2	4.78	0.01	2.1	0.395	0.2	0.03	0.01		0.03	0.0065
Sheep Creek	5/26/2006	0.01	0.01	0.01	0.03	0.05	0.01	21	0.005	0.03	0.05	0.3	2	0.2	4.04	0.01	2.1	0.331	0.2	0.03	0.01		0.03	0.005
Sheep Creek	5/26/2007	0.0002	0.0002	0.0007	0.12	0.0002	0.002	23.1	0.0002	0.0009	0.0004	0.03	0.94	0.002	3.93	0.00005	1.85	0.331	0.00002	0.0002	0.0002	0.0042	0.0003	0.001
Sheep Creek	9/12/2007	0.001	0.0002	0.0006	0.032	0.0001	0.01	23.5	0.00039	0.0009	0.001	0.3	2	0.002	5.13	0.00002	2.6	0.383	0.0002	0.0002	0.01	0.0047	0.002	0.007
Sheep Creek	5/15/2008	0.0002	3E-05	0.0007	0.005	8.4E-05	0.0022	17.3	0.00017	ND	0.0004	ND	ND	0.002	4.03	ND	1.69	0.322	ND	ND	ND	0.0035	ND	0.0044
Sheep Creek	9/15/2008	ND	3E-05	0.0006	0.004	0.00017	0.0016	19	0.00017	0.0009	0.0005	ND	0.82	7E-04	4.85	ND	2.25	0.37	0.000007	ND	ND	0.0045	ND	0.0044
Sweet Creek	9/23/2004	0.01	0.01	0.01	0.03	0.05	0.01	152	0.005	0.03	0.05	0.3	2	0.2	6.03	0.01	9.6	1.14	0.2	0.03	0.01		0.03	0.005
Sweet Creek	5/15/2005	0.01	0.01	0.01	0.03	0.05	0.01	138	0.005	0.03	0.05	0.3	2	0.2	5.18	0.01	8.1	0.989	0.2	0.03	0.01		0.037	0.005
Sweet Creek	9/17/2005	0.01	0.01	0.01	0.03	0.05	0.01	180	0.005	0.03	0.05	0.3	2	0.2	5.85	0.01	10.3	1.1	0.2	0.03	0.01		0.047	0.005
Sweet Creek	5/26/2006	0.01	0.01	0.01	0.03	0.05	0.01	156	0.005	0.03	0.05	0.3	2.1	0.2	5.56	0.01	9.9	0.945	0.2	0.03	0.01		0.03	0.005
Sweet Creek	9/23/2006	0.01	0.01	0.01	0.03	0.05	0.015	184	0.005	0.03	0.05	0.3	2	0.2	6.12	0.01	11.1	1.06	0.2	0.074	0.01		0.03	0.005
Sweet Creek	5/26/2007	0.0002	0.0002	0.0012	0.49	0.0002	0.007	194	0.0002	0.0009	0.0038	0.03	1.99	0.003	5.69	0.00005	8.26	1.1	0.00002	0.0002	0.0003	0.026	0.0006	0.006
Sweet Creek	9/12/2007	0.0025	0.0005	0.0006	0.03	0.00071	0.025	208	0.0012	0.0009	0.0048	0.3	2.6	0.005	6.35	0.00005	12.1	1.18	0.0005	0.0005	0.011	0.0324	0.005	0.005
Sweet Creek	5/15/2008	ND	0.0001	0.0008	0.009	0.00011	0.009	153	0.0005	ND	0.0038	ND	ND	7E-04	5.4	ND	8.89	1.14	ND	ND	ND	0.0336	ND	0.0075
Sweet Creek	9/15/2008	ND	0.0001	0.0007	0.01	0.00007	0.012	225	ND	0.001	0.0047	ND	2.85	8E-04	6.51	ND	12.1	1.33	ND	ND	0.004	0.0361	0.001	0.0019
WTA02	9/23/2004	0.01	0.01	0.01	0.03	0.05	0.01	9.52	0.005	0.03	0.05	0.3	2	0.2	4.4	0.01	2	0.291	0.2	0.03	0.01		0.03	0.005
WTA02	5/18/2005	0.01	0.01	0.01	0.03	0.05	0.01	37.9	0.005	0.03	0.05	0.3	2	0.2	4.31	0.01	3.1	0.677	0.2	0.03	0.01		0.03	0.005
WTA02	5/26/2006	0.01	0.01	0.01	0.03	0.05	0.01	11.1	0.005	0.03	0.05	0.3	2	0.2	4.2	0.01	2	0.324	0.2	0.03	0.01		0.03	0.005
WTA02	9/24/2006	0.01	0.01	0.01	0.03	0.05	0.01	10.3	0.0182	0.03	0.05	0.3	2	0.2	3.97	0.01	2	0.294	0.2	0.03	0.01		0.03	0.0375
WTA02	5/26/2007	0.0002	0.0002	0.0008	0.12	0.0002	0.001	9.2	0.0005	0.001	0.0003	0.03	0.47	0.001	3.99	0.00005	1.44	0.276	0.00002	0.0002	0.0002	0.0021	0.0003	0.001
WTA02	9/12/2007	0.0005	0.0001	0.0005	0.261	0.00005	0.005	10.7	0.00238	0.0007	0.0005	0.3	2	0.001	4.71	0.00001	2	0.283	0.0001	0.0001	0.01	0.002	0.001	0.006
WTA02	5/15/2008	ND	3E-05	0.0004	0.007	9.7E-05	0.0011	7.84	0.00036	ND	0.0002	ND	ND	0.001	3.96	ND	1.37	0.252	ND	ND	ND	0.0024	ND	0.0005
WTA02	9/15/2008	ND	3E-05	0.0006	0.002	4.1E-05	0.0011	9.21	0.00014	0.0009	0.0003	ND	0.46	8E-04	4.49	ND	1.65	0.282	0.000006	ND	ND	0.0021	ND	0.0005
WGD01	9/23/2004	0.01	0.01	0.01	0.03	0.05	0.012	54.1	0.005	0.03	0.05	0.3	2	0.2	5.09	0.01	3.8	0.957	0.2	0.03	0.01		0.03	0.005
WGD01	9/16/2005	0.01	0.01	0.01	0.03	0.05	0.01	56	0.005	0.03	0.05	0.3	2	0.2	5.03	0.01	3.4	0.89	0.2	0.03	0.01		0.03	0.005
WGD01	5/26/2006	0.01	0.01	0.01	0.09	0.05	0.01	44	0.0813	0.03	0.05	0.3	2	0.2	4.79	0.01	3.7	0.711	0.2	0.03	0.01		0.03	0.005
WGD01	9/23/2006	0.01	0.01	0.01	0.03	0.05	0.01	58.4	0.005	0.03	0.05	0.3	2	0.2	5.17	0.01	3.6	0.856	0.2	0.03	0.01		0.03	0.0059
WGD01	5/26/2007	0.0002	0.0002	0.0008	0.18	0.0002	0.004	43.8	0.0005	0.0004	0.0007	0.03	1.01	0.002	3.92	0.00005	2.42	0.594	0.00002	0.0002	0.0002	0.0053	0.0003	0.002
WGD01	9/12/2007	0.001	0.0002	0.0017	0.068	0.00052	0.01	58.5	0.00723	0.0005	0.001	0.3	2	0.002	5.45	0.00002	4	0.802	0.0002	0.0002	0.01	0.0078	0.002	0.0392
WGD01	5/15/2008	ND	1E-04	0.0006	0.005	0.00011	0.006	44.5	0.00162	ND	0.001	ND	ND	0.002	4.86	ND	4.62	0.839	ND	ND	ND	0.0072	ND	0.0014
WGD01	9/15/2008	0.0006	0.0003	0.0035	0.02	0.00015	0.0394	336	0.00045	0.0024	0.0054	ND	7.99	0.008	28.2	ND	24	5.54	0.000013	2E-05	0.001	0.0463	ND	0.0048

Appendix A3

2005-2008 Groundwater Data

		Field Parameters			Physical Tests			Anions		Dissolved Metals							
STATION	DATE	pH s.u.	Cond uS/cm	Temp oC	pH	Cond µS/cm	Hardness meq/L	Alk-T meq/L	SO4-D mg/L	Ag mg/L	Al mg/L	As mg/L	Ba mg/L	B mg/L	Be mg/L	Ca mg/L	Cd mg/L
SRK04-5A	25-Sep-04				8.34	459	198	140	108	<0.000050	<0.010	0.0079	0.046	<0.10	<0.0050	54.2	50
SRK-04-ARTA	9-May-05				7.96	449	172	154	89.8	<0.000050	<0.010	0.0121	0.032	<0.10	<0.0050	47.5	50
SRK04-5A	7-Jun-06	8	434.9	3.9		448	197	144	98.4	< 0.00002	0.012	0.0126	0.056	< 0.1	< 0.001	53.8	2.4E-05
SRK04-5A	19-Sep-06	7.9	418	4.5		439	212	149	94.9	< 0.00002	0.0075	0.00822	0.038	< 0.1	< 0.001	56.7	0.00001
SRK04-5B	25-Sep-04				8.31	450	185	138	100	<0.000050	<0.010	0.012	0.058	<0.10	<0.0050	51.1	50
SRK-04-ARTB	9-May-05				8.08	435	172	153	85.3	<0.000050	<0.010	0.0169	0.049	<0.10	<0.0050	47.6	50
SRK04-5B	7-Jun-06	7.75	219.8	4.8		430	206	140	89	< 0.00002	< 0.005	0.00593	0.031	< 0.1	< 0.001	55.5	2.1E-05
SRK04-5B	19-Sep-06	7.88	418	3.6		465	219	144	109	< 0.00002	0.0071	0.0148	0.083	< 0.1	< 0.001	58.6	2.2E-05
SRK05-5c	22-Nov-05				7.51	651	n/a	187	173	<0.010	<0.20	<0.20	0.091	<0.10	<0.0050	78.6	<0.010
SRK05-05C	21-Sep-06	6.81	1175	5.9		1040	591	240	387	< 0.0001	< 0.02	0.0053	0.17	< 0.1	< 0.005	143	< 0.0001
SRK05-05C	12-Oct-07	7.64	915	2.3		1080	664	218	372	< 0.00004	< 0.01	0.0079	0.146	< 0.1	< 0.002	156	9.5E-05
SRK05-05C	4-Jun-08	7.79	1145		7.78	1120			410	< 0.00004	< 0.01	0.0037	0.164	< 0.1	< 0.002	174	7.9E-05
SRK05-05C	18-Sep-08	6.66	974		8.1	990		210	340	0.000013	0.0262	0.00701	0.143	< 0.05	0.00001	132	2.3E-05
SRK05-06	8-Jun-06	7.61	1453	4.3		1260	790	246	450	< 0.0001	< 0.025	< 0.0025	0.044	< 0.1	< 0.005	163	0.00008
SRK05-06	19-Sep-06	7.48	1531	8.4						< 0.0001	< 0.025	< 0.0025	0.055	< 0.1	< 0.005	226	0.00043
SRK05-06	30-May-07	7.67	1142	2.3		1050	764	224	444	< 0.00004	< 0.01	< 0.001	< 0.02	< 0.1	< 0.002	165	0.00018
SRK05-06	12-Oct-07	8.15	1766	2.5		2030	1385	352	916	< 0.0001	< 0.025	< 0.0025	0.049	< 0.1	< 0.005	276	0.00027
SRK05-07	19-Sep-06	6.71	2580	6.2		2560	1784	765	1080	< 0.0001	0.033	0.0266	0.141	< 0.1	< 0.005	340	0.00008
SRK05-07	30-May-07					1600	1338	532	706	< 0.0001	0.059	0.0073	0.126	< 0.1	< 0.005	290	0.00008
SRK05-07	12-Oct-07	7.38	2250	1.8		2680	1929	735	1080	< 0.0002	< 0.05	< 0.005	0.074	< 0.1	< 0.01	408	0.0003
SRK05-07	4-Jun-08	7.04	2090		7.54	2340			1140	< 0.0001	0.302	0.0075	0.059	< 0.1	< 0.005	373	0.00011
SRK05-07	18-Sep-08	6.52	2040		7.9	3000		560	1600	0.00012	0.006	0.0059	0.0727	< 0.3	0.00005	510	0.00015
SRK05-08	7-Jun-06	7.04	876	4.5		1510	917	500	458	< 0.00004	0.016	< 0.001	0.057	< 0.1	< 0.002	194	4.2E-05
SRK05-08	19-Sep-06	7.3	1501		7.78	1600		516	494	< 0.0001	< 0.025	< 0.0025	0.032	< 0.1	< 0.005	212	0.00008
SRK05-08	30-May-07	7.09	1779		7.84	1540		514	634	< 0.0001	< 0.025	< 0.0025	0.028	< 0.1	< 0.005	243	0.00008
SRK05-08	12-Oct-07	7.5	1755		7.8	1980		558	664	< 0.0001	< 0.025	< 0.0025	< 0.02	< 0.1	< 0.005	282	0.00008
SRK05-08	4-Jun-08	7.22	1940		7.56	2060			758	< 0.0001	< 0.025	< 0.0025	< 0.02	< 0.1	< 0.005	281	0.00008
SRK05-08	18-Sep-08	6.66	1857		7.9	1900		500	780	0.000005	0.0037	0.00027	0.0153	< 0.05	0.00001	303	1.7E-05

