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Deloitte & Touche

AMP Event #4 Response: Status Report

Prepared for:

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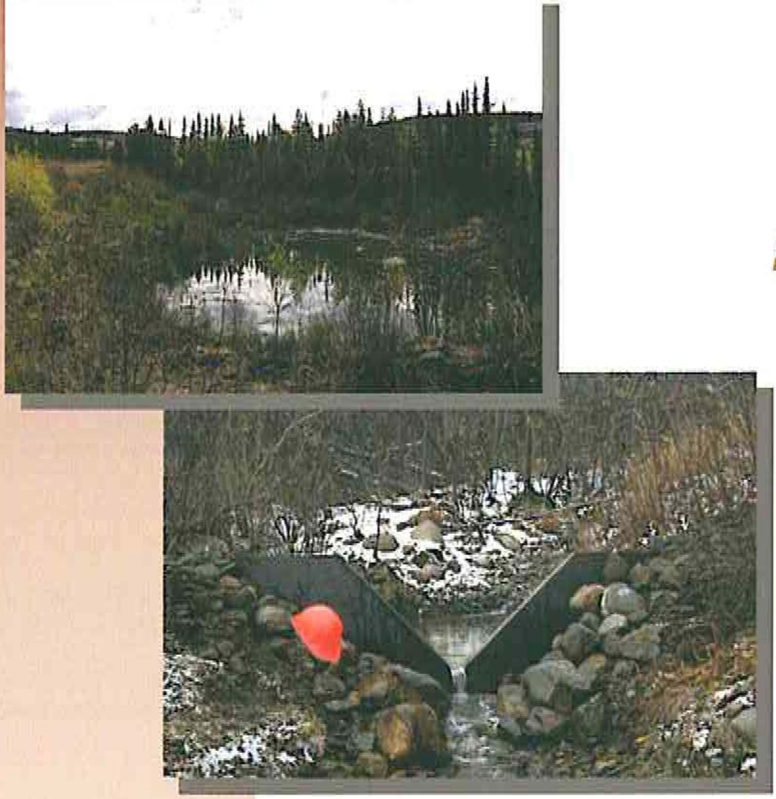

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1 Introduction

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, 2004a). The AMP outlines the short-term mine management strategies that has been instituted to ensure environmental protection during the period leading up to the implementation of a Final Closure and Reclamation Plan, which is expected to be in place in 2008.

The AMP specifies eight events that, if triggered, would require a management response to ensure maintenance of acceptable environmental conditions. 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, over the 1998 to 2002 reference period. This trigger was intended to provide an indication that oxidation products are being released from the dump, and that increased monitoring and surveillance is now required to ensure protection of Vangorda Creek.

Loadings from Grum Dump to Vangorda Creek have historically been monitored at station V2, on Tributary A of Grum Creek (Figure 1.1). As indicated in the July 16, 2004 letter of notification to the Water Board (SRK 2004a- see Appendix D), the specific threshold for total sulphate at V2 was exceeded on the date of AMP implementation (July 1, 2004).

Although increased sulphate concentrations do not in themselves present a threat to Vangorda Creek, a management response is required as part of the AMP. On August 16, 2004, SRK Consulting (SRK) submitted a letter to the Water Board, on behalf of Deloitte and Touche, outlining the proposed response plan to address this issue (SRK 2004b- see Appendix D). The plan included a series of investigative actions intended to better understand hydrological and geochemical conditions downgradient of the Grum Dump, and to assess the level of environmental impact of Grum Dump loadings on Vangorda Creek.

Key components of the plan were:

- Collection of routine water quality samples;
- Review of existing water quality records;
- Seepage surveys;
- Detailed contaminant pathway survey;
- Installation of flow monitoring station on Grum Creek;
- Groundwater monitoring well installation; and
- Reporting.

The potential for increased contaminant loading from the Grum Dump was acknowledged prior to implementation of the AMP. Therefore, several of these activities were already underway. Where relevant, results from these studies are included in this report. In addition, an evaluation of seepage collection options for surface and shallow groundwater downgradient of Grum Dump was completed in June 2004 (SRK 2004d).

The Response Plan was initiated in the second half of 2004. This document is intended to record the current status of the various response activities, to present estimates of contaminant loading from the Grum Dump to Vangorda Creek, to evaluate the environmental significance of the contaminant loading, to determine thresholds for implementation of mitigation measures, and to outline plans for continuation of response activities.

The document is organized as follows:

- Section 2 summarizes the field investigation and data review activities that were completed as part of AMP response.
- Section 3 provides a discussion of water quality data in Vangorda Creek, and in the various surface and groundwater pathways identified downgradient of the Grum Dump.
- Section 4 presents a water and load balance for Vangorda Creek and the Grum Dump;
- Section 5 presents a summary and conclusions of the study; and
- Section 6 presents recommendations for further monitoring, investigations and proposed thresholds for implementation of mitigation methods.

2 Field Investigations and Data Review

2.1 Overview

A number of activities and investigations were outlined in the Response Plan (SRK 2004b). The following is a brief summary of the field investigations and data review undertaken to improve the understanding of the hydrological and geochemical conditions downgradient of the Grum Dump.

2.2 Ongoing Collection of Routine Water Samples

The Water Licence specifies five surface water quality stations, and one groundwater well downgradient of Grum Dump that are to be monitored either monthly or on a spring-fall basis (Figure 2.1). These include:

- V2 - located on the main stem of Grum Creek, below Tributary B
- V2A - located on the ditch that presently diverts Grum Creek into Moose Pond
- V14 - located at the Grum Dump Toe Access Road upgradient of Sheep Creek. This station appears to have changed locations over the course of monitoring and may also have been monitored on the road downgradient of SRK-GD05, and upstream of V15 at the dump toe.
- V16 - located in the ditch adjacent to the Grum Toe Access Road between V15 and Grum Creek
- V15 - located at the outlet of the Tributary A sedimentation pond
- P96-9A- located adjacent to Tributary A, downgradient from V15.

The AMP defines these as Reference Water Quality (RWQ) stations. Monitoring of these stations is intended to identify the arrival of sulphide oxidation products from the upgradient sulphide waste, and to guide water management decisions to ensure protection of the aquatic receiving environment in Vangorda Creek. Monitoring of these stations was undertaken by site environmental staff according to the schedule defined in the Water Licence. Results of this ongoing water quality monitoring are reported in the Annual Environmental Reports (GLL 2003, 2004b, 2005a), and are summarized in Section 3.2.

Routine monitoring is also completed on a spring/fall basis at Station V1, upstream of the Vangorda Pit, and at V27, downstream of the Grum Dump, immediately above the confluence with Shrimp Creek, and historical baseline monitoring was completed at Station V1, and three stations (V11, V3 and V10) downstream of the Vangorda Deposit. This data is useful for determining background concentrations and loadings as well as evaluating whether there have been any changes in water quality since the start of mining operations. However, it must be recognized that Station V27 is located in-between the baseline stations V3 and V10, and that data from these stations may not reflect baseline conditions at Station V27.

2.3 Review of Existing Water Quality Record

The historical water quality data for the RWQ stations was verified to ensure that data held in the electronic environmental database agreed with the laboratory analytical certificates. A number of minor errors were identified, and the master database is in the process of being updated to reflect these corrections. The 2004 AMP Annual Report (GLL, 2005b) includes revisions to the section pertaining to seepage from the Grum Dump that reflect the corrections identified as part of this process.

It was found that errors in the database were related to incorrect sample station identification on field samples. These were later identified and corrected on paper copies of the laboratory analyses, but the electronic database was never updated to reflect the corrections. Errors were also found in the electronic data, which were due to the station names becoming separated from the appropriate records, and also where there was inconsistent handling of detection limit values. These types of errors are commonly found in historical monitoring databases, and do not negate the value of the historical data in evaluating mining related impacts. However, they must be recognized in the interpretation and analysis of the data.

The revisions to the data set have resulted in correcting what previously appeared to be erratic time-series records for some stations, particularly V2 and V2A. However, the revisions have not changed the conclusions that arise from review of the data, in that it is clear that an increased loading of oxidation products from Grum Dump is being detected at the downgradient monitoring sites.

2.4 Ongoing Waste Rock Seepage Surveys

Seeps at the toe of the Grum Dump have been sampled as part of the spring (May/June) and fall (September) seepage surveys completed since 2002. Results of the seep surveys are reported in SRK (2004c) and a summary of the relevant data is provided in Section 3.3. The purpose of the surveys was to determine the water quality associated with discrete seepage pathways exiting the toe of the dump, prior to any dilution or attenuation that could occur downgradient of the dump. The toe seeps are typically free of suspended sediments, and are analyzed for routine parameters and dissolved metals. Total metals are not included due to the potential for entrainment of sediments during sampling. The locations of the toe monitoring stations are shown in Figure 2.1.

2.5 Detailed Contaminant Pathway Survey

Additional sampling of seeps and surface water flows downgradient of the Grum Dump was initiated in 2003. This program was expanded in September 2004. The purpose of the more detailed investigation was to identify surface water flows and groundwater seeps that are not covered by the routine monitoring programs or by the annual waste rock seepage surveys, and to determine whether any of these other surface flows were contributing significantly to the zinc and sulphate loading in Vangorda Creek. Three general areas were surveyed: downgradient of Moose Pond, between the

Grum Creek diversion and Tributary A above V2, and south of Grum Dump to the west of Tributary A.