		Dissolved Metals (continued)																				
STATION	DATE	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Hg mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	Pb mg/L	Sb mg/L	Se mg/L	Sn mg/L	Ti mg/L	Tl mg/L	U mg/L	V mg/L	Zn mg/L
SRK04-5A	25-Sep-04	0	0	<0.0010	0.272	0		<0.050	15.3	0.063	0.0186	17.7	<0.0050	<0.0010	0.00068	<0.0010		<0.050	0	0.00489	<0.030	0.0081
SRK-04-ARTA	9-May-05	0	0	<0.0010	0.701		n/a	<0.050	13	0.08	0.0179	13.2	<0.0050	<0.0010	0	<0.0010	n/a	<0.050	0	0.00114	<0.030	0.0105
SRK04-5A	7-Jun-06	< 0.0003	< 0.001	< 0.001	1.27	0.00002	< 2	0.0078	15.3	0.0887	0.0199	19.5	< 0.001	0.00138	< 0.0005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.00117	< 0.03	0.053
SRK04-5A	19-Sep-06	< 0.0003	< 0.001	< 0.001	0.744	0.00002	< 2	0.0106	17	0.0487	0.0178	19.1	< 0.001	< 0.0005	< 0.0005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.00216	< 0.03	0.0064
SRK04-5B	25-Sep-04	0	0	<0.0010	0.316	0		<0.050	14.1	0.069	0.0236	18.6	<0.0050	<0.0010	0.00088	<0.0010		<0.050	0	0.00727	<0.030	0.0154
SRK-04-ARTB	9-May-05	0	0	<0.0010	0.479		n/a	<0.050	12.9	0.08	0.0204	15.8	<0.0050	<0.0010	50	<0.0010	n/a	<0.050	0	0.00201	<0.030	0.0066
SRK04-5B	7-Jun-06	0.00033	< 0.001	< 0.001	1.42	0.00002	< 2	0.0101	16.3	0.0536	0.0174	18.6	< 0.001	0.00064	< 0.0005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.00142	< 0.03	0.402
SRK04-5B	19-Sep-06	< 0.0003	< 0.001	< 0.001	0.205	0.00002	< 2	0.0095	17.5	0.0811	0.0231	24.2	< 0.001	< 0.0005	0.00076	< 0.001	< 0.0005	< 0.01	< 0.0002	0.00318	< 0.03	0.0062
SRK05-5c	22-Nov-05	<0.010	<0.010	<0.010	0.055		<2.0	<0.010	26.8	1.05	<0.030	16.8	<0.050	<0.050	<0.20	<0.20	<0.030	<0.010	<0.20	n/a	<0.030	<0.0050
SRK05-05C	21-Sep-06	0.0037	< 0.001	< 0.002	1.24	< 0.0002		< 0.05	56.7	3.97	0.0123	<=> 13.6	< 0.01	< 0.002	< 0.001	< 0.002		< 0.05	< 0.0004	0.00337	< 0.03	0.0195
SRK05-05C	12-Oct-07	0.00231	< 0.002	< 0.002	0.775	0.00002	2.1	< 0.01	66.7	2.41	0.0139	14.7	0.0053	< 0.001	< 0.001	< 0.002	< 0.001	< 0.01	< 0.0004	0.00543	< 0.002	0.012
SRK05-05C	4-Jun-08	0.00184	< 0.002	< 0.002	0.609	0.00002	2.6	< 0.01	76.2	1.8	0.0131	13.8	0.0035	< 0.001	< 0.001	< 0.002	< 0.001	< 0.01	< 0.0004	0.00833	< 0.002	0.007
SRK05-05C	18-Sep-08	0.00147	< 0.0001	0.00041	0.735	0.00001	2.14	0.0057	54.1	1.75	0.0159	14.4	0.00334	0.00122	0.00047	0.00007	0.00003	0.0014	0.00001	0.00726	0.0012	0.0062
SRK05-06	8-Jun-06	< 0.0015	< 0.005	< 0.005	< 0.03	0.00002	2.1	< 0.025	92.9	0.0504	< 0.005	7	< 0.005	< 0.0025	< 0.0025	< 0.005	< 0.0025	< 0.01	< 0.001	0.0157	< 0.03	0.131
SRK05-06	19-Sep-06	< 0.0015	< 0.005	0.0092	< 0.03	0.00002	3.5	< 0.025	124	0.0316	< 0.005	10	< 0.005	0.0041	< 0.0025	< 0.005	< 0.0025	< 0.01	< 0.001	0.0253	< 0.03	0.055
SRK05-06	30-May-07	< 0.0006	< 0.002	0.0029	0.392	0.00002	< 2	< 0.01	85.4	0.00357	< 0.002	6.3	< 0.002	< 0.001	< 0.001	< 0.002	< 0.001	< 0.01	< 0.0004	0.016	< 0.03	< 0.017
SRK05-06	12-Oct-07	< 0.0015	< 0.005	< 0.005	< 0.03	0.00002	3.6	< 0.025	169	0.0035	< 0.005	10.5	< 0.005	< 0.0025	< 0.0025	< 0.005	< 0.0025	< 0.01	< 0.001	0.0319	< 0.005	0.0173
SRK05-07	19-Sep-06	0.0146	< 0.005	< 0.005	1.82	0.00002	3.2	< 0.025	227	1.15	0.0188	13.4	0.0715	< 0.0025	0.0032	< 0.005	< 0.0025	< 0.01	< 0.001	0.016	< 0.03	< 0.025
SRK05-07	30-May-07	0.0077	< 0.005	< 0.005	0.575	0.00002	3.5	< 0.025	149	0.421	0.0102	7.5	0.0936	< 0.0025	< 0.0025	< 0.005	< 0.0025	< 0.01	< 0.001	0.0142	< 0.03	< 0.025
SRK05-07	12-Oct-07	0.0097	< 0.01	< 0.01	< 0.03	0.00002	3.6	< 0.05	221	0.692	< 0.01	10.6	0.147	< 0.005	< 0.005	< 0.01	< 0.005	< 0.01	< 0.002	0.0157	< 0.01	0.0269
SRK05-07	4-Jun-08	0.0048	< 0.005	< 0.005	0.354	0.00002	2.2	< 0.025	161	0.0831	< 0.005	7.6	0.0888	0.0048	0.0025	< 0.005	< 0.0025	0.011	< 0.001	0.0134	< 0.005	0.028
SRK05-07	18-Sep-08	0.00424	< 0.0005	0.0011	0.015	0.00005	1.63	0.006	227	0.106	0.001	13.9	0.113	0.00037	0.0016	0.0007	0.00011	0.007	0.00003	0.0214	< 0.001	0.0293
SRK05-08	7-Jun-06	0.00128	< 0.002	< 0.002	< 0.03	0.00002	< 2	0.011	105	0.0161	< 0.002	7.4	< 0.002	< 0.001	< 0.001	< 0.002	< 0.001	< 0.01	< 0.0004	0.0132	< 0.03	0.0092
SRK05-08	19-Sep-06	< 0.0015	< 0.005	< 0.005	< 0.03	0.00002	< 2	< 0.025	108	0.0198	< 0.005	7.2	< 0.005	< 0.0025	< 0.0025	< 0.005	< 0.0025	< 0.01	< 0.001	0.0143	< 0.03	0.052
SRK05-08	30-May-07	< 0.0015	< 0.005	< 0.005	< 0.03	0.00002	< 2	< 0.025	126	0.003	< 0.005	7.5	< 0.005	< 0.0025	< 0.0025	< 0.005	< 0.0025	< 0.01	< 0.001	0.0174	< 0.03	0.013
SRK05-08	12-Oct-07	< 0.0015	< 0.005	< 0.005	< 0.03	0.00002	< 2	< 0.025	156	0.0017	< 0.005	8.9	< 0.005	< 0.0025	< 0.0025	< 0.005	< 0.0025	< 0.01	< 0.001	0.0181	< 0.005	0.0088
SRK05-08	4-Jun-08	< 0.0015	< 0.005	< 0.005	< 0.03	0.00002	< 2	< 0.025	160	< 0.0015	< 0.005	9.1	< 0.005	< 0.0025	< 0.0025	< 0.005	< 0.0025	< 0.01	< 0.001	0.0188	< 0.005	< 0.005
SRK05-08	18-Sep-08	0.00062	0.0005	0.00166	0.003	0.00001	1.75	0.016	159	0.00022	0.0006	9.54	0.00098	4.5E-05	0.0001	0.00068	0.00001	< 0.0005	2E-06	0.02	< 0.0002	0.0047

Appendix B

"2008 Groundwater Review, Anvil Range Mining Complex"
Robertson GeoConsultants, February 2009

Report No. 118014/1

2008 GROUNDWATER REVIEW

ANVIL RANGE MINING COMPLEX, YUKON TERRITORY

Submitted to:

DELOITTE & TOUCHE INC.

On behalf of

Faro Mine Closure Planning Office

Prepared by:

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February 2009

EXECUTIVE SUMMARY

Recent time trends in groundwater quality were reviewed in different reaches of the Anvil Range Mining Complex in order to identify changes in groundwater quality that have occurred since July 2007. The main conclusions of this review can be summarized as follows:

Faro Mine Site

Elevated levels of ARD products were observed in selected wells of the Emergency Tailings Area (ETA), which is consistent with the conclusion that this area remains a major source of contaminant loading.

The groundwater quality in several wells located in the S-cluster area continued to deteriorate over the monitoring period, supporting earlier recommendations that seepage interception in this area should be prioritized;

Groundwater quality down-gradient of the Northeastern Dump at BH14A/B deteriorated over the monitoring period, probably due to seepage from the sulphide-rich waste rock that has been identified in the area. This observation raises concerns that contaminant loading from the Northeastern Dump to the NFRC may increase over time and thus could also require seepage interception.

Rose Creek Tailings Facility

Groundwater quality in the northern portion of the Rose Creek aquifer deteriorated significantly during the 2008 monitoring period. Of particular concern are recent increases in SO_4, Mg, and metal concentrations (including Fe, Zn, and Mn) observed at P03-06, located near the Faro Creek Canyon and immediately downgradient of the Original Impoundment. The recent time trends in this and other wells further downgradient confirm that the entire depth of the aquifer is affected by seepage. The most probable sources of ARD seepage in this area include the coarse tailings beaches located in the northern portion of the Second or Original Impoundments and/or seepage from the Faro Creek canyon/diversion channel.

Impacted groundwater continues to move downgradient in the northern portion of the Rose Creek aquifer, as evidenced by a gradual breakthrough of SO_4, Mg, alkalinity and selected metals (Fe, Mn) in monitoring wells at the Intermediate dam (X24), Cross Valley Dam (P01-11, P05-01) and further downstream (X18, P01-01). The transport of Zn is still significantly delayed due to chemical attenuation in the aquifer.