Downgradient of Moose Pond

Grum Creek currently flows into Moose Pond at station V2A (Figure 2.1). Rapid infiltration occurs into the base of Moose Pond such that ponded water is rarely observed and no surface flows or siphoning of water have occurred from Moose Pond since Grum Creek was diverted in 1995. Water quality at V2A is unacceptable for direct discharge to Vangorda Creek, and a seepage survey between Moose Pond and Vangorda Creek was included in the response plan to determine water quality in surface seepage waters.

The seepage survey was conducted from east to west along the gentle slope between the south wall of Moose Pond and Vangorda Creek. Three seeps were identified in this area, as discussed in Section 3.4.

Downgradient of Grum Creek diversion

It was suspected that the increases in sulphate concentrations at V2 may have been the result of leakage from the Grum Creek diversion (see Figure 1.1). As outlined in the Response Plan, a seepage survey was carried out in the small east of Tributary A upstream of V2 to identify any surface seepage from the diversion. Seepage was identified in two locations coincident with former stream channels, as discussed in Section 3.4.

West of Tributary A

No comprehensive seepage survey had previously been undertaken downgradient of Grum Dump west of Tributary A. To ensure that all surface seeps in this area were characterized, SRK conducted a survey from Tributary A to the hill west of Sheep Creek, and from Vangorda Creek to Grum Dump (Figure 2.1). This survey consisted of looking for seepage and surface water while traversing the south facing slope south of Grum Dump, between Grum Dump Toe Access Road and Vangorda Creek, and to the west of Grum Dump upslope of the road. Seepage water was located and sampled at five locations as discussed in Section 3.4.

2.6 Installation of Flow Monitoring Station on Grum Creek

Quantifying flow volumes in Grum Creek is necessary to accurately estimate contaminant loads moved via this pathway. To allow accurate flow measurements to be collected, a V-notch weir was installed on the main stem of Grum Creek immediately upstream of the Grum Toe Access Road, above the confluence of Grum Creek and Tributary B (Figure 2.1).

The weir is a 90° sharp-crested v-notch steel plate. Installation was accomplished by excavation of an upstream holding pond (1.1 to 1.7 m wide by 4.2 m long) with the site's rubber-tired Case backhoe.

The 1.5 m-long weir plate was installed across a narrow section by excavating a trench perpendicular to the stream, placing the weir plate using the backhoe, and backfilling the trench using native soil amended with bentonite pellets. A layer of bentonite pellets approximately 3 cm thick was placed against the upstream side of the weir and extended upstream for approximately 1 m, in an effort to form an upstream blanket to minimize seepage beneath the weir. The channel immediately below the weir was armoured with rocks for a distance of 0.6 m to protect against erosion.

Installation of water level monitoring equipment and instrumentation was partially completed in October 2004. A stilling well was positioned in the pool upstream of the weir in preparation for installation of a Thalimedes water level recorder prior to the 2005 freshet. An interim report on the hardware installation is provided as Appendix A.

2.7 Groundwater Monitoring Well Installation

Prior to 2004, groundwater monitoring downgradient of Grum Dump was limited to a single well (P96-9) adjacent to Tributary A. Due to the large flows and high contaminant concentrations in Grum Creek at the dump toe, the aquifer beneath Grum Creek is considered a potentially significant contaminant pathway. In order to monitor groundwater contamination along this flowpath, a single hole (SRK04-5) was drilled adjacent to Grum Creek just upslope of the Grum Toe Access Road and two nested monitoring wells were installed during September 2004. Drilling and installation is described in detail in a separate report (SRK 2004e). Location of these wells is shown in Figure 2.1, and the drill log for SRK04-5 is provided in Appendix C1. A brief summary of stratigraphic observations, well installation details and initial water quality results is provided in Section 3.5.2. Installation of additional monitoring wells downgradient of Grum Dump is planned for 2005.

3 Water Quality

3.1 Vangorda Creek

3.1.1 Baseline Conditions

The earliest available water quality available for Vangorda Creek is summarised in the Initial Environmental Evaluation (IEE) submitted to the Water Board by Curragh Resources Inc. (Curragh) as part of the permitting process for the Vangorda Plateau Mine (Curragh, 1989). Water quality in Vangorda Creek was monitored during the pre-mining period at Stations V1, V2, V3, V10, and V11. The resulting monitoring data provides pre-mining baseline conditions that existed in Vangorda Creek prior to development. Locations of the baseline monitoring stations are shown in Figure 2.1.

The discovery of the Vangorda ore deposit occurred when prospectors identified mineralization outcropping in Vangorda Creek. Baseline monitoring of water quality in Vangorda Creek upstream (at station V1) and downstream of the deposit (at station V11) showed an approximately two fold increase in zinc concentrations between the two stations (Figure 3.1), indicating that mineralization in the vicinity of the deposit was contributing to zinc loading in the creek.

Monitoring was also carried out to establish pre-development water quality in Vangorda Creek downstream of Grum Creek (station V3), and in Vangorda Creek downstream of Shrimp Creek (station V10). Zinc data for these stations are also summarized in Figure 3.1. The results indicate further increases in zinc concentration below Grum Creek: i.e. a two to five fold increase above those measured upstream of the deposit (station V1). Concentrations in V3 periodically exceeded the CCME guidelines for zinc of 0.03 mg/L. Zinc concentrations tended to be highest during the winter months when contributions from surface flows were at a minimum. Potential sources of zinc loading at this location include groundwater seepage from mineralized rock in the vicinity of the Vangorda and Grum deposits.

3.1.2 Operational and Post-operational Conditions

Water quality monitoring was a water licence condition from the onset of operations at the Vangorda Plateau mine site. Monitoring of upstream water quality at station V1 has been completed on at least a quarterly basis since the start of operations.

During operational monitoring, station V27 was established immediately upstream of the confluence of Vangorda Creek and Shrimp Creek. This station was intended to monitor the cumulative loading from the mine site upstream of Shrimp Creek, and replaced the baseline stations V11, V3 and V10.

Sulphate concentrations at Station V1 (Figure 3.2) were typically in the range of 5 to 20 mg/L. Sulphate concentrations at Station V27 were typically in the range of 20 to 100 mg/L, with occasional spikes of up to 200 mg/L. Concentrations have remained reasonably constant through the monitoring period, and concentrations downstream of the mine do not appear to have increased over time.

Zinc concentrations at Station V1 (Figure 3.3) have typically been in the range of 0.01 to 0.05 mg/L (average 0.025 mg/L). However, occasional spikes of up to 0.25 mg/L have been recorded. Zinc concentrations at Station V27 were typically in the range of 0.03 to 0.07 mg/L (average 0.052 mg/L), although concentrations of 0.1 mg/L were recorded on a regular basis, and occasional spikes of up to 0.17 mg/L have been recorded. Although average concentrations exceeded baseline concentrations at Station V3, there is no evidence of an increasing trend in zinc concentrations since the start of mining in 1991. This suggests that the difference between average baseline concentrations and average concentrations since the start of mining is not due to mining activities, but instead could be due to additional sources of natural mineralization between Grum Creek and Station V27. Zinc concentrations in the downstream station were typically above the CCME guidelines for freshwater aquatic life.

3.2 Grum Dump Reference Water Quality Stations

3.2.1 Baseline Conditions

Pre-development baseline conditions were monitored in Grum Creek at station V2, and were initially reported in the IEE (Curragh, 1989). Prior to the establishment of Grum Dump, Grum Creek consisted of a main stem, and two smaller tributaries named Tributary A and Tributary B. Station V2 was established on the main stem of Grum Creek a short distance above the confluence with Vangorda Creek, and downstream of the point of entry of both tributaries.

Figure 3.4 shows total zinc and sulphate concentrations for station V2 from prior to onset of mining at Grum in 1991 (RGI, 1996) to present. As shown in the figure, sulphate concentrations were approximately 25 mg/L and zinc concentrations were in the range of 0.01 mg/L prior to mining.

3.2.2 Operational and Post-operational Conditions

Station V2

Station V2, originally established as a baseline monitoring station, was included in the routine monitoring programs from the start of operations to present.

Construction of the Grum Dump began in 1991 with placement of waste rock and till. Erosion of dump material led to increased TSS and elevated zinc concentrations at V2, and in 1995, a sedimentation pond was constructed on Tributary A to reduce sediment transport from Grum Dump to V2 and Vangorda Creek. The Sheep Pad Ponds were also constructed to remove sediment from flows in Grum Interceptor Ditch, which were contributing to high TSS at V2 in Grum Creek (SRK 2002).

Also during 1995, the mine undertook surface works to redirect the entire flow of the main stem of Grum Creek above Tributary A to a natural depression referred to as Moose Pond (Figure 1.1). Since that time, Moose Pond has acted as a combination sedimentation pond and infiltration basin, and the majority of the flows from the main stem of Grum Creek report to that location. A siphon pipeline was installed from Moose Pond to V2, to be used to dewater Moose Pond in the event that water within the pond exceeded a specified elevation. This event has never occurred, and the siphon pipeline has never been put into service.

Concentration of runoff on the haul road and the surface of Grum Dump from 2000 to early 2002 lead to erosion of the dump face at several locations, and to increases in TSS and zinc concentrations at V2 over this time period. Deloitte & Touche completed surface water management works to prevent surface runoff from eroding dump faces, and TSS and zinc concentrations have since been lower and less erratic.

The record of zinc and sulphate concentrations at V2 is shown in Figure 3.4. The figure is annotated to outline the periods of different operational influences on water quality at V2. There is a clear trend of increasing sulphate concentrations at V2, with values increasing from approximately 25 mg/L prior to mining, to between 50 and 300 mg/L during operations, and then a further increase from 500 to 900 mg/L between 1999 and 2004. Zinc concentrations were initially in the range of 0.01 mg/L in the baseline data, and varied from 0.01 mg/L to as high as 4.4 mg/L (average 0.14 mg/L, 75th percentile 0.08 mg/L, 95th percentile 0.54 mg/L) from the start of operations to approximately 2002 when the erosion control measures were implemented. More recent concentrations have been consistently below 0.05 mg/L, typically in the range of 0.01 mg/L.

Station V2A

Station V2A was established in 1997 to monitor water quality in the main stem of Grum Creek, which was diverted to Moose Pond in 1995. The station is located immediately prior to the point of discharge into Moose Pond. The majority of the flow at V2A originates as seepage from the toe at the intersection of the dump and the original Grum Creek channel at SRK-GD01 (see Section 2.3). Tributary B also contributes runoff from east of Grum Creek to this flow. V2A has shown increasing trends of both sulphate and zinc concentrations, as shown in Figure 3.5, along with slightly alkaline pH values. Recent total zinc concentrations have been varied from near detection levels to nearly 3 mg/L, with the highest concentrations coinciding with the 2004 freshet. Average total zinc concentrations in the 2004 monitoring data were 1.0 mg/L.

Station V14 and V16

Stations V14 and V16 have been monitored on a sporadic basis, from 1989 in the case of V14 and from 1995 in the case of V16. V14 was originally established to sample seepage present on the Grum Dump Toe Access Road upgradient of Sheep Creek (Figure 2.1). However, station location maps also occasionally show V14 to be located on the road downgradient of SRK-GD05, as well as upstream of V15 at the dump toe. Given the uncertainty in the station location, the pre-2004 data for V14 should not be considered in assessing trends in seepage chemistry.

Station V16 is located in the ditch adjacent to the Grum Toe Access Road between V15 and Grum Creek (Figure 2.1), and was initially established in 1995 when water management activities included selective diversion of Grum Creek water to either Moose Pond or to V15, depending on water quality. During September 2004, this station was observed to receive seepage from the adjacent disturbed ground, particular in the area of SRK04-5. No September 2004 sample was collected during routine monitoring.

Zinc and sulphate data for the period of record are shown in Figure 3.6. Given the sporadic nature of the monitoring, trends in concentration cannot be reliably evaluated.

Station V15

Station V15 is located at the outlet of the Tributary A sedimentation pond (Figure 2.1), and has been a reliable sampling point since pond construction in 1995. This location is thought to be directly downgradient from the Grum sulphide cell, 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. A summary of sulphate and total and dissolved zinc concentrations at V15 is shown in Figure 3.7.

Sulphate concentrations at V15 have steadily increased since 1995 and were approximately 1500 mg/L as of November 2004. Dissolved and total zinc concentrations at V15 had high variably from 1995 to 2002, typically ranging from 0.01 to 0.1 mg/L, with occasional values as high as 1 mg/L. Following the implementation of dump runoff control in 2002, zinc concentrations have been lower and more uniform, ranging between 0.006 and 0.04 mg/L. Slightly alkaline waters have been observed over the period of record, with pH values consistently between 7 and 8 since 2000.

Station P96-9a and -9b

Wells P96-9a and P96-9b were installed in 1996 to monitor shallow and deep groundwater adjacent to Tributary A downstream of the Grum dump toe access road. Installation details and a summary of water quality results are included in the groundwater discussion in Section 3.5.

3.3 Grum Dump Toe Seepage Survey

SRK-GD01

SRK-GD01 is located where the main stem of Grum Creek emerges from the toe of Grum Dump (Figure 2.1). During initial surveys, two seeps were identified and separately sampled as SRK-GD01 and SRK-GD02. Review of analytical results showed that both had similar chemistry and were likely from the same source, and monitoring of SRK-GD02 was terminated.

SRK-GD01 represents the largest surface flow identified at the toe of Grum Dump by a wide margin, and is thus considered to be the most important single source of surface flows originating from the dump. Sulphate concentrations have remained between 1080 and 1320 mg/L over the monitoring period, and dissolved zinc concentrations have displayed a similar pattern from 2.5 to 5.1 mg/L, with one spike of 17.2 mg/L in May 2004. Neutral pH conditions were observed during all sampling rounds. Figure 3.8 shows dissolved zinc and total sulphate at SRK-GD01 over the three year period from 2002 to 2004.

SRK-GD04 and SRK-GD21

SRK-GD04 and SRK-GD21 are located immediately upgradient of V15 and Tributary A (Figure 2.1) at a minor topographic low along the dump toe. Surface flow in this area was observed during only 3 of 6 sampling rounds. Sulphate concentrations ranged from 1350 to 2170 mg/L, zinc concentrations ranged from 1.8 to 3.7 mg/L, and pH ranged from 7.1 to 7.6 standard pH units.

SRK-GD05 and SRK-GD06

SRK-GD05 and SRK–GD06 are located at the dump toe directly upgradient of the linear topographic depression shown on Figure 2.1 as No Fork Creek. During initial surveys, two seeps were identified and separately sampled as SRK-GD05 and SRK-GD06. Review of analytical results showed that both had similar chemistry and were likely from the same source. Therefore, monitoring of SRK-GD06 was terminated.

Sulphate and dissolved zinc data for SRK-GD05 are summarized in Figure 3.9. Slightly alkaline pH was observed at SRK-GD05 during all sampling rounds. Sulphate concentrations ranged from 1080 to 1680 mg/L over the monitoring period, and a general trend of increasing sulphate concentrations is apparent. Zinc concentrations range from 1.7 to 4.9 mg/L, with the highest concentrations measured in 2004. However, it is premature to infer an increasing trend in zinc concentrations, as the lowest concentrations were measured the previous year (2003).

Flows volumes at SRK-GD05 and SRK–GD06 are low compared to Grum Creek flows, but these seeps appear to flow continuously and were sampled during all sampling rounds. Although seepage infiltrates into the ground within a few metres of the dump toe, emergent seepage is observed topographically downgradient in No Fork Creek, 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 and a potential route for transport of contaminants from Grum Dump to Vangorda Creek. Sampling results from No Fork Creek are discussed in Section 3.4.

SRK-GD16

SRK-GD16 is located at the toe of Grum Dump topographically upgradient from the linear alignment shown on Figure 2.1 as Sweet Creek. Flows were observed during only one of six sampling rounds. Seepage had a field pH value of 7.5, a sulphate concentration of 1680 mg/L, and a dissolved zinc concentration of 10.8 mg/L.

During geotechnical investigations in 2003, a 4 m test pit was excavated adjacent to the Grum Dump toe access road (SRK, 2004d) at a location immediately downgradient of SRK-GD16. The pit was sited in a gentle topographic swale that is the upstream extension of the linear depression occupied by Sweet Creek. Although no surface flow was observed at SRK-GD16 at the time, heavy seepage into the test pit was observed at a depth of 3 m. The observed seepage flow rate was sufficient to cause destabilization and collapse of the test pit walls, and indicated that subsurface flow was likely occurring upgradient of Sweet Creek.

3.4 2004 Detailed Contaminant Pathway Survey

As discussed in Section 2.4, the detailed pathways survey covered three general areas: downgradient of Moose Pond, between the Grum Creek diversion and Tributary A above V2, and south of Grum Dump to the west of Tributary A. Results for each of these areas are discussed as follows.

Downgradient of Moose Pond

As discussed in Section 2.2.2, Grum Creek currently flows into Moose Pond at station V2A (Figure 2.1). Rapid infiltration occurs into the base of Moose Pond such that ponded water is rarely observed and no surface flows or siphoning of water have occurred from Moose Pond since Grum Creek was diverted in 1995. Water quality at V2A is unacceptable for direct discharge to Vangorda Creek, and a pathways survey between Moose Pond and Vangorda Creek was included in the response plan to identify and sample any groundwater seepage daylighting below the pond.

The seepage survey was conducted from east to west along the gentle slope between the south wall of Moose Pond and Vangorda Creek. Three seeps were identified in this area, as follows.

MP01

MP01 was the easternmost seep located between Moose Pond and Vangorda Creek (Figure 2.1). Seepage occurred from an area of disturbed ground that appeared to have been cleared to make a drill site, at the southwest end of the old road visible in the aerial photograph (Figure 2.1). The soil appeared to be glacial till, in contrast to the coarse sand and gravel that makes up the southern wall of Moose Pond. The ground at MP01 was saturated, and surface water was present in small depressions. However, flow was negligible, being evident only when sediment was disturbed.