The groundwater in the southern portion of the aquifer did not experience the same deterioration in groundwater quality in recent years as observed in the northern portion. Several of the highly impacted wells screened beneath the Second impoundment either stabilized in recent years (e.g. P03-03) or even showed a notable improvement in groundwater quality (e.g. P03-04). Decommissioning of several “leaky wells” may have contributed to the recent improvement in groundwater quality in the southern portion of the aquifer.

Grum/Vangorda Mine Site

Groundwater quality for most of the wells located downgradient of Grum Rock Dump and screened in shallow overburden soils continued to show some impact of neutralized mine drainage but did not deteriorate further during 2008. However, recent monitoring in two shallow bedrock wells (SRK05-07 and SRK05-08) showed a continued increase in oxidation products (SO_4, Mg and alkalinity) suggesting that a gradual breakthrough of seepage from Grum Dump is also occurring in the weathered bedrock.

Groundwater quality in monitoring wells located downgradient of the Vangorda Rock Dump (and screened in till) continued to show limited impact of neutralized mine drainage. No significant changes in groundwater quality were observed for the wells in this area.

Report No. 118014/1

2008 GROUNDWATER REVIEW
ANVIL RANGE MINING COMPLEX, YUKON TERRITORY

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ANVIL RANGE MINING COMPLEX, YUKON TERRITORY

1 INTRODUCTION

1.1 Terms of Reference

Groundwater monitoring wells at the Anvil Range Mine Complex (ARMC) are sampled at least twice per year as part of a routine monitoring program carried out by Gartner Lee Limited (GLL). In 2004, Robertson GeoConsultants Inc. (RGC) completed an initial review of the groundwater quality monitoring data collected near the Faro and Grum/Vangorda rock dumps in order to assist in the deign of additional field programs (RGC, 2004) and develop water and contaminant load balances for the Rose Creek Tailings area (RGC, 2006a). In 2007, RGC was commissioned to carry out a comprehensive review of the recent groundwater monitoring data collected across the ARMC from 2005 to mid-2007 (RGC, 2008).

1.2 Study Objectives

The main objective of this report was to review groundwater monitoring data collected since the completion of the last comprehensive review of groundwater monitoring and identify any changes in groundwater quality that have occurred since mid-2007. A corollary objective was to provide recommendations with respect to the routine groundwater monitoring program.

1.3 Scope of Work

This review covers the following geographic areas of the Anvil Range Mining Complex:

- Faro Mine Site (Faro WRDs & ETA);
- Rose Creek Valley (tailings facility); and
- Grum and Vangorda Mine Site (Grum and Vangorda WRDs);

All groundwater quality data reviewed here were downloaded from the Faro database on December 8, 2008. A QA/QC of the raw data was beyond the scope of this review. The scope of 2008 monitoring, field and laboratory methods, and QA/QC results are reported in AECOM (2009).

Note that this review does not include initial groundwater quality data obtained from new monitoring wells installed in the fall of 2008 by SRK Consultants (SRK, 2009).

This scope of work was authorized as 2008/09 Task #26-4 - Ground Water Monitoring Review and this report represents the final deliverable of this task.

2 FARO MINE SITE

2.1 Geographic Overview

The general layout of the Faro mine site and the locations of groundwater monitoring wells are illustrated in Figure 2-1. The Faro mine site comprises the Faro Pit, the surrounding Faro waste-rock dumps (WRDs), the mill area, and the Emergency Tailings Area (ETA).

Groundwater monitoring is generally focused on specific geographic areas where an impact from mine waste seepage has been identified at surface. These areas are considered “priority areas” and include:

- the Emergency Tailings Area (ETA);
- the S-cluster area; and
- the Zone 2 Outwash area.

Additional monitoring wells are situated along the toe of the WRDs in order to monitor drainage towards the North Fork of Rose Creek (NFRC) and within the main Rose Creek valley in order to enhance the spatial coverage of groundwater monitoring. In the following sub-sections, the recent time trends in groundwater water quality for these geographic areas are discussed separately.

2.2 Emergency Tailings Area (ETA)

2.2.1 Background

Figure 2-2 shows the general layout of the ETA area and the groundwater monitoring wells located in this area.

Table 2-1 summarizes pertinent information related to the groundwater monitoring wells located in the ETA area, including year of construction, installation details (total depth, screening interval), and the status of monitoring.

Table 2-1. Monitoring wells in the Emergency Tailings Area (ETA), Faro Mine Site

Well ID	Year of Construction	Total Depth (m bgs)	Top of Screen (m bgs)	Bottom of Screen (m bgs)	Top of Casing Elevation (m asl)	Current Status of Monitoring	Formation
ETA Area							
P96-8A	1996	4.2	1.15	4.17	1109.39	bi-annual	Alluvium
P96-8B	1996	8.6	5.50	8.52	1109.48	bi-annual	Alluvium
SRK04-3A	2004	11.9	10.40	11.90	1104.55	bi-annual	Tailings/All
SRK04-3B	2004	7.1	5.50	7.00	1104.63	no longer sampled	All/BR
SRK04-4	2004	11.6	7.64	11.6	1104.80	not routinely monitored	Alluvium
SRK05-ETA-BR1	2005	12.4	9	12	1105.21	bi-annual	Alluvium
SRK05-ETA-BR2	2005	18.4	14.6	18.9	1103.75	bi-annual	BR (Schist)
ETA-05-1	2005	7.3	4.3	7.3	1105.13	not routinely monitored	Tailings
ETA-05-2	2005	7.5	5	7.5	1105.06	not routinely monitored	Till
ETA-05-3	2005	8.8	7	8.8	1103.98	not routinely monitored	All/Till
ETA-05-4	2005	9.0	6.7	9	1105.37	not routinely monitored	All/Till
ETA-05-5	2005	5.2	2	5.2	1105.44	not routinely monitored	Tailings

2.2.2 Review of Time Trends

Figure 2-3a/b shows selected water quality time trends for monitoring well P96-8A/B (located at the toe of the Faro Main Dump) and for seepage (X23) discharging from the toe of the Main Dump.

The concentrations of SO_4, Mg, and key metals of interest (Zn, Fe, Mn) have increased considerably in X23 over the last year. Historically, a rapid increase in the concentrations of metals in X23 is related to the ‘flushing’ of accumulated oxidation products from the WRD in response to the infiltration of precipitation (Figure 2-3a). In the two nested piezometers P96-8A/B, temporal variation in the concentrations of major ions and metals of interest generally mimicked the trends observed in surface seepage at X23. Historic trends suggest that it can take a year or more for dissolved metal concentrations, such as Zn, to return to ‘normal’ levels after a ‘flushing’ event, yet major ions appear to be less susceptible to short-term changes. In 2008, precipitation was well above average suggesting that recent increases in water quality parameters are related to several ‘flushing’ events from the Main Dump.

Note that prior to 2006, the shallow well (P96-8A) showed a greater impact from WRD seepage than the deeper well (P96-8B). Starting in 2006, the deeper well abruptly showed a higher impact than the shallow well. This abrupt change in water quality pattern is suspicious and suggests that the two nested piezometers might have been incorrectly relabelled. The depth of these two piezometers should be checked during the next monitoring campaign to confirm proper labelling of these wells.

Figure 2-4a/b illustrates the time trends for selected water quality parameters in the four monitoring wells located up-gradient of the mine access road in the ETA area. Water quality differs significantly among these wells due to differences in screened lithologies (RGC, 2008). Groundwater in wells screened in the alluvial sediments of the Faro Creek channel (SRK04-3A and SRK05-ETA-BR1) or in a mixture of tailings and alluvial sands (SRK04-3B) has a slightly acidic pH, low alkalinity, and elevated levels of SO_4, Mg, and the key metals of concern (Zn, Fe, and Mn). By contrast, groundwater that resides in bedrock underlying the alluvium is less affected by mine waste seepage than the highly-impacted alluvial channel that occurs above. Nonetheless, metal concentrations in this deeper groundwater (e.g. 10 mg/L Zn) are higher than natural background for local bedrock, which suggests some direct impact by seepage from the ETA area and/or WRD seepage from areas located up-gradient.

In contrast to trends observed for X23, groundwater quality in this area did not deteriorate further over the current monitoring period.

2.3 S-Cluster Area

2.3.1 Background

Figure 2-5 shows the general layout of the “S cluster area” and the groundwater monitoring wells located in the area.

Table 2-2 summarizes pertinent information related to the groundwater monitoring wells located in the S-cluster area, including year of construction, installation details (total depth, screening interval), and the status of monitoring.

Table 2-2 Monitoring wells in the S-cluster area, Faro Mine Site

Well ID	Year of Construction	Total Depth (m bgs)	Top of Screen (m bgs)	Bottom of Screen (m bgs)	Top of Casing Elevation (m asl)	Current Status of Monitoring	Formation
S-cluster Area							
S1A	1989	12.0	9.2	12.2	1085.43	bi-annual	BR (phyllite)
S1B	1989	3.8	1.3	4.3	1085.27	bi-annual	Till
S2A	1989	11.2	9.2	12.2	1086.03	bi-annual	BR (phyllite)
S2B	1989	7.0	3.7	6.7	1086.30	bi-annual	Till
S3	1989	4.8	2.6	5.6	1085.53	bi-annual	Till
P96-7	1996	9.2	6.26	9.24	~1127	bi-annual	Overburden/BR
SRK05-SP-1A	2005	19.2	13.7	19.2	1091.99	bi-annual	Overburden/BR
SRK05-SP-1B	2005	12.3	9	12.3	1091.94	bi-annual	Overburden
SRK05-SP-2	2005	11.0	7.9	11	1086.70	bi-annual	Alluvium/BR
SRK05-SP-3A	2005	22.9	17.4	21.9	1088.50	bi-annual	Overburden
SRK05-SP-3B	2005	12.3	8.3	11.4	1088.41	bi-annual	Overburden
SRK05-SP-4A	2005	21.6	16.5	21	1087.27	bi-annual	Overburden/BR
SRK05-SP-4B	2005	4.0	0.6	3.5	1087.44	bi-annual	Overburden
SRK05-SP-5	2005	14.0	9.4	12.5	1087.53	bi-annual	Overburden/BR
SRK05-SP-6	2005	11.0	3.1	11	1097.73	bi-annual	BR(Schist)
DP1	2005	n/a	1.14	1.14	1083.97	not routinely monitored	NFRC sediments
DP2	2005	n/a	0.53	0.53	1082.55	not routinely monitored	NFRC sediments
DP3	2005	n/a	0.75	0.75	1081.89	not routinely monitored	NFRC sediments
DP4	2005	n/a	0.94	0.94	1082.19	not routinely monitored	NFRC sediments
SRK04-2B	2004					no longer sampled	Alluvium
SRK04-2A	2004					no longer sampled	Alluvium

2.3.2 Review of Time Trends

Figures 2-6a/b and 2-7a/b show the time trends for selected water quality parameters in groundwater from the historical "S" wells and well P96-7. Identical plots for the "SRK05-SP" series of wells are shown in Figure 2-7a/b. Groundwater quality in the S-cluster area can be grouped into three broad categories:

- Highly-impacted groundwater (S1A, S2A/B, S3, SRK05-SP4B and -SP5);
- Moderately-impacted groundwater (SRK05-SP1A, -SP3A, SP3B and -SP4A);
- Slightly-impacted groundwater (S1B, SRK05-SP1B and -SP2).

The contaminant concentrations in the highly-impacted groundwater have increased steadily since 2000 and this trend continued throughout the current monitoring period. Of particular concern is the rapid rise in the concentrations of Mg, SO_4, and selected metals in S2B. Specifically, the concentration of Zn in S2B has risen significantly and is now approximately equivalent to S1A, S2A, and S3.

Piezometer S2B is reportedly a shallow piezometer (screened at 4 to 7m depth; Table 2-2). The recent breakthrough of highly-impacted seepage in this piezometer suggests that the shallow (perched) seepage first identified further east at SP-4B (SRK, 2006) may be laterally more extensive than originally thought. Alternatively, the breakthrough of waste rock seepage at SP2B may be an indication of deeper seepage (e.g. observed at SRK05-SP5) upwelling further down-slope.

The other monitoring wells classified as moderately-impacted or slightly-impacted did not show the same dramatic deterioration in groundwater quality. However, several of those wells have shown a gradual increase in SO4 and Mg concentrations over time (e.g. at SRK05-SP1A, -SP3A, -SP4a) suggesting increasing impact of waste rock seepage. Thus far, a breakthrough of elevated Zn concentrations in those moderately impacted wells appears to be imminent only at SRK05-SP4A.

The continued deterioration of groundwater quality along this reach of the NFRC, including breakthrough of highly elevated Zn concentrations, represents an increasing risk of contaminant loading to the nearby North Fork of Rose Creek. As a result, a seepage interception system consisting of a shallow interception trench and several recovery wells was installed in the fall of 2008 to intercept this highly impacted groundwater in this area (SRK, 2009). Start-up of operation of this SIS is planned for early 2009. Continued monitoring of groundwater quality downstream of this SIS will be required to assess the effect of this new seepage interception system on groundwater quality in this reach of the NFRC.

2.4 Zone 2 Outwash Area

2.4.1 Background

Figure 2-8 shows the general layout of the Faro WRDs and the groundwater monitoring wells in the area. Drainage from the WRDs generally flows towards the North Fork Rose Creek (NFRC), which is located up-gradient of the rock drain. Most of the groundwater monitoring wells are located in the Zone 2 outwash area (Figure 2-9), but additional monitoring wells are located along the toes of the Northeast Rock Dump and the Intermediate Rock Dump.

Table 2-3 summarizes pertinent information related to the groundwater monitoring wells located in the Zone 2 Outwash area, including year of construction, installation details (total depth, screening interval), and the status of monitoring.

Table 2-3. Monitoring wells in the Zone 2 Outwash Area, Faro Mine Site

Well ID	Year of Construction	Total Depth (m bgs)	Top of Screen (m bgs)	Bottom of Screen (m bgs)	Top of Casing Elevation (m asl)	Current Status of Monitoring	Formation
Zone 2 Outwash Area							
BH1	1992	5.2				bi-annual	n/a
BH2	1992	4.8			1099.70	bi-annual	n/a
BH4	1992	2.5			1097.02	bi-annual	n/a
BH5	1994	7.6	6.01	7.62	1095.57	not routinely monitored	Alluvium
BH6	1994	6.3	4.72	6.25	1097.84	not routinely monitored	Alluvium
BH7D (A)	1994	8.8	6.71	8.84	1100.70	no longer sampled	Overburden (?)
BH7S (B)	1994	6.4	4.27	6.4	1101.16	no longer sampled	BR (phyllite?)
BH8	1994	20.6	19.05	20.57	1123.37	not routinely monitored	BR (phyllite?)
BH9	1994	54.9	53.34	54.86	1141.30	abandoned	BR (Biotite-schist)
BH10A	1994	36.6	35.05	36.58	1101.73	not routinely monitored	BR (Biotite-schist)
BH10B	1994	54.9	53.34	54.84	1101.72	not routinely monitored	BR (phyllite/schist)
BH05-01	2005	3.8	2.3	3.81	1095.57	abandoned	Outwash Sed
P05-04	2005	6.3	2.19	6.34	1097.70	bi-annual	Alluvium
RGC-PW3	2005	7.4	5.5	7	1097.92	not routinely monitored	Alluvium
DP5	2005	n/a	n/a	n/a	1095.73	not routinely monitored	NFRC sediments
DP6	2005	n/a	n/a	n/a	1094.71	not routinely monitored	NFRC sediments
Zone 2 Pumping Well (X26)	n/a						waste rock (?)

2.4.2 Review of Time Trends

Figure 2-10a/b shows selected water quality time trends for the monitoring wells located in the Zone 2 outwash area.

The Zone 2 outwash area is located immediately down-gradient of the Zone 2 pit which has been back-filled with waste rock. Pumping well X26 reflects changes in the quality of water accumulating in the Zone 2 pit and pumped out during the summer months. Water quality in the Zone 2 pit shows seasonal dilution due to recharge during spring runoff. However, average water quality in the Zone 2 pit has remained remarkably constant over the last few years.

Monitoring well BH8, located immediately downgradient of the Zone 2 pit and screened in a fault zone in weathered bedrock, was sampled in 2008 for the first time since 1997. Water quality in this deep bedrock well continues to be highly impacted with SO4 concentrations ~4,000 mg/L and Zn concentrations of about 300 mg/L. Note that groundwater in this bedrock well is acidic (pH ~4.5) and has consistently shown significantly higher concentrations of Fe and Zn and other trace metals (Cd, Cu, Pb) than the water pumped from the Zone 2 pit (X26). At present, it is unclear whether the very poor water quality in BH08 is a result of seepage from the Zone 2 Pit, overlying waste rock and/or mineralized bedrock in the area and will require further study.

Trends in groundwater quality in the Zone 2 Outwash area for the current monitoring period were generally similar to those observed in previous years. The shallow wells (BH1, 2 and 4), at least partially screened in the outwash sediments, continued to show a very similar general water quality (or “fingerprint”) to that observed in the deeper wells screened in the alluvial sediments (BH5, BH6, P05-04). The groundwater quality in this area differs from other seepage areas (e.g. ETA and S-cluster) in that elevated Zn concentrations are observed in groundwater with relatively low concentrations of SO4, Mg, iron and manganese.

Several shallow wells (e.g. BH2 and in particular BH4 located near the NFRC) showed a gradual increase in Zn, manganese and SO4 during calendar year 2008. Similar increases in contaminants had been observed in previous wet years. These increases are therefore likely temporary in nature and not related to an overall long-term increase in contaminant loading in this area.

Monitoring well BH5 is located immediately downgradient of the Zone area and is screened in the permeable alluvial sediments of the NFRC valley. Sampling in this well recommenced in 2008 for the first time since 1997. Concentrations of SO_4, Mg and Zn have either remained constant or marginally improved in BH5 over this eleven year time span. This suggests that contaminant loading to the NFRC from the Zone 2 pit and associated waste rock dumps has not increased significantly over this time period.

Pumping tests conducted in this area have demonstrated that the local NFRC sediments are very permeable, that zinc loading to the NFRC sediments is significant and seepage interception may be required in this area (SRK, 2007). In preparation of such design work, we recommend that additional geochemical characterization work be completed (including geochemical finger-printing, mixing calculations and potentially use of isotopic tracers) to determine the relative contribution of Zone 2 pit seepage, waste rock seepage and leakage from the outwash sediments in this reach of the NFRC.

2.5 Northeast and Intermediate Dumps towards NFRC

2.5.1 Background

Figure 2-8 shows the monitoring wells located along the toe of the Northeast Dumps and the Intermediate Dump. Table 2-4 lists pertinent information of all groundwater monitoring wells located down-gradient of the Northeast Rock Dump and the Intermediate Rock Dump.

2.5.2 Review of Time Trends

Figure 2-11a/b shows selected water quality time trends for the three sets of nested piezometers located along the toe of the Northeast Dumps.

BH14A/B has historically shown the greatest impact of WRD seepage in this area and groundwater quality in these wells deteriorated significantly in 2008. For example, in the latest round of sampling (August 2008) SO_4 and Zn concentrations in BH14A jumped to 3,200 mg/L SO_4 and 11.9 mg/L.Zn, respectively. Similar increases were observed in the deeper piezometer BH14B. The observed increases in major ions (SO_4 and Mg) are consistent with elevated field EC readings during this sampling date suggesting that these results are not caused by a sample handling or laboratory error.

Table 2-4. Monitoring wells at the toe of Northeast Dumps and Intermediate Dump (NFRC), Faro Mine Site

Well ID	Year of Construction	Total Depth (m bgs)	Top of Screen (m bgs)	Bottom of Screen (m bgs)	Top of Casing Elevation (m asl)	Current Status of Monitoring	Formation
Toe of Northeast Dumps (NFRC)							
BH12A	1994	3.1	1.53	3.05	1157.39	bi-annual	BR (weath)
BH12B	1994	8.2	6.1	8.23	1157.50	bi-annual	BR (phyllite/schist)
BH13A	1994	3.8	2.29	3.81	1187.91	bi-annual	A
BH13B	1994	8.2	6.71	8.23	1188.18	bi-annual	BR (phyllite/schist)
BH14A	1994	6.3	4.72	6.25	1157.52	bi-annual	BR (weath)
BH14B	1994	9.3	7.77	9.3	1158.16	bi-annual	BR (Qtz/diorite)
Toe of Intermediate Dump (NFRC)							
P96-6	1996	20.1	18.07	20.12	~1102	bi-annual	Alluvium

Groundwater collected from wells BH12A/B and BH13A/B has remained relatively dilute in terms of major ions and dissolved metals compared to those observed at BH14A/B. However, monitoring well BH13B has shown a recent increase in concentrations of SO_4 and Mg indicative of waste rock seepage.

Increases in the concentrations of SO_4, Mg, and Zn in these wells (in particular at BH14A/B) are cause for concern because their increase are likely indicative of seepage related to the sulphide-rich waste rock that has been identified in this portion of the Northeast Dumps (RGC, 2008). If seepage continues, it is likely that groundwater quality in this reach will deteriorate further until concentrations of SO_4, Mg, and Zn reach the levels observed in the ETA and S-cluster areas. Extrapolating historic time trends observed at the S-cluster area, zinc concentrations in BH14 may exceed 100 mg/L in groundwater within the next 2 to 5 years. Over time, such seepage could negatively impact on the water quality of the NFRC in the reach upstream of the Zone 2 area.

Figure 2-12a/b shows selected water quality time trends for P96-6. This well is located along the toe of the Intermediate Dump and monitors groundwater flowing from the Intermediate Dump towards the NFRC. Similar to selected wells in the S-cluster area (e.g. SRK05-SP1A, -SP3A, SP3B and -SP4A), groundwater quality in this monitoring well is considered “moderately-impacted” by seepage. In 2008, the concentrations of SO_4 and Mg also increased in P96-6. These increases may be indicative of increased seepage from the Intermediate Dump and could precede similar increases in the concentrations of dissolved metals.

3 ROSE CREEK VALLEY (TAILINGS FACILITY)

3.1 Geographic Overview

Figure 3-1 shows the general layout of the Rose Creek tailings facility and the groundwater monitoring wells in the area. The Rose Creek tailings facility comprises the Original Impoundment, Second Impoundment, Intermediate Impoundment (w/ Intermediate Dam), and the Polishing Pond (w/ Cross Valley Dam).

The groundwater monitoring network in the Rose Creek tailings facility is extensive and for the purpose of this report, the recent time trends of groundwater quality in the Rose Creek valley are discussed separately for the following geographic areas:

- Upstream of Rose Creek Tailings Facility;
- Original Impoundment;
- Second Impoundment;
- Intermediate Impoundment;
- Toe of Intermediate Dam;
- Toe of Cross Valley Dam; and
- Downstream of Cross Valley Dam.

Note that the majority of “P01” series of monitoring wells (installed in 2001) were decommissioned in October 2005 due to concerns about the integrity of these wells (RGC, 2006b). Historic water quality time trends of those “leaky wells” are not presented here. For a review of those historic time trends, the reader is referred to the 2007 Groundwater Monitoring Review Report (RGC, 2008).

3.2 Upstream of Rose Creek Tailings Facility

3.2.1 Background

Groundwater quality up-gradient of the Rose Creek tailings facility is routinely monitored in monitoring well TH86-17, which is located approximately 450-m southeast of the Original Impoundment (Figure 3-1).

3.2.2 Review of Time Trends

Figure 3-2a/b shows selected water quality time trends for TH86-17 and other piezometers measured once in 2008. Groundwater quality in TH86-17 reflects natural base-line conditions in the Rose Creek valley sediments. Groundwater from TH86-17 remains relatively dilute in terms of major ions and dissolved metals and there continues to be no indication of mine waste seepage impact on groundwater quality at this location.