Seepage at MP01 had a field pH of 6.7, a sulphate concentration of 147 mg/L, and a dissolved zinc concentration of 0.009 mg/L (detection limit 0.005 mg/L). Complete results are provided in Appendix B1.

MP02

MP02 was located west of MP01 between Moose Pond and Vangorda Creek (Figure 2.1). Seepage was trickling from a large natural depression in original ground, with mineral soil (till) exposed in the base of the depression. Hard tan to greyish-white precipitate was observed as encrustations on moss and rocks present in the flow. The moss-covered ground adjacent to MP02 was saturated over a wide area, and surface water was present in small depressions. Surface flow from the sampled depression was estimated by the bucket-and-stopwatch method to be 1.4 L/minute.

Seepage at MP01 had a field pH of 7.1, a sulphate concentration of 248 mg/L, and a dissolved zinc concentration of <0.005 mg/L. Complete results are provided in Appendix B1.

MP03 (previously sampled as Moose Seep)

MP03 was located west of MP02, approximately 25 m upslope from Vangorda Creek just upstream of Grum Creek (Figure 2.1). This site was sampled previously as Moose Seep in Spring 2004 and Fall 2003. Discontinuous surface flow was observed between natural depressions in the original moss ground cover for approximately 25 m upslope of the sample station and downslope to the edge of Vangorda Creek. No mineral soil was exposed in this vicinity. Minor lime-green algae were present in the sampled pond at the time of sampling. Surface flow into the sampled depression was visually estimated to be 1 L/minute and was the largest of the three seeps sampled below Moose Pond. No surface outflow was present. A sediment ring around the sampled pond indicated that higher pond levels had previously occurred.

Seepage at MP03 had similar water quality to previous sampling rounds, with field pH of 7.3, sulphate concentration of 728 mg/L, and dissolved zinc concentration of 0.006 mg/L (detection limit 0.005 mg/L). Complete results, including Fall 2003 and Spring 2004 data, are provided in Appendix B1.

Downgradient of Grum Creek diversion

It was suspected that the increases in sulphate concentrations at V2 may have been the result of leakage from the Grum Creek diversion. As outlined in the Response Plan, a seepage survey was carried out east of Tributary A upstream of V2 to identify any surface seepage from the diversion. Seepage was identified in two locations, as discussed below.

GC01

GC01 was located adjacent to and immediately upstream of the V2 access road. The seepage formed 3 free-flowing streams and considerable diffuse surface flow, and was traced upstream for approximately 100 m. The three flows were estimated by the bucket flow method to have flow volumes of 37 L/minute. The source appeared most likely to be the Grum Creek Diversion, although seepage from Moose Pond is possible based on visual field estimates of elevations.

Seepage at GC01 had a field pH of 7.4, a sulphate concentration of 492 mg/L, and a dissolved zinc concentration of 0.044 mg/L. Complete results are provided in Appendix B2.

GC02

GC02 was located in the original main stem Grum Creek channel upstream of the former confluence with Tributary A. Surface flow was traced in former channel upstream to 35 m below Grum Dump toe access road. Flow was visually estimated to be 1.5 L/s, and appeared to represent approximately half of the Tributary A flow immediately above the confluence. This station is downgradient of well SRK04-5, which is discussed in Section 3.5.

Seepage at GC02 had a field pH of 6.3, a sulphate concentration of 487 mg/L, and a dissolved zinc concentration of <0.005 mg/L. Complete results are provided in Appendix B2.

West of Tributary A

No comprehensive seepage survey had previously been undertaken downgradient of Grum Dump west of Tributary A. To ensure that all surface flows in this area were characterized, SRK conducted a survey from Tributary A to the hill west of Sheep Creek, and from Vangorda Creek to Grum Dump (Figure 2.1). Surface flows and groundwater seeps were sampled at five locations as described below.

GD05 d/s

Station GD 05 d/s is located in the linear depression topographically downgradient from the toe seep station SRK-GD05 (Figure 2.1), which was discussed in Section 2.3. This station, which is the downstream limit of surface flow, was previously sampled by SRK in Fall 2003 and Spring 2004. Surface flow at GD05 d/s was estimated by the bucket-and-stopwatch method to be 2 L/min. in September 2004; this was similar flow volume to that observed during previously sampling. The bed of the flow was original ground (moss and vegetation), with minor hard tan precipitate observed on the moss.

Seepage at GD05 d/s had a field pH of 7.5, a sulphate concentration of 1300 mg/L, and a dissolved zinc concentration of <0.005 mg/L. Complete results are provided in Appendix B3.

WTA01

Station WTA01 is located on Sweet Creek, 20 metres above the confluence with Vangorda Creek (Figure 2.1). This station is downgradient of dump toe seepage station SRK-GD16, as discussed in Section 3.3. At this location a small inactive fan has formed at the mouth of the steep Sweet Creek drainage within the incised Vangorda Creek valley. This fan may provide a subsurface flow path to Vangorda Creek. Surface flow volumes were estimated by the bucket-and-stopwatch method to be approximately 90 L/min. The steam bed at this location was covered with moss or vegetation, which had been coated with a hard tan to orangey tan precipitate crust.

Seepage at WTA01 had a field pH of 8.0, a sulphate concentration of 1030 mg/L, and a dissolved zinc concentration of <0.005 mg/L. Complete results are provided in Appendix B3.

WTA02

Station WTA02 represented seepage ponded on the roadway of the Grum Dump toe access road near the upper end of Sheep Creek (Figure 2.1). Seepage originates as diffuse flow from a 10 metre section of the upslope road cut and is sufficiently concentrated to sample only in the roadway. Dark grey phyllitic bedrock is exposed in the road cut. Upslope topography suggests that the seepage face is the intersection of the road cut with a minor topographic swale, and the surface topography indicates that this station should not be influenced by Grum Dump drainage. Surface flow volume was visually estimated 1 L/minute. Clasts in the roadway within and adjacent to flow had encrustations of white hard precipitate.

Seepage at WTA02 had a field pH of 8.0, a sulphate concentration of 18 mg/L, and a dissolved zinc concentration of <0.005 mg/L. Complete results are provided in Appendix B3.

Sheep Seep

Sheep Seep is located at the break in slope where Sheep Creek enters the incised Vangorda Creek valley (Figure 2.1). Upstream of this point, flow in the Sheep Creek drainage occurs largely as diffuse flow in the shallow subsurface across the width of the gentle topographic depression shown in Figure 2.1. Continuous surface flow originates at the increase in slope where the Sheep Creek depression intersects the incised Vangorda Creek valley, and remains on surface to immediately above the confluence with Vangorda Creek. At this point, the entire flow infiltrates into a fan deposit adjacent to Vangorda Creek. This station was previously sampled by SRK in Fall 2003 and Spring 2004.

Seepage at Sheep Seep in September 2004 had a field pH of 8.0, a sulphate concentration of 60 mg/L, and a dissolved zinc concentration of <0.005 mg/L. Complete results are provided in Appendix B3.

WGD01

Station WGD01 is located above Sheep Creek west of Grum Dump (Figure 2.1). At WGD01, seepage over a diffuse area approximately 40 m by 50 m, beginning 15 m laterally out from the dump toe. This area does not appear to be topographically downgradient of the dump. However, clasts within the exposed mineral soil were coated with hard white to tan encrustations of precipitate, which suggests high dissolved solids concentrations in water from either natural mineralization or influence from the dump. The surrounding area appears boggy, with stunted trees growing on small dispersed hummocks. Filamentous green algae were observed in isolated locations within the larger seepage area. Total flow was visually estimated to be approximately 2 L/minute.

between V1 and V27. Other sources of zinc load are required to contribute the remainder of the zinc load increase, such as those discussed in Section 4.2.1.

Scoping level calculations suggest that the flux of zinc from the Grum Dump is 1700 kg per year. It is clear that attenuation along groundwater flowpaths, and to a lesser extent surface flowpaths, is minimizing the amount of zinc loading from the Grum Dump to Vangorda Creek at the present time.

Scoping level calculations suggest that discharges from the Vangorda Plateau Water Treatment Plant could have contributed between 20 and 40 kg of zinc load during the 45 day summer 2003 treatment period. The catchments of the Grum Interceptor Ditch (GID) and the Overburden Dump also enter the water treatment effluent flowpath upstream of the monitoring point below Sheep Pond. Zinc loading from the GID and Overburden Dump catchments is estimated to be an additional 100 kg annually. While the combined load of the Sheep Pond catchment is larger than that contributed by Grum Dump over an entire year, it is insufficient to account for the increase in zinc load in Vangorda Creek between V1 and V27.

Two other potential sources of loading to Vangorda Creek at station V27, as discussed in Section 4.1, are natural groundwater recharge to Vangorda Creek from naturally mineralized zones, and release or remobilization from stream sediments in Vangorda Creek downstream of the former Vangorda ore outcrop. The magnitude of these sources of loading is unknown. However, the baseline data indicates that combined loading from these sources was on the order of 200 kg/year prior to mining. It is unclear whether any additional baseline load could have originated between baseline station V3 and the current downstream location (station V27).

Another possible source of zinc loading downgradient of the dump is deep groundwater inflows originating from the Grum Dump. However, monitoring data at station V27 has not shown an increasing trend in zinc concentrations since the start of mining (1991), which suggests that deep groundwater recharge to Vangorda Creek has not been a significant source of loading to date.