The other piezometers sampled in 2008 generally showed similar groundwater quality. For example, SO_4 concentrations ranged from 21 to 48 mg/L (average = 31 mg/L) compared to ~15mg/L in TH-86-17 and Zn concentrations ranged from < 0.005 mg/L to 0.01 mg/L (average = 0.0075 mg/L) compared to 0.017 mg/L in TH86-17. The lower SO_4 concentrations (and higher Zn concentrations) observed at TH86-17 may be a result of recharge from the nearby NFRC to the Rose Creek sediments. We recommend that monitoring wells TH86-2 and TH86-5, screened in shallow and deep alluvial sediments, respectively, be included in future routine monitoring as additional background wells for the Rose Creek valley.

3.3 Original Impoundment

3.3.1 Background

Table 3-1 summarizes pertinent information related to the groundwater monitoring wells located in the Original Impoundment, including year of construction, installation details (total depth, screening interval) and status of monitoring.

Table 3-1. Monitoring wells upgradient of and in the Original Impoundment, Rose Creek Tailings Facility

Well ID	Year of Construction	Total Depth (m bgs)	Top of Screen (m bgs)	Bottom of Screen (m bgs)	Top of Casing Elevation (m asl)	Current Status of Monitoring	Formation
Original Impoundment							
TH86-17	1986	13.9	n/a	n/a	~1070	bi-annual	n/a
P03-07-01	2003	38.4	38.10	38.40	1064.98	not routinely monitored	Alluvium
P03-07-02	2003	33.8	33.53	33.83	1064.98	not routinely monitored	Alluvium
P03-07-03	2003	29.0	28.65	28.96	1064.98	not routinely monitored	Alluvium
P03-07-04	2003	21.6	21.34	21.64	1064.98	not routinely monitored	Alluvium
P03-07-05	2003	20.1	19.81	20.12	1064.98	not routinely monitored	Alluvium
P03-07-06	2003	18.3	17.98	18.29	1064.98	not routinely monitored	Tailings
P03-07-07	2003	16.8	16.46	16.76	1064.98	not routinely monitored	Tailings
P03-07-08	2003	13.7	13.41	13.72	1064.98	not routinely monitored	Tailings
NA05-11A	2005	14.3	12.8	14.3	1068.35	not routinely monitored	Alluvium

3.3.2 Review of Time Trends

None of the existing monitoring wells in the Original Impoundment are currently monitored routinely. Hence no additional water quality data was collected during the current monitoring period.

3.4 Second Impoundment

3.4.1 Background

Table 3-2 summarizes pertinent information related to the groundwater monitoring wells located in the Second Impoundment, including year of construction, installation details (total depth, screening interval), and the status of monitoring.

3.4.2 Review of Time Trends and Depth Profiles

Six multi-level wells (P03-01 to P03-06) were installed within the footprint of the Second Impoundment in 2003. Water quality depth profiles for these wells are illustrated in Figures 3-3a/b to 3-8a/b. The general shapes of the depth profiles observed during the current monitoring period are very similar to those observed in previous monitoring campaigns. In accordance with previous findings, the highest levels of ARD products (SO_4, Mg and Zn) are still observed in tailings pore-water in the south-eastern (P03-01, P03-03) and north-western sections (P03-06) of the Second Impoundment, whereas the lowest levels of ARD products were observed in the south-western section (P03-05) (RGC, 2008).

Table 3-2. Monitoring wells in the Second Impoundment, Rose Creek Tailings Facility

Well ID	Year of Construction	Total Depth (m bgs)	Top of Screen (m bgs)	Bottom of Screen (m bgs)	Top of Casing Elevation (m asl)	Current Status of Monitoring	Formation
Second Impoundment							
P03-01-01	2003	46.8	46.48	46.79	1061.11	bi-annual	Alluvium
P03-01-02	2003	38.9	38.56	38.86	1061.11	bi-annual	Alluvium
P03-01-03	2003	30.6	30.33	30.63	1061.11	bi-annual	Alluvium
P03-01-04	2003	24.5	24.23	24.54	1061.11	bi-annual	Alluvium
P03-01-05	2003	18.4	18.14	18.44	1061.11	bi-annual	Alluvium
P03-01-06	2003	13.3	12.95	13.26	1061.11	bi-annual	Alluvium
P03-01-07	2003	10.8	10.52	10.82	1061.11	bi-annual	Alluvium
P03-01-08	2003	9.3	8.99	9.30	1061.11	bi-annual	Tailings
P03-01-09	2003	7.8	7.47	7.77	1061.11	bi-annual	Tailings
P03-02-01	2003	33.8	33.53	33.83	1060.60	not routinely monitored	Alluvium
P03-02-02	2003	30.5	30.18	30.48	1060.60	not routinely monitored	Alluvium
P03-02-03	2003	22.9	22.56	22.86	1060.60	not routinely monitored	Alluvium
P03-02-04	2003	16.8	16.46	16.76	1060.60	not routinely monitored	Alluvium
P03-02-05	2003	13.7	13.41	13.72	1060.60	not routinely monitored	Alluvium
P03-02-06	2003	12.8	12.50	12.80	1060.60	not routinely monitored	Alluvium
P03-02-07	2003	11.9	11.58	11.89	1060.60	not routinely monitored	Tailings
P03-02-08	2003	8.8	8.53	8.84	1060.60	not routinely monitored	Tailings
P03-02-09	2003	7.6	7.32	7.62	1060.60	not routinely monitored	Tailings
P03-03-01	2003	43.0	42.67	42.98	1061.49	bi-annual	Alluvium
P03-03-02	2003	33.2	32.92	33.22	1061.49	bi-annual	Alluvium
P03-03-03	2003	27.1	26.82	27.13	1061.49	bi-annual	Alluvium
P03-03-04	2003	22.3	21.95	22.25	1061.49	bi-annual	Alluvium
P03-03-05	2003	18.6	18.29	18.59	1061.49	bi-annual	Alluvium
P03-03-06	2003	17.1	16.76	17.07	1061.49	bi-annual	Alluvium
P03-03-07	2003	15.2	14.94	15.24	1061.49	bi-annual	Tailings
P03-03-08	2003	12.2	11.89	12.19	1061.49	bi-annual	Tailings
P03-03-09	2003	9.1	8.84	9.14	1061.49	bi-annual	Tailings
P03-04-01	2003	58.2	57.91	58.22	1061.21	bi-annual plus AMP	Alluvium
P03-04-02	2003	47.5	47.24	47.55	1061.21	bi-annual plus AMP	Alluvium
P03-04-03	2003	41.5	41.15	41.45	1061.21	bi-annual plus AMP	Alluvium
P03-04-04	2003	35.1	34.75	35.05	1061.21	bi-annual plus AMP	Alluvium
P03-04-05	2003	26.1	25.76	26.06	1061.21	bi-annual plus AMP	Alluvium
P03-04-06	2003	17.4	17.07	17.37	1061.21	bi-annual plus AMP	Alluvium
P03-04-07	2003	15.5	15.24	15.54	1061.21	bi-annual plus AMP	Alluvium
P03-04-08	2003	13.7	13.41	13.72	1061.21	bi-annual plus AMP	Tailings
P03-04-09	2003	12.8	12.50	12.80	1061.21	bi-annual plus AMP	Tailings
P03-05-01	2003	44.5	44.20	44.50	1060.43	not routinely monitored	Alluvium
P03-05-02	2003	36.9	36.58	36.88	1060.43	not routinely monitored	Alluvium
P03-05-03	2003	27.7	27.43	27.74	1060.43	not routinely monitored	Alluvium
P03-05-04	2003	23.5	23.16	23.47	1060.43	not routinely monitored	Alluvium
P03-05-05	2003	21.6	21.34	21.64	1060.43	not routinely monitored	Alluvium
P03-05-06	2003	18.6	18.29	18.59	1060.43	not routinely monitored	Tailings
P03-05-07	2003	14.0	13.72	14.02	1060.43	not routinely monitored	Tailings
P03-05-08	2003	11.0	10.67	10.97	1060.43	not routinely monitored	Tailings
P03-06-01	2003	25.9	25.60	25.91	1062.79	bi-annual	Alluvium
P03-06-02	2003	22.9	22.56	22.86	1062.79	bi-annual	Alluvium
P03-06-03	2003	19.8	19.51	19.81	1062.79	bi-annual	Alluvium
P03-06-04	2003	16.5	16.15	16.46	1062.79	bi-annual	Alluvium
P03-06-05	2003	14.3	14.02	14.33	1062.79	bi-annual	Alluvium
P03-06-06	2003	12.5	12.19	12.50	1062.79	bi-annual	Tailings
P03-06-07	2003	11.0	10.67	10.97	1062.79	bi-annual	Tailings
NA05-9D	2005	11.0	7.9	10.9	1060.81	not routinely monitored	Alluvium
NA05-9S	2005	6.1	1.4	4.4	1060.57	not routinely monitored	Tailings

Contaminant concentrations in the underlying aquifer are typically highest in the shallow piezometers screened near the interface of the sand and gravel aquifer and the overlying tailings. However, different depth profiles continue to be observed at P03-03 and P03-06. At P03-03, SO_4 concentrations are elevated throughout the entire depth of the aquifer and Zn concentrations actually increase significantly with depth. At P03-06, SO_4 concentrations continued to remain higher at greater depth and Zn concentrations also continued to increase throughout the entire depth of the aquifer. In both cases these depth profiles suggest significant contributions from an upgradient source (RGC, 2008).

In October 2005, the nested monitoring wells P01-07A/B/C/D/E and P01-09A/B/C/D were decommissioned by sealing the piezometer with a bentonite slurry. At both locations, multilevel piezometers are located within a relatively short distance (<150-m) downgradient of the decommissioned wells allowing a preliminary assessment of any potential effects of this decommissioning work on the groundwater quality in the Rose Creek sediments.

Figure 3-9a/b shows the time trends of selected water quality parameters for P03-03, located about 140-m downgradient of the decommissoned wells P01-09A/B/C/D. Previous analyses had suggested that leakage from P01-09 (in particular from P01-09E) is the most likely cause for the highly elevated SO_4 and Zn at depth at this location (RGC, 2006a; RGC, 2008). However, current time trends at this location are inconclusive. While a notable decrease in Zn concentrations since decommissioning has been observed in some piezometers (P03-03-03 and -04), other piezometers have shown an increase in Zn concentrations (P03-03-05 and -06). The most impacted piezometer (P03-03-02) initially showed a decrease in Zn (and SO_4) concentrations but those contaminant concentrations rebounded in 2008. The lack of a rapid and consistent recovery in this highly impacted, deep piezometer after well decommissioning could be due to a slower than expected flushing of the residual contaminant plume. Alternatively, tailings seepage from further upgradient (unrelated to “leaky wells”) could be the source of the highly elevated Zn concentrations observed at depth at this location.

Figure 3-10a/b shows the time trends of selected water quality parameters for P03-04, located about 140-m downgradient of the decommissioned wells P01-07A/B/C/D/E. At this location, the shallow piezometer P03-04-06 (screened near the interface with the tailings) has shown a significant decrease in Zn and other ARD products (SO_4, Mg, Mn and Fe) since decommissioning of the leaky wells. Contaminant concentrations in the deeper piezometers at this location (P03-04-01 to -05) all peaked around 2007 and started to decline in 2008. These observations would suggest that sealing of the leaky wells indeed reduced the contaminant loading and improved groundwater quality in the Rose Creek aquifer at P03-04.

Figure 3-10c/d shows the time trends of selected water quality parameters for P03-06, located in the northwestern portion of the Second Impoundment (near Faro Creek canyon). Earlier monitoring had indicated significant increases in oxidation products and metal concentrations at this location (in particular at depth) (RGC, 2008). The most recent monitoring data show a continued increase in Zn and other ARD products (SO_4, Mg, Mn and Fe) at P03-06. Of particular concern is the rapid increase in Zn concentrations which approximately doubled over the last two years and currently averages about 2 to 5 mg/L Zn. Note that only one piezometer, P03-06-05 screened just beneath the tailings, showed a decline in oxidation products (in particularly SO_4 and Mg but also Zn and other metals).

A more detailed geochemical assessment, including mixing calculations, suggested that groundwater in this area may be impacted by a combination of seepage from coarse and well-drained tailings located in the Original Impoundment and seepage from the Faro Creek channel/diversion channel (RGC, 2009). This study suggested that the recent increases in oxidation products (in particular SO_4 and Zn) in the Rose Creek aquifer at this location (and further downgradient) could be a result of the recent deterioration of water quality in the Faro Creek seepage.

It was also noted that operation of a new seepage interception system (SIS) (operating below the ETA area since the fall of 2006) may reduce contaminant concentrations in the northern portion of the Rose Creek aquifer (at P03-06) by as much as 50% (RGC, 2009). Conservative transport calculations suggested that an improvement in groundwater quality at P03-06 due to operation of the Faro Creek SIS could be expected to occur after 1 to 5 years. The sharp decrease in SO_4 and, to a lesser extent Zn, at P03-06-05 observed in 2008 could potentially be a result of operation of the SIS. However, other factors such as ‘flushing’ during a very wet spring runoff could also explain this decrease. Longer-term monitoring will be required to determine the source(s) of contaminants and the effect of intercepting Faro Creek seepage on groundwater quality at this location.

In summary, groundwater quality data collected from the Rose Creek aquifer beneath the Second Impoundment suggests an incremental loading from east (upstream) to west (downstream). However, while some reaches of the aquifer experience continued deterioration of groundwater quality (in particular near P03-06) other reaches appear to have stabilized or even show a notable improvement in groundwater quality. These observations suggest that groundwater quality in the aquifer sediments beneath the Second Impoundment is strongly influenced by different local sources, including concentrated ARD seepage from coarse, fully oxidized tailings beaches, residual contamination from leaky wells (now sealed) and Faro Creek seepage.

3.5 Intermediate Impoundment

3.5.1 Background

Table 3-3 summarizes pertinent information related to the groundwater monitoring wells located in the Intermediate Impoundment, including year of construction, installation details (total depth, screening interval), and the status of monitoring.

3.5.2 Review of Time Trends

Water quality time trends for the X21 well series are shown in Figures 3-11a/b. Aside from the increase in Na concentration observed in X21A, groundwater quality in X21A and X21B did not change during the current monitoring period and no new data for X21C was available.

Note that monitoring wells X21A/B have not shown the same increase in SO_4 and Zn concentrations in the aquifer that have been observed in recent years at P03-06. Assuming a direct hydraulic connection in a contiguous aquifer, a similar breakthrough (at least of SO4) would be expected at X21A/B in about 2 to 10 years.

Water quality depth profiles for P03-08 are shown in Figure 3-12a/b. Depth profiles for the current monitoring period were similar to those defined by previously-collected data and no appreciable changes in water quality were observed.

Table 3-3. Monitoring wells in the Intermediate Impoundment, Rose Creek Tailings Facility

Well ID	Year of Construction	Total Depth (m bgs)	Top of Screen (m bgs)	Bottom of Screen (m bgs)	Top of Casing Elevation (m asl)	Current Status of Monitoring	Formation
Intermediate							
X21A-96	1996	8.5	2.43	8.53	1052.09	bi-annual	Tailings
X21B-96	1996	14.7	11.64	14.69	1052.14	bi-annual	Alluvium
X21C-96	1996	29.4	27.86	29.37	1052.21	no longer sampled	Alluvium
P03-08-01	2003	32.6	32.31	32.61	1048.35	bi-annual plus AMP	Alluvium
P03-08-02	2003	28.3	28.04	28.35	1048.35	bi-annual plus AMP	Alluvium
P03-08-03	2003	24.7	24.38	24.69	1048.35	bi-annual plus AMP	Alluvium
P03-08-04	2003	23.2	22.86	23.16	1048.35	bi-annual plus AMP	Alluvium
P03-08-05	2003	21.6	21.34	21.64	1048.35	bi-annual plus AMP	Alluvium
P03-08-06	2003	20.1	19.81	20.12	1048.35	bi-annual plus AMP	Tailings
P03-08-07	2003	17.1	16.76	17.07	1048.35	bi-annual plus AMP	Tailings
P03-08-08	2003	14.0	13.72	14.02	1048.35	bi-annual plus AMP	Tailings
NA05-2D	2005	13.7	10.7	13.7	1052.13	not routinely monitored	Alluvium
NA05-2S	2005	8.8	4.5	7.5	1052.11	not routinely monitored	Tailings

3.6 Toe of Intermediate Dam

3.6.1 Background

Table 3-4 summarizes pertinent information related to the groundwater monitoring wells located at the toe of the Intermediate Dam, including year of construction, installation details (total depth, screening interval), and the status of monitoring.

Table 3-4. Monitoring wells at the toe of the Intermediate Dam, Rose Creek Tailings Facility

Well ID	Year of Construction	Total Depth (m bgs)	Top of Screen (m bgs)	Bottom of Screen (m bgs)	Top of Casing Elevation (m asl)	Current Status of Monitoring	Formation
Intermediate Dam							
X24A-96	1996	6.5	6.46	6.48	1033.10	no longer sampled	Alluvium
X24B-96	1996	11.3	9.8	11.3	1033.05	no longer sampled	Alluvium
X24C-96	1996	16.5	14.97	16.47	1033.00	no longer sampled	Alluvium
X24D-96	1996	28.3	26.84	28.34	1032.90	bi-annual	Alluvium
X25A-96	1996	8.9	7.44	8.97	1032.08	bi-annual	Alluvium
X25B-96	1996	19.1	17.7	19.17	1032.03	bi-annual	Alluvium
P01-03	2001	9.3	7.78	9.3	1032.21	bi-annual	Alluvium
P01-04A	2001	34.1	32.53	34.05	1031.90	bi-annual	Alluvium
P01-04B	2001	53.4	51.89	53.41	1031.89	bi-annual	Till

3.6.2 Review of Time Trends

Figure 3-13a/b illustrates the water quality time trends for wells located in the northern section of the Intermediate Dam (X24A/B/C/D and P01-03). Since 2001, SO4, Mg, Zn and Mn concentrations have increased in each of these wells. This trend continued throughout most of the current monitoring period. Note that the highest contaminant concentrations have been consistently observed in the deepest well (X24D).

The trend of increasing oxidation products and metal concentrations in the aquifer at X24 is indicative of mine waste seepage. The exact source cannot be deduced from the available data yet seepage from the Intermediate Pond was excluded by RGC (2008). Hence the coarse tailings beaches located in the northern portions of the Intermediate, Second or Original Impoundments and/or seepage from the Faro Creek channel/diversion channel are the probable sources.

As noted earlier, a more detailed geochemical assessment of groundwater quality at P03-06 had indicated that seepage from the Faro Creek diversion/channel is impacting the northern portion of the Rose Creek aquifer (RGC, 2009). Again, interception of Faro Creek seepage (since late 2006) may potentially improve groundwater quality at X24. However, a reduction in contaminant concentrations at X24 can be expected to be significantly delayed (by 4 to 20 years) owing to the long travel distance and potential for geochemical reactions (RGC, 2009). It is recommended that a similar geochemical assessment (including finger-printing and geochemical mixing calculations) be performed for groundwater at X24 to determine the proportion of Faro Creek seepage in groundwater in this reach of the aquifer.

Figure 3-14a/b illustrates the water quality time trends in the wells screened in the southern section of the Intermediate Dam (X25A/B, P01-04A/B). Note that there appears to be a mix-up in well ID of P01-04A and P01-04B starting in 2006. The depth of these two wells should be checked in the field and the existing groundwater quality data corrected in the field/database as required.

Groundwater quality in the aquifer beneath the southern portion of the Intermediate Dam is generally characterized by significantly lower SO_4 and Mg concentrations than observed in the northern portion. Most water quality parameters remained unchanged in the wells of the southern section of the Intermediate Dam. A notable exception was the concentration of SO_4, which increased in each of the wells except P01-04B (or P01-04A?). Note that Zn concentrations have remained at or below the detection limit for the current monitoring period in all wells located on the southern side of the Intermediate Dam.

3.7 Toe of Cross Valley Dam

3.7.1 Background

Table 3-5 summarizes pertinent information related to the groundwater monitoring wells located along the toe of the Cross Valley Dam, including year of construction, installation details (total depth, screening interval) and status of monitoring.

3.7.2 Review of Time Trends

Water quality time trends in the wells screened at the toe of the Cross Valley Dam are shown in Figures 3-15a/b to 3-17a/b. Concentrations of oxidation products (i.e. SO_4, Mg, and alkalinity) and Mn continued to increase in wells located along the northern toe of the Cross Valley Dam (P01-11, P05-01 and P05-02). This gradual increase in oxidation products (primarily SO_4 and Mg) on the north side of Cross Valley Dam mimics the breakthrough of those constituents observed further upgradient at the Intermediate Dam (at X24), except for a delay by about 3-4 years.

Table 3-5. Monitoring wells at the toe of the Cross Valley Dam, Rose Creek Tailings Facility

Well ID	Year of Construction	Total Depth (m bgs)	Top of Screen (m bgs)	Bottom of Screen (m bgs)	Top of Casing Elevation (m asl)	Current Status of Monitoring	Formation
Toe of Cross Valley							
P01-02A	2001	14.1	12.54	14.06	1019.73	bi-annual	Alluvium
P01-02B	2001	28.4	26.88	28.4	1019.71	bi-annual	Till
P01-11	2001	10.7	9.15	10.67	1017.83	bi-annual	Alluvium
P03-09-01	2003	35.1	34.75	35.05	1018.51	bi-annual plus AMP	Alluvium
P03-09-02	2003	32.3	32.00	32.31	1018.51	bi-annual plus AMP	Alluvium
P03-09-03	2003	27.1	26.82	27.13	1018.51	bi-annual plus AMP	Alluvium
P03-09-04	2003	23.8	23.47	23.77	1018.51	bi-annual plus AMP	Alluvium
P03-09-05	2003	21.9	21.64	21.95	1018.51	bi-annual plus AMP	Alluvium
P03-09-06	2003	18.9	18.59	18.90	1018.51	bi-annual plus AMP	Alluvium
P03-09-07	2003	13.4	13.11	13.41	1018.51	bi-annual plus AMP	Alluvium
P03-09-08	2003	9.4	9.14	9.45	1018.51	bi-annual plus AMP	Alluvium
P03-09-09	2003	7.6	7.32	7.62	1018.51	bi-annual plus AMP	Alluvium
MW1	2005	17.7	1.95/12.19	9.74/17.67	1016.97	not routinely monitored	Alluvium
MW2	2005	14.9	2.19	14.89	1018.23	not routinely monitored	Alluvium
P05-01-01	2005	25.5	25.15	25.45	1018.00	bi-annual	Till/BR
P05-01-02	2005	19.8	19.67	19.82	1018.00	bi-annual	Alluvium
P05-01-03	2005	16.8	16.62	16.77	1018.00	bi-annual	Alluvium
P05-01-04	2005	11.3	11.13	11.28	1018.00	bi-annual	Alluvium
P05-01-05	2005	5.5	5.33	5.48	1018.00	bi-annual	Alluvium
P05-01-06	2005	3.4	3.20	3.35	1018.00	bi-annual	Alluvium
P05-02	2005	5.2	1.83	4.88	1016.67	bi-annual	Alluvium
P05-03	2005	7.6	3.44	7.62	1019.79	bi-annual	Alluvium
RGC-PW1	2005	21.1	4.19/16.38	5.79/19.59	1017.31	not routinely monitored	Alluvium
RGC-PW2	2005	16.9	4.19	15.39	1018.64	not routinely monitored	Alluvium

Note that Zn (and Fe) did not increase during the current observation period and even decreased in some wells (e.g. in P01-11, P05-01)[1]. This lag in breakthrough of Zn may be a result of sorption along the flow path which results in retardation of the Zn relative to transport of SO4 and Mg. Nevertheless, it is anticipated that contaminant concentrations (including Zn) in the northern portion of the aquifer will further increase over time and will gradually approach those observed at X24.