5 Summary and Conclusions

Water quality data for Vangorda Creek indicate concentrations of zinc and sulphate are variable, but have remained relatively constant since the start of mining. Zinc concentrations in the downstream station (V27) are slightly higher than baseline concentrations observed in three other stations downstream of the mining area (V11, V3 and V10). However, this may be due in part to the difference in location. Zinc concentrations in Vangorda Creek downstream of Grum Dump (station V27) are above the CCME guidelines for freshwater aquatic life.

The main stem of Grum Creek is the main pathway for surface flows from Grum Dump to Vangorda Creek. Flows along this creek are monitored at seepage station SRK-GD1, and Station V2a. Water quality data indicate that zinc and sulphate concentrations at both these stations have increased over the past several years, with concentrations in V2a reaching average levels of over 0.5 mg/L in 2004. These flows are directed to a small pond referred to as Moose Pond. Water in Moose Pond is allowed to percolate into the groundwater system. Groundwater seeps daylighting below this area had elevated sulphate concentrations, but low zinc concentrations (<0.006 mg/L), indicating substantial attenuation is occurring in the groundwater flow system.

Flows from Tributary A of Grum Creek cannot be directly traced to seepage from the toe of the dump. However, flows in Tributary A are assumed to consist of shallow groundwater seepage that originates from the dump. Seepage at the toe of the dump is represented by water quality at SRK-GD04, where average dissolved zinc concentrations were 2.7 mg/L. Tributary A itself is monitored at two locations, Station V15 and V2. Zinc concentrations in Tributary A, which no longer receives surface flow from the main stem of Grum Creek, have decreased to less than 0.035 mg/L over the past two years due to improved management of dump runoff and TSS. However, sulphate concentrations have continued to increase, reflecting progression of oxidation and contaminant leaching from the waste rock dump.

Two additional flowpaths were identified during the detailed contaminant pathway surveys. These are referred to as the Sweet Creek flowpath, which is directly downgradient of the dump, and the Sheep Creek flowpath, which is partially influenced by the dump. Seeps emerging from the toe of the pile (GD05) had average zinc concentrations of 3.2 mg/L. However, seepage daylighting in the lower part of these flow systems had elevated sulphate, and low zinc concentrations, reflecting significant attenuation along these flowpaths.

Loading calculations indicate the current zinc load from the dump is on the order of 1700 kg/year. However, significant attenuation is occurring along all of the flow paths, resulting in a substantial reduction in the zinc loading to Vangorda Creek to approximately 5 kg/year. This represents less than 1% of the total zinc load present in Vangorda Creek, indicating that the increased concentrations observed at Stations V2 and V2a are not currently having an impact on water quality in Vangorda Creek.

The attenuation capacity of the groundwater flow system cannot be accurately quantified at this time. However, it is evident that zinc concentrations in seepage at V15 and in groundwater well P96-6A and 6B, which are located approximately 100 to 150 metres from the toe of the waste rock pile have remained low, despite the appearance of elevated zinc concentrations (>2 mg/L) at the toe of the pile between a seep survey completed in 1997 (data supplied by Environment Canada) and 2002 when regular toe seepage monitoring began. This suggests that the zinc front is moving at less than 14 to 35 metres/year. At this rate, the zinc front in the Sheep Creek and Sweet Creek flow paths could be expected to take at least 10 years, and possibly much longer, to reach Vangorda Creek, which is roughly 400 metres from the toe of the pile.

Zinc breakthrough could conceivably occur much sooner in the area below Moose Pond and between the toe of the dump and Station V15 due to the relatively steep gradients and relatively short flow paths. The surficial material between Moose Pond and Moose Seep is thought to consist of highly permeable sands and gravels, with a veneer of organic material covering both the base of Moose Pond and the slope where seepage emerges downgradient of the pond. These soils have a finite attenuation capacity and, if flows continue to be directed to Moose Pond, elevated zinc concentrations could eventually be expected to increase to levels that would be unacceptable for direct discharge to Vangorda Creek.

As a result, increased monitoring in these areas is recommended to ensure that zinc loads do not reach environmentally unacceptable levels. Specific recommendations are provided in Section 6.

6 Recommendations and Commitments for Further Action

A number of recommendations based on the investigations carried out as part of the AMP Response Plan are outlined below.

1. Increase monitoring of surface and groundwater pathways to detect increases in zinc concentrations.
    a. Increase the frequency of monitoring to twice-monthly at stations V15, V2, V2a, and establish a new routine monitoring station at Moose Seep (also twice-monthly), beginning in early May 2005.
    b. Install groundwater monitoring well between Moose Pond and Moose Seep, as soon as ground conditions allow.
    c. Undertake twice-monthly monitoring of groundwater well as soon as possible following well installation and development.
    d. Review monitoring data on an ongoing basis. Results of the routine monitoring should be included as part of the regular monthly report to the Water Board.
2. Continue discussions with site management regarding the requirements for installation of a surface water collection and transfer system, in the event that zinc breakthrough occurs in the future. These discussions should include realistic lead times required for sourcing pumps, piping and related hardware, and time required for installation of same.
3. Implement collection and transfer of water to Vangorda Pit if zinc concentrations exceed acceptable levels at station V2, at Moose Seep, or in the proposed groundwater monitoring well between Moose Pond and Moose Seep.
    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 the proposed groundwater well 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. Flow paths other than Grum Creek have much higher potential for continued attenuation, and field data have indicated no imminent concerns with respect to loading to Vangorda Creek due to the long groundwater flow paths and longer travel times. Therefore, spring/fall monitoring of these other pathways and stations (Sweet Creek, Sheep Creek, No Fork Creek, dump toe seeps SRK-GD01, SRK-GD04, SRK-GD05, and SRK-GD16) should be continued.

5. Continue additional investigations and ongoing monitoring activities that are currently planned in this area, including:

    a. Grum Creek flow monitoring at the new weir to establish a hydrograph for the Grum Creek catchment.

    b. Groundwater well installation and hydraulic testing in other downgradient locations to provide an intermediate monitoring location and to assess the requirements for a groundwater collection system.

    c. Monitoring of routine Reference Water Quality surface and groundwater as required by water licence.

6. The results of the monitoring activities will be reported in the AMP annual report, which is filed with the Water Board annually.

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

Dylan MacGregor, GIT

Kelly Sexsmith, P.Geo.

Reviewed by:

Peter Healey, P.Eng.

7 References

Curragh Resources, Inc. 1989. Vangorda Plateau Development: Initial Environmental Evaluation.

Gartner Lee Limited 2003. 2002 Vangorda Plateau Annual Environmental Report Water License IN89-002. March 2003.

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

Gartner Lee Limited 2004b. Vangorda Plateau Mine Site 2003 Annual Environmental Report Water Licence IN89-002. February 2004.

Gartner Lee Limited 2005a. Anvil Range Mine Complex 2004 Annual Environmental Report Water Licence QZ03-059

Gartner Lee Limited 2005b. Anvil Range Mine Adaptive Management Plan Annual Review for 2004- Draft.

Robertson Geoconsultants Incorporated, 1996. Integrated Comprehensive Abandonment Plan, December 1996. Report # 033002/1.

SRK Consulting 2000. Interim Report of the Feasibility of Reclaiming Vangorda Pit as a Clean Water System. October 2000.

SRK Consulting 2002. Memorandum: Grum Dump Seepage. To: Doug Sedgwick, Deloitte & Touche; Fr: Peter Healey, SRK Consulting.

SRK Consulting 2004a. 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. July 15, 2004.

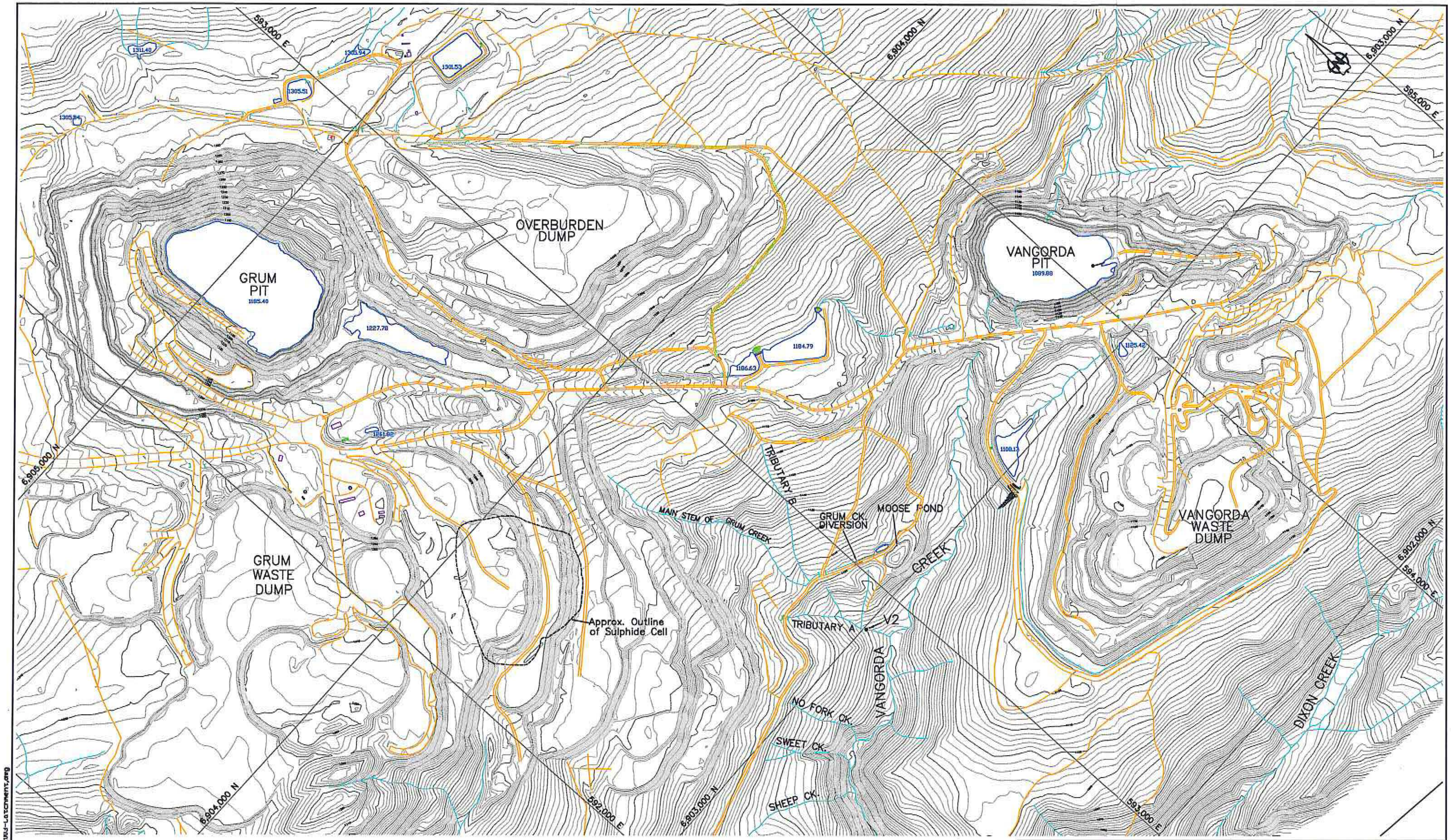
SRK Consulting 2004b. Letter to Tony Polyck, Manager: Water Inspections Section, Department of Environment, Government of Yukon, RE: AMP Event #4, Seepage Water Quality from Grum Rock Dump, Anvil Range Mine, Yukon. August 16, 2004.

SRK Consulting 2004c. 2004 Waste Rock and Seepage Monitoring Report: Draft. December 2004.

SRK Consulting 2004d. Design Options for Seepage Collection- Grum Rock Dump. June 2004.

SRK Consulting 2004e. Preliminary Seepage Collection Options- Faro and Grum Waste Rock Dumps: Draft. December 2004.

FIGURES



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Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

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

0 100 200 300 400 500 Metres
1:10,000

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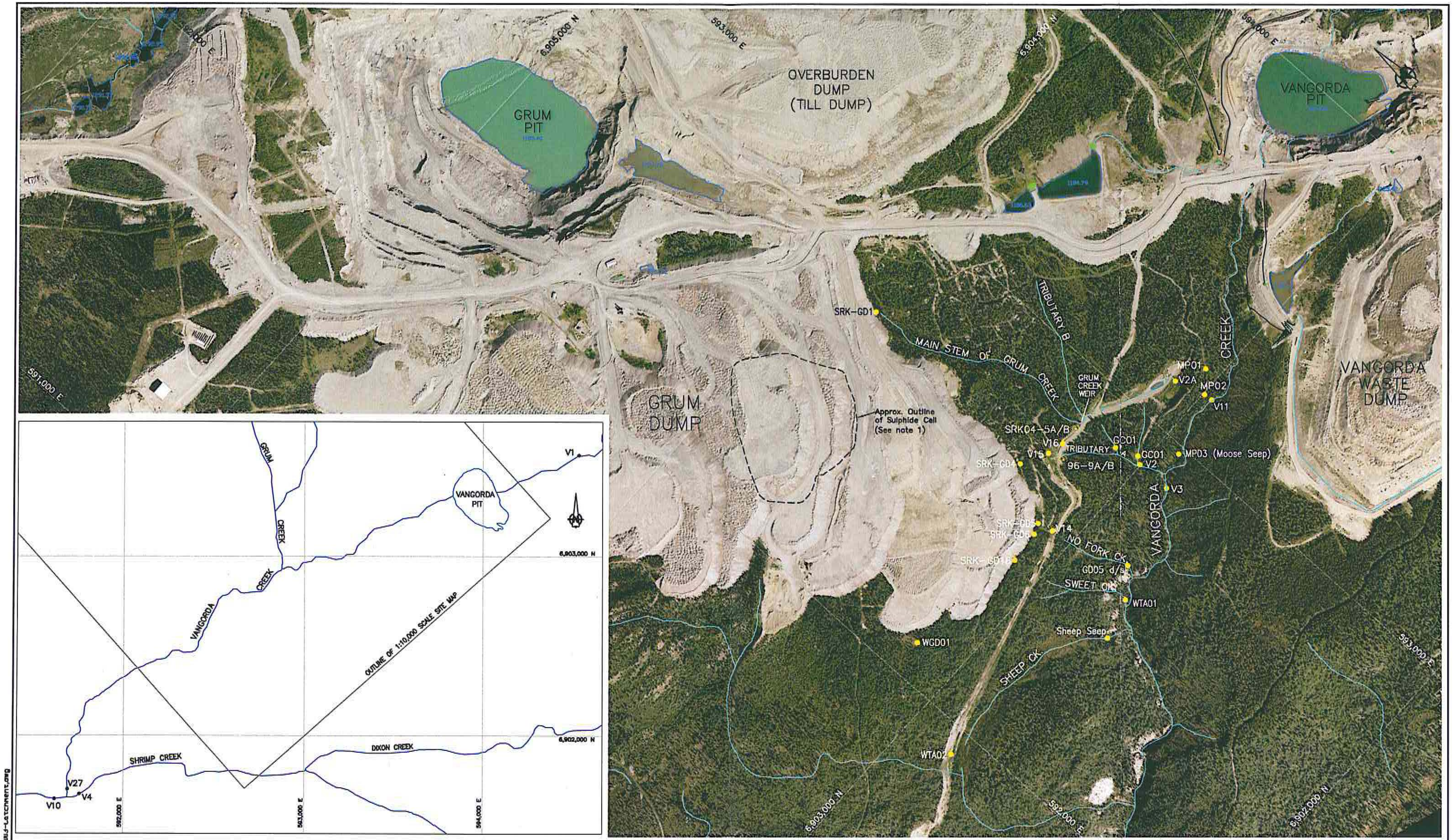
AMP Event #4 Response: Status Report

SITE PLAN

PROJECT NO.	DATE	FIGURE
1CD003.063.0100	Feb. 2005	1.1



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Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8886

Note 1:
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File Ref: site_plan_Grum-catchment.dwg

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AMP Event #4 Response: Status Report