The monitoring well located near the center of the Cross Valley Dam (P03-09 and P05-03) continue to be less impacted than the northern portion of the aquifer. However, most oxidation products (SO4,

[1] Note that the laboratory method for metals (including zinc) was changed in 2008 resulting in much lower method of detection limits for zinc. In some cases this resulted in an apparent decrease in observed zinc concentrations as the concentrations are plotted at the mdl.

Mg, alkalinity) and Mn continued to increase during the current observation period indicating a gradual breakthrough of seepage water from upgradient. As observed further north, Zn concentrations did not increase in those wells (P03-09) or actually decreased (e.g. in P05-03).

The two monitoring wells located near the southern abutment of the Cross Valley Dam (P01-11A/B) continued to show no impact of tailings seepage.

3.8 Downstream of Cross Valley Dam

3.8.1 Background

Table 3-6 lists pertinent information of all groundwater monitoring wells located down-gradient of the Cross Valley Dam, including year of construction, installation details (total depth, screening interval) and status of monitoring.

Table 3-6. Monitoring wells downgradient of Cross Valley Dam, Rose Creek Tailings Facility

Well ID	Year of Construction	Total Depth (m bgs)	Top of Screen (m bgs)	Bottom of Screen (m bgs)	Top of Casing Elevation (m asl)	Current Status of Monitoring	Formation
Downgradient of							
X16A	1981	6.0	3	6	1016.41	bi-annual	Alluvium
X16B	1981	34.0	20	34	1016.01	bi-annual	Alluvium
X17A	1981	6.2	4.5	6.2	1015.45	bi-annual	Alluvium
X17B	1981	25.0	17	25	1014.89	bi-annual	Alluvium
X18A	1981	10.6	8.8	10.6	1019.59	bi-annual	Alluvium
X18B	1981	22.8	16.6	22.8	1019.65	bi-annual	Alluvium
P01-01A	2001	21.4	19.8	21.36	1015.86	bi-annual	Alluvium
P01-01B	2001	35.3	33.78	35.3	1015.86	bi-annual	Alluvium

3.8.2 Review of Time Trends

Figures 3-18a/b show the water quality time trends in wells (X16A/B, X17A/B, X18A/B and P01-01A/B) located at some distance down-gradient of the Cross Valley Dam. Monitoring wells located on the northern side of Rose Creek Valley (X18A/B, P01-01A/B) continued to show an increase in oxidation products (SO4 and Mg) during the current monitoring period. As observed near the Cross Valley Dam, Zn concentrations remained constant or actually decreased in 2008.

This gradual increase in oxidation products (primarily SO_4 and Mg) on the north side of Rose Creek aquifer is believed to represent the leading edge of the breakthrough of those constituents observed further upgradient at the Cross Valley Dam (P01-11, P05-01) and ultimately at the Intermediate Dam (at X24). It is therefore anticipated that concentrations of SO_4 and Mg, and eventually Zn and other metals (Fe, Mn) will continue to increase over time.

The monitoring wells located in the center of the Rose Creek valley (X16A/B, X17A/B) continued to show no signs of a breakthrough of tailings seepage suggesting that the impact of tailings seepage is limited to the northern portion of the aquifer at greater distance from the Cross Valley Dam.

4 GRUM & VANGORDA MINE SITE

4.1 Geographic Overview

Figure 4-1 shows the general layout of the Grum/Vangorda mine-site, including the mine waste-units and the groundwater monitoring wells in the area. The Grum site comprises the Grum Pit, Grum rock dump (with sulphide cell) and the overburden stockpile. The Vangorda site comprises the Vangorda Pit (with in-pit rock dumps) and the Vangorda rock dump. Groundwater monitoring is generally concentrated along the toes of the rock dumps.

4.2 Downstream of Grum Rock Dump

4.2.1 Background

Figure 4-2 shows the locations of the monitoring wells located down-gradient of the Grum Rock Dump and Table 4-1 lists pertinent information of those monitoring wells, including year of construction, installation details (total depth, screening interval) and status of monitoring.

Table 4-1. Monitoring wells downgradient of Grum Rock Dump

Well ID	Year of Construction	Total Depth (m bgs)	Top of Screen (m bgs)	Bottom of Screen (m bgs)	Top of Casing Elevation (m asl)	Current Status of Monitoring	Formation
Grum WRD Area							
P96-9A	1996	9.5	4.96	9.45	~1098	bi-annual	Overburden
SRK04-5A	2004	23.7	22.7	23.7	1103.93	no longer sampled	BR (weathered)
SRK04-5B	2004	14.7	13.7	14.7	1103.95	no longer sampled	Overburden
BH05-9B-R	2005	18.6	15.5	18.6	1101.06	bi-annual	Overburden/BR
SRK05-05C	2005	3.2	1.5	3	1104.08	bi-annual	Overburden
SRK05-06	2005	2.7	0.7	2.7	1073.83	bi-annual	Overburden
SRK05-07	2005	5.8	0.75	5.8	1107.30	bi-annual	Overburden/BR
SRK05-08	2005	7.6	2.1	7.6	1105.25	bi-annual	Overburden
SRK05-09	2005	3.7	0.5	3.5	1072.82	no longer sampled	Overburden

4.2.2 Review of Time Trends

Figure 4-3a/b shows selected water quality time trends for the monitoring wells located near Grum Creek and down-gradient of the Moose Pond. Groundwater quality for most of the wells located down-stream of Grum Rock Dump remained unchanged during the monitoring period. An exception was SRK05-09 (a.k.a. Moose Well 2), which is located downstream of Moose Pond. In this well, the concentrations of SO_4 and Mg increased significantly throughout 2008. Groundwater quality in Moose Well #2 has been shown to be impacted by seepage from Moose Pond (station V2A), which collects seepage from the Grum Rock Dump (RGC, 2008). Note that the seepage collection system at Grum Dump was changed in 2007, resulting in direction of more contaminated water to Moose Pond (to prevent direct discharge to surface waters). This change in seepage management is likely responsible for the deterioration in groundwater quality at 'Moose Well 2'.

Note that Zn concentrations in SRK05-09 decreased during the current observation period. It is unclear whether this is a result of improved detection limits in the laboratory or reduced loading (or higher adsorption) in the field.

Water quality time trends for monitoring wells located west of Grum Creek are shown in Figure 4-4a/b. Concentrations of oxidation products (SO_4, Mg and alkalinity) in P96-9A, screened in alluvial sediments in a narrow side drainage, appeared to reach a plateau in 2007 and did not further increase in 2008. Zn concentrations in this well remained below peak concentrations observed in previous years.

The two monitoring wells located further west (SRK05-07 and SRK05-08) and screened in shallow phyllite bedrock showed a continued increase in oxidation products (SO_4, Mg and alkalinity) suggesting that a gradual breakthrough of seepage from Grum Dump is also occurring in the weathered bedrock. Zn concentrations remained elevated in SRK05-07 but decreased in SRK05-08.

These monitoring data suggest that seepage from the Grum waste rock dump affects groundwater quality not only in narrow valleys with permeable alluvial sediments (e.g. near P96-9A0 but also increasingly in the less permeable weathered bedrock along the toe of Grum Dump. Nevertheless, contaminant loads are likely to be significantly higher in the alluvial sediments due to the higher permeability and hence higher flow rates.

4.3 Vangorda WRD area

4.3.1 Background

Figure 4-5 shows the locations of the monitoring wells located down-gradient of the Vangorda Rock Dump and Table 4-2 summarizes pertinent information related to those monitoring wells, including year of construction, installation details (total depth, screening interval) and status of monitoring.

Table 4-2. Monitoring wells downgradient of Vangorda Rock Dump

Well ID	Year of Construction	Total Depth (m bgs)	Top of Screen (m bgs)	Bottom of Screen (m bgs)	Top of Casing Elevation (m asl)	Current Status of Monitoring	Formation
Vangorda WRD Area							
V34	1994	12.5	n/a	n/a	1117.45	bi-annual	BR
V35	1994	15.5	n/a	n/a	1117.41	bi-annual	Alluvium
V36	1994	11.9	n/a	n/a	1118.43	bi-annual	Alluvium
V37	1994	14.1	n/a	n/a	1116.17	bi-annual	Alluvium
P2001-02A	2001	13.6	n/a	n/a	~1118	bi-annual	n/a
P2001-02B	2001	27.0	n/a	n/a	~1118	bi-annual	n/a
P2001-03	2001	n/a	n/a	n/a	~1121	bi-annual	n/a

4.3.2 Review of Time Trends

Figure 4-6a/b shows selected water quality time trends for the monitoring wells located down-gradient of the Vangorda Rock Dump. No significant changes in groundwater quality were observed for the wells in this area. Note, however, that monitoring well V34, located to the southeast of Vangorda Rock Dump, continued to show a gradual increase in concentrations of SO4, Mg and alkalinity suggesting a gradual breakthrough of neutralized waste rock seepage.

Note also that Zn concentrations were consistently lower in 2008 compared to 2007 in all wells (except V34). It is unclear whether this is a result of the change in laboratory methods (and detection limit) or dilution in the groundwater system.

5 CONCLUSIONS & RECOMMENDATIONS

Recent time trends in groundwater quality were reviewed in different reaches of the Anvil Range Mining Complex in order to identify changes in groundwater quality that have occurred since July 2007. The following sub-sections summarize the main conclusions and recommendations of this review by reach.

5.1 Conclusions

5.1.1 Faro Mine Site

The main conclusions of the groundwater quality review at the Faro Mine Site are as follows:

- Elevated levels of ARD products were observed in selected wells of the Emergency Tailings Area (ETA), which is consistent with the conclusion that this area remains a major source of contaminant loading;
- The groundwater quality in several wells located in the S-cluster area continued to deteriorate over the monitoring period, supporting earlier recommendations that seepage interception in this area should be prioritized;
- Groundwater quality in the Zone 2 Outwash Area remained relatively stable over the monitoring period;
- Groundwater quality down-gradient of the Northeastern Dump at BH14A/B deteriorated over the monitoring period, probably due to seepage from the sulphide-rich waste rock that has been identified in the area. This observation raises concerns that contaminant loading from the Northeastern Dump to the NFRC may increase over time potentially also requiring seepage interception.

5.1.2 Rose Creek Tailings Facility

The main conclusions of the groundwater quality review at the Rose Creek Tailings facility are as follows:

- Groundwater quality in the northern portion of the Rose Creek aquifer continued to deteriorate during the 2008 monitoring period. Of particular concern are recent increases in SO_4, Mg, and metal concentrations (including Fe, Zn, and Mn) observed at P03-06, located near the Faro Creek Canyon and immediately downgradient of the Original Impoundment. The recent time trends in this and other wells further downgradient confirm that the entire depth of the aquifer is affected by seepage. The most probable sources of ARD seepage in this area include the coarse tailings beaches located in the northern portion of the Second or Original Impoundments and/or seepage from the Faro Creek canyon/diversion channel (RGC, 2009).
- Impacted groundwater continues to move downgradient in the northern portion of the Rose Creek aquifer, as evidenced by a gradual breakthrough of SO_4, Mg, alkalinity and selected metals (Fe, Mn) in monitoring wells at the Intermediate dam (X24), Cross Valley Dam (P01-11, P05-01) and further downstream (X18, P01-01). The transport of Zn is still significantly

delayed due to chemical attenuation in the aquifer. In fact, Zn concentrations in many monitoring wells located at the Cross Valley Dam showed an apparent decline in Zn concentrations in 2008. This apparent decline could be, at least in part due to improved laboratory techniques implemented in 2008 resulting in a lower method of detection limit (mdl).

- The groundwater in the southern portion of the aquifer did not experience the same deterioration in groundwater quality in recent years as observed in the northern portion. Several of the highly impacted wells screened beneath the Second impoundment either stabilized in recent years (e.g. P03-03) or even showed a notable improvement in groundwater quality (e.g. P03-04). Decommissioning of several “leaky wells” may have contributed to the recent improvement in groundwater quality in the southern portion of the aquifer.