WATER SAMPLING STATIONS

PROJECT NO.	DATE	APPROVED	FIG.
1CD003.063.0100	Feb. 2005		2.1

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

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

Note 2:
Pre-Mining topography shown, Contour Interval = 5m

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1:10,000

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GRUM DUMP CATCHMENTS

PROJECT NO.	DATE	APPROVED	FIG.
1CD003.063.0100	Feb. 2005		4.1

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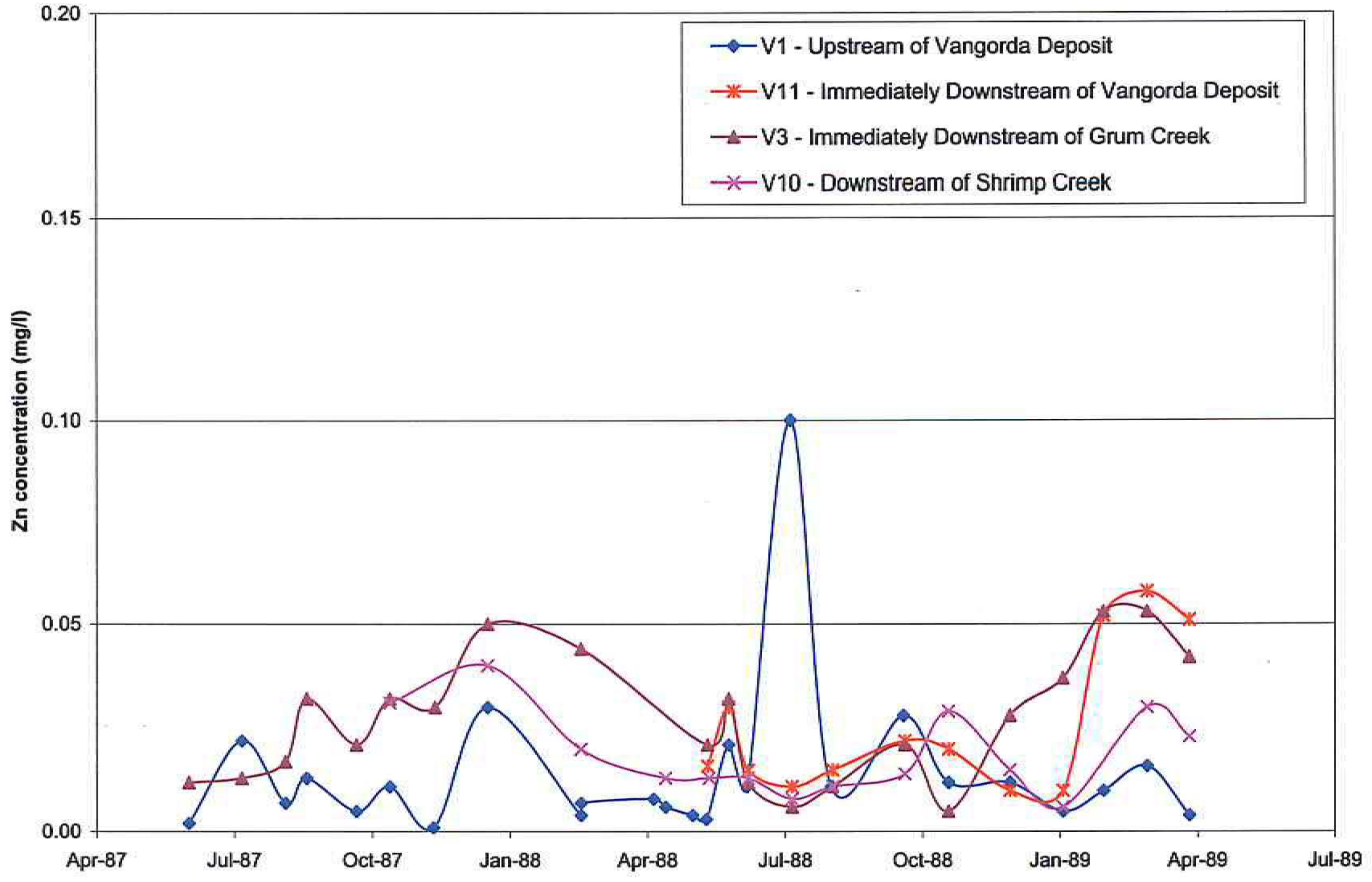

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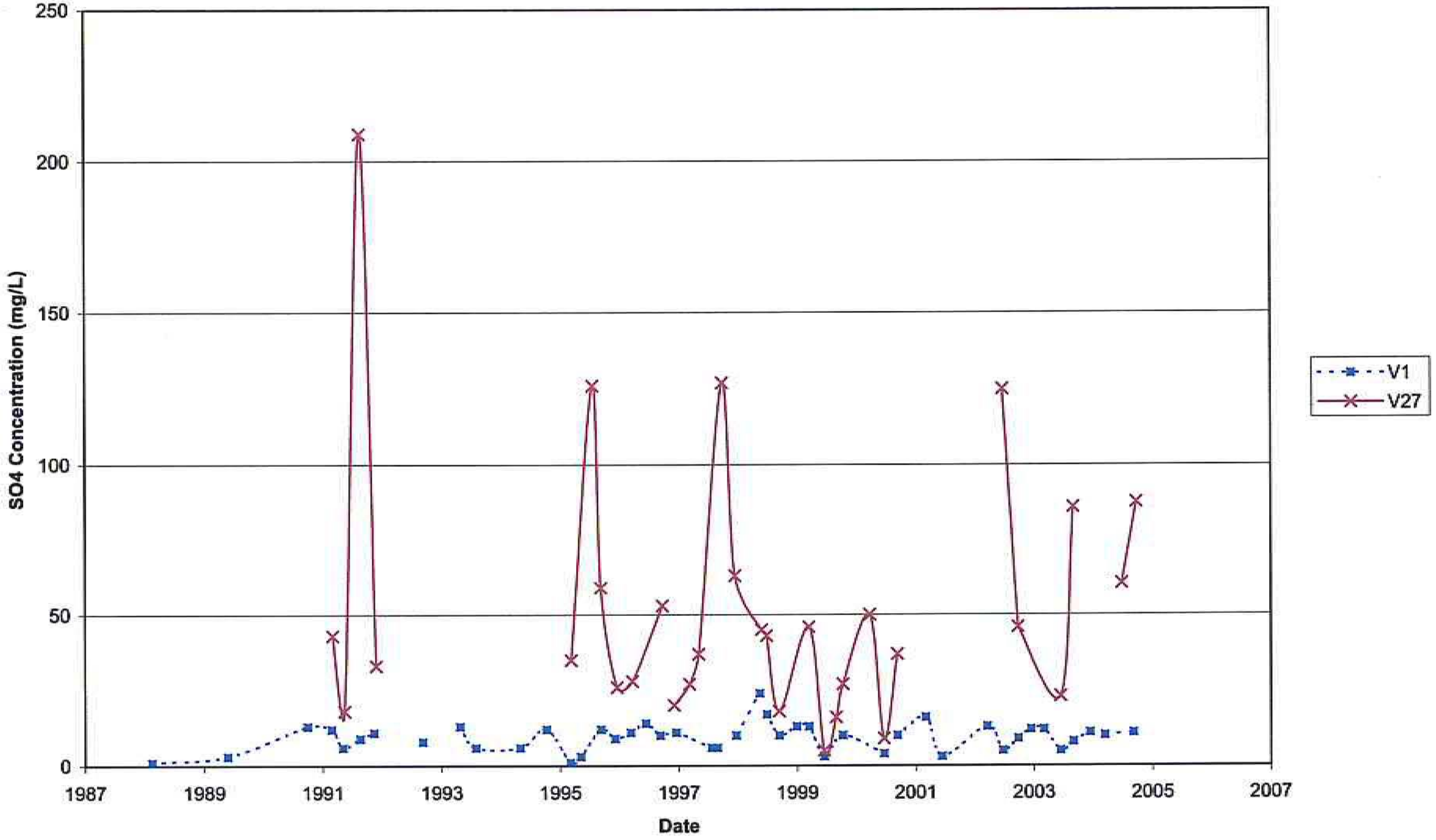
AMP Event #4 Response:
Status Report



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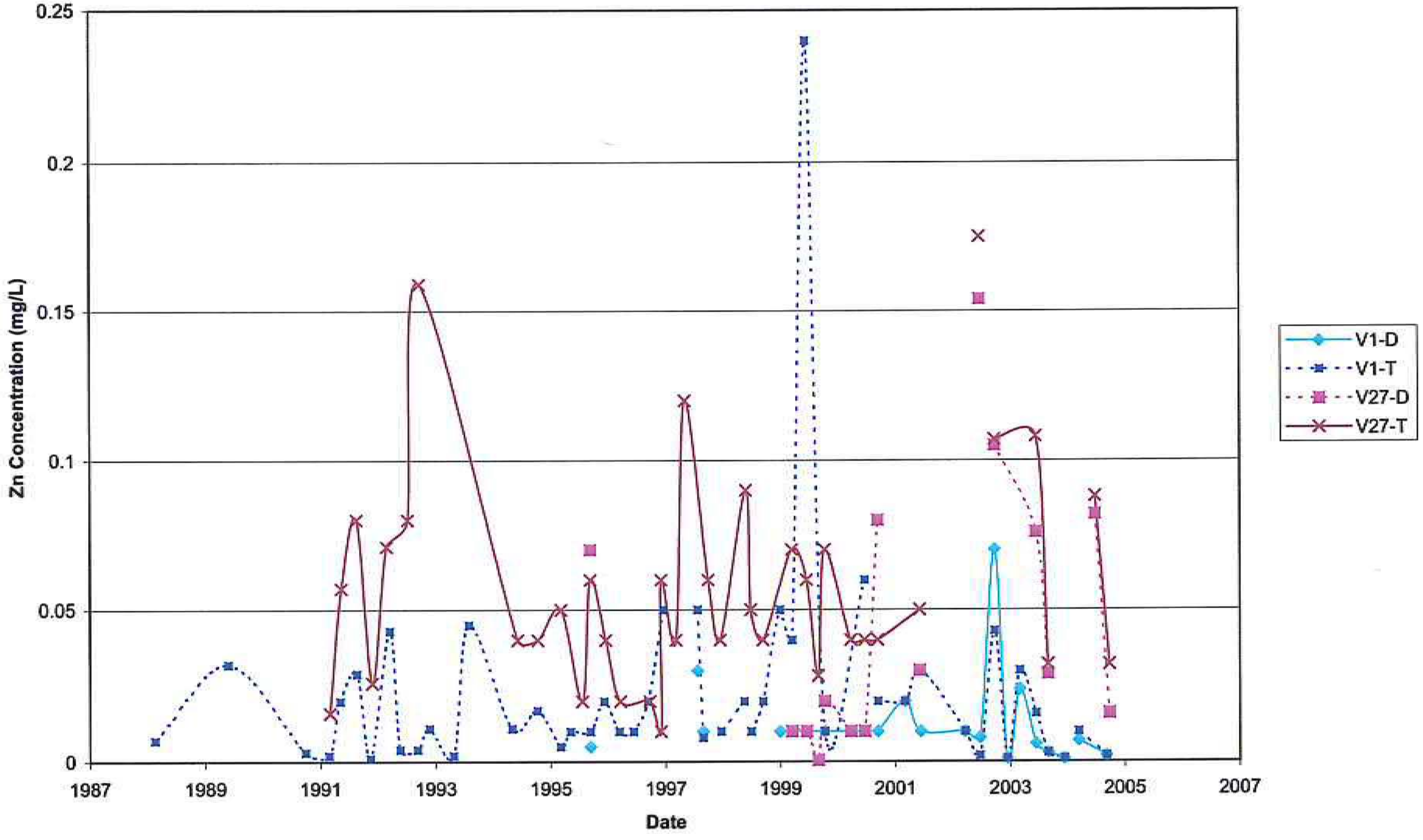
AMP Event #4 Response:
Status Report