5.1.3 Grum/Vangorda Mine Site

The main conclusions of the groundwater quality review at the Grum/Vangorda mine site are as follows:

- Groundwater quality for most of the wells located downgradient of Grum Rock Dump and screened in shallow overburden soils continued to show some impact of neutralized mine drainage but did not deteriorate further during 2008. However, recent monitoring in two shallow bedrock wells (SRK05-07 and SRK05-08) showed a continued increase in oxidation products (SO4, Mg and alkalinity) suggesting that a gradual breakthrough of seepage from Grum Dump is also occurring in the weathered bedrock.
- Groundwater quality in monitoring wells located downgradient of the Vangorda Rock Dump (and screened in till) continued to show limited impact of neutralized mine drainage. No significant changes in groundwater quality were observed for the wells in this area. Zn concentrations were consistently lower in 2008 compared to 2007 in all wells possibly due to improved laboratory techniques implemented in 2008 resulting in a lower method of detection limit (mdl).

5.2 Recommendations

5.2.1 Routine Groundwater Monitoring

In general, the 2008 groundwater monitoring program at the Anvil Range Mining Complex followed the scope of monitoring proposed in the 2007 Groundwater Review Report (see tables 5.1 to 5.3 in RGC, 2008). Based on the review of the 2008 monitoring data we recommend the following changes to the groundwater monitoring program for 2009 (see tables 5-1 to 5-3):

- Increase frequency of monitoring to four times per season (May to November) for selected monitoring wells located on the northern side of Rose Creek valley (P03-06, X21, X24, P01-11, P05-01) to monitor ongoing breakthrough of contaminants and potential benefit of seepage interception of Faro Creek seepage at ETA SIS;
- Include all new monitoring wells installed in 2008 at the Faro and Grum/Vangorda mine sites (SRK, 2009) into the routine monitoring program. Those wells should be initally sampled two

additional times during the 2009 season (May and September). Those initial results should be reviewed in the 2009 groundwater review report to determine long-term monitoring requirements in those new wells.

- Monitoring wells TH86-2 and TH86-5, located upgradient of the Rose Creek Tailings facility, should be included in future routine monitoring as additional background wells for the Rose Creek valley (to be sampled annually).
- Chloride should be dropped from the “full suite” of parameters to be analysed in most wells (see RGC, 2008); a “reduced suite” of parameters (lab-EC, lab-pH, Ca, Mg, Na, K, SO4, alkalinity, Fe, Mn, and Zn) should be analyzed in selected wells to be sampled annually (see tables 5-1 to 5-3).

Table 5-1.

Recommended Scope of Groundwater Monitoring in 2009 for Faro Mine Site.

Well ID	Region	Northing UTM z8 NAD27	Easting UTM z8 NAD27	Proposed Frequency	Proposed Analysis Scheme
Faro Mine Site					
P96-8A	ETA Area	6913898	583328	Semi-annual	Full
P96-8B	ETA Area	6913898	583328	Semi-annual	Full
SRK04-3A	ETA Area	6913824	582977	Annual	Reduced
SRK05-ETA-BR1	ETA Area	6913846	582972	Annual	Reduced
SRK05-ETA-BR2	ETA Area	6913825	582987	Annual	Reduced
S1A	S-cluster Area	6912942	584539	Semi-annual	Full
S1B	S-cluster Area	6912942	584539	Semi-annual	Full
S2A	S-cluster Area	6912944	584577	Semi-annual	Full
S2B	S-cluster Area	6912944	584577	Semi-annual	Full
P96-7	S-cluster Area	6913105	584225	Semi-annual	Full
SRK05-SP-1A	S-cluster Area	6912901	584727	Annual	Reduced
SRK05-SP-1B	S-cluster Area	6912901	584726	Annual	Reduced
SRK05-SP-2	S-cluster Area	6912861	584791	Annual	Reduced
SRK05-SP-3A	S-cluster Area	6912924	584651	Annual	Reduced
SRK05-SP-3B	S-cluster Area	6912924	584652	Annual	Reduced
SRK05-SP-4A	S-cluster Area	6912939	584612	Semi-annual	Full
SRK05-SP-4B	S-cluster Area	6912939	584611	Semi-annual	Full
SRK05-SP-5	S-cluster Area	6912956	584576	Semi-annual	Full
BH1	Zone 2 Outwash	6913532	585267	Semi-annual	Full
BH2	Zone 2 Outwash	6913523	585206	Semi-annual	Full
BH4	Zone 2 Outwash	6913467	585247	Semi-annual	Full
BH5	Zone 2 Outwash	6913377	585194	Semi-annual	Full
BH6	Zone 2 Outwash	6913466	585198	Semi-annual	Full
BH8	Zone 2 Outwash	6913599	585253	Annual	Full
BH10A	Zone 2 Outwash	6913533	585190	Annual	Full
BH10B	Zone 2 Outwash	6913533	585191	Annual	Full
P05-04	Zone 2 Outwash	6913475	585224	Semi-annual	Full
Zone 2 Pumping Well (X26)	Zone 2 pit	6913770	584868	Semi-annual	Full
BH12A	NE Dumps	6914068	585871	Semi-annual	Reduced
BH12B	NE Dumps	6914068	585871	Semi-annual	Reduced
BH13A	NE Dumps	6914339	585844	Semi-annual	Reduced
BH13B	NE Dumps	6914339	585844	Semi-annual	Reduced
BH14A	NE Dumps	6913826	585676	Semi-annual	Full
BH14B	NE Dumps	6913826	585676	Semi-annual	Full
P96-6	Intermediate Dump (NFRC)	6913133	584999	Semi-annual	Full

Table 5-2

Recommended Scope of Groundwater Monitoring in 2009 for Rose Creek Tailings Facility.

Well ID	Region	Northing UTM z8 NAD27	Easting UTM z8 NAD27	Proposed Frequency	Proposed Analysis Scheme
Rose Creek Tailings Facility					
TH86-2	upgradient	?	?	Annual	Reduced
TH86-5	upgradient	?	?	Annual	Reduced
TH86-17	upgradient	6912489	583943	Annual	Reduced
P03-01 (-02,-04,-06,-08,-09)	Second Impoundment	6912580	583301	Annual	Full
P03-03 (-02,-04,-06,-08,-09)	Second Impoundment	6912698	583068	Annual	Full
P03-04 (-02,-04,-06,-08)	Second Impoundment	6913186	582085	Annual	Full
P03-05 (-02,-04,-06,-08)	Second Impoundment	6912934	582605	Annual	Full
P03-06 (all ports)	Second Impoundment	6913309	582573	4x per season	Full
X21A-96	Intermediate Impoundment	6913417	581989	4x per season	Full
X21B-96	Intermediate Impoundment	6913417	581989	4x per season	Full
P03-08 (-02,-04,-06,-07,-08)	Intermediate Impoundment	6913514	580980	Annual	Full
X24D-96	Intermediate Dam	6914124	580655	4x per season	Full
X25A-96	Intermediate Dam	6913945	580519	Semi-annual	Full
X25B-96	Intermediate Dam	6913945	580519	Semi-annual	Full
P01-03	Intermediate Dam	6914071	580639	4x per season	Full
P01-04A	Intermediate Dam	6913893	580496	Semi-annual	Full
P01-04B	Intermediate Dam	6913893	580496	Semi-annual	Full
P01-02A	Cross Valley Dam	6914044	580051	Semi-annual	Full
P01-02B	Cross Valley Dam	6914044	580051	Semi-annual	Full
P01-11	Cross Valley Dam	6914306	580214	4x per season	Full
P03-09 (-02,-04,-06,-08,-09)	Cross Valley Dam	6914229	580065	Semi-annual	Full
P05-01 (all ports)	Cross Valley Dam	6914335	580165	4x per season	Full
P05-02	Cross Valley Dam	6914265	580144	Semi-annual	Full
P05-03	Cross Valley Dam	6914171	580088	Semi-annual	Full
X16A	Downgradient of CVD	6914672	579574	Semi-annual	Full
X16B	Downgradient of CVD	6914672	579574	Semi-annual	Full
X17A	Downgradient of CVD	6914475	579874	Semi-annual	Full
X17B	Downgradient of CVD	6914475	579874	Semi-annual	Full
X18A	Downgradient of CVD	6914539	580105	Semi-annual	Full
X18B	Downgradient of CVD	6914539	580105	Semi-annual	Full
P01-01A	Downgradient of CVD	6914675	579819	Semi-annual	Full
P01-01B	Downgradient of CVD	6914675	579819	Semi-annual	Full

Table 5-3

Recommended Scope of Groundwater Monitoring in 2009 for Grum/Vangorda Mine Site

Well ID	Region	Northing UTM z8 NAD27	Easting UTM z8 NAD27	Proposed Frequency	Proposed Analysis Scheme
Grum/Vangorda Mine Site					
P96-9A	Grum Rock Dump	6903165	592753	Semi-annual	Full
BH05-9B-R	Grum Rock Dump	6903172	592747	Semi-annual	Full
SRK05-05C	Grum Rock Dump	6903208	592873	Semi-annual	Full
SRK05-07	Grum Rock Dump	6903011	592477	Semi-annual	Full
SRK05-08	Grum Rock Dump	6903063	592690	Semi-annual	Full
SRK05-09 ("Moose Well 2")	Grum Rock Dump	6902986	593058	Semi-annual	Full
V34	Vangorda Rock Dump	6902295	593553	Semi-annual	Full
V35	Vangorda Rock Dump	6902371	593293	Semi-annual	Full
V36	Vangorda Rock Dump	6902733	593243	Semi-annual	Full
V37	Vangorda Rock Dump	6902913	593420	Semi-annual	Full
P2001-02A	Vangorda Rock Dump	6902880	593098	Semi-annual	Full
P2001-02B	Vangorda Rock Dump	6902880	593098	Semi-annual	Full
P2001-03	Vangorda Rock Dump	6902865	593131	Semi-annual	Full

5.2.2 Future Assessment Work

Groundwater monitoring in the Rose Creek valley has shown a significant deterioration in groundwater quality in the last 2 - 3 years in the northern portion of the valley, from P03-06 in the Second Impoundment to the Intermediate Dam (at X24) and Cross Valley Dam (at P01-11, P05-01, P05-02). Geochemical fingerprinting and mixing calculations suggest that Faro Creek seepage could have caused, or at least contributed to, this recent deterioration in groundwater quality in the northern portion of the Rose Creek aquifer (RGC, 2009).

If this hypothesis is correct, the recent start-up of the seepage interception system in the ETA area (intercepting much of the Faro Creek seepage) may, in time, result in an improvement of groundwater quality on the north side of the Rose Creek aquifer.

We recommend that a more comprehensive geochemical assessment be completed that includes additional mixing calculations for other wells located downgradient of the Intermediate Dam (X21, X24) and the Cross Valley Dam (P01-11, P05-01, P05-02) which have shown recent increases in contaminant concentrations. In addition, consideration should be given to collecting stable isotope data in order to further constrain the sources of contaminants to the Rose Creek aquifer.

We also recommend that the performance of the ETA seepage interception system be reviewed to assess the extent of contaminant load reduction from Faro Creek seepage to the Rose Creek aquifer.

Groundwater monitoring in the North Fork Rose Creek area, upgradient of the rock drain, has shown consistently elevated zinc concentrations. Owing to the high permeability of the NFRC sediments the zinc load in this aquifer is significant. We recommend that additional geochemical characterization work be completed (including geochemical finger-printing, mixing calculations and potentially use of isotopic tracers) to determine the relative contribution of Zone 2 pit seepage, waste rock seepage and leakage from the outwash sediments in this reach of the NFRC. Such an analysis would provide guidance in the design of a seepage interception system along the NFRC reach.

6 CLOSURE

This report was prepared by Robertson GeoConsultants Inc., for Deloitte & Touche Inc. in its capacity as Interim Receiver of Anvil Range Mining Corporation. No third-party engineer or consultant shall rely on any of the information, conclusions, opinions, or any other material contained in this report without the express written consent of Deloitte & Touche Inc. and RGC.

We trust that the information provided in this report meets your requirements at this time. Should you have any questions or if we can be of further assistance, please do not hesitate to contact the undersigned.

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