Sulphate Concentrations at Stations V1 and V27

PROJECT	DATE	APPROVED	FIGURE
1D003.063.0100	February 2005		3.2

AMP Water Quality Figures.xls



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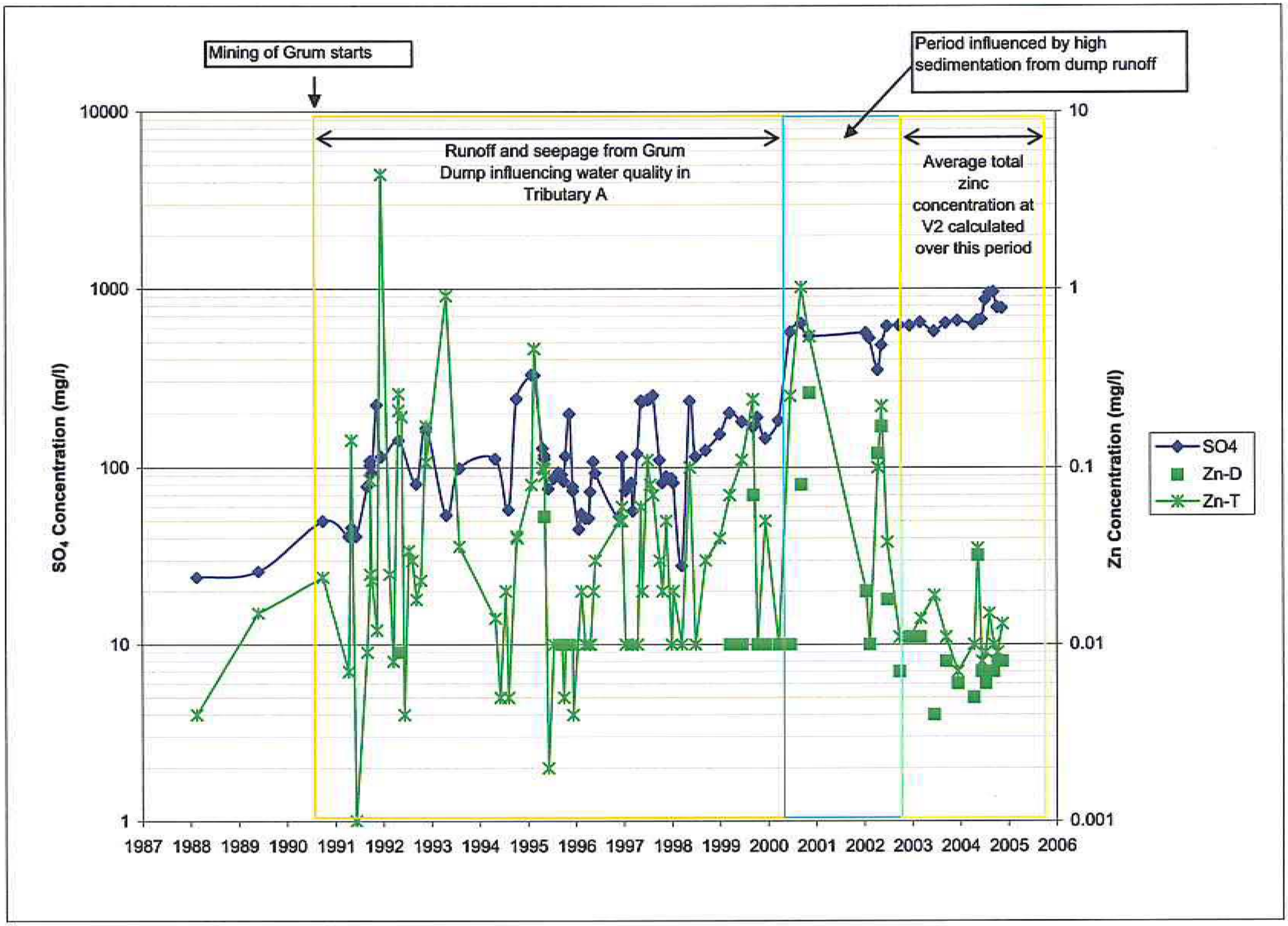
AMP Event #4 Response:
Status Report

Zinc Concentrations at Stations V1 and V27

PROJECT	DATE	APPROVED	FIGURE
1D003.063.0100	February 2005		**3.3**

AMP Water Quality Figures.xls



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AMP Event #4 Response:
Status Report

Zinc and Sulphate Concentrations at V2

PROJECT	DATE	APPROVED	FIGURE
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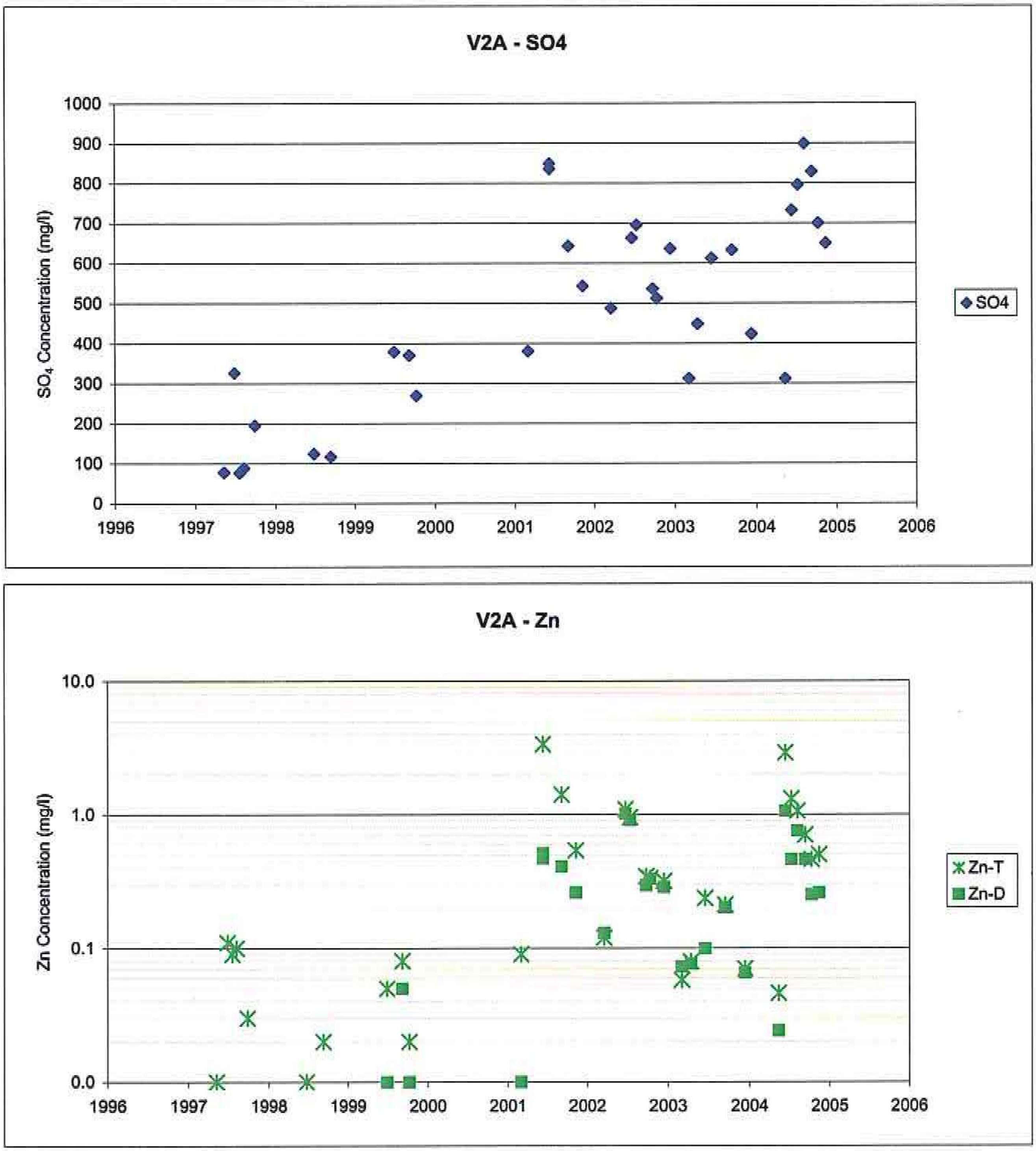

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AMP Event #4 Response:
Status Report

Zinc and Sulphate Concentrations at V2A

Project	Date	Approved	Figure
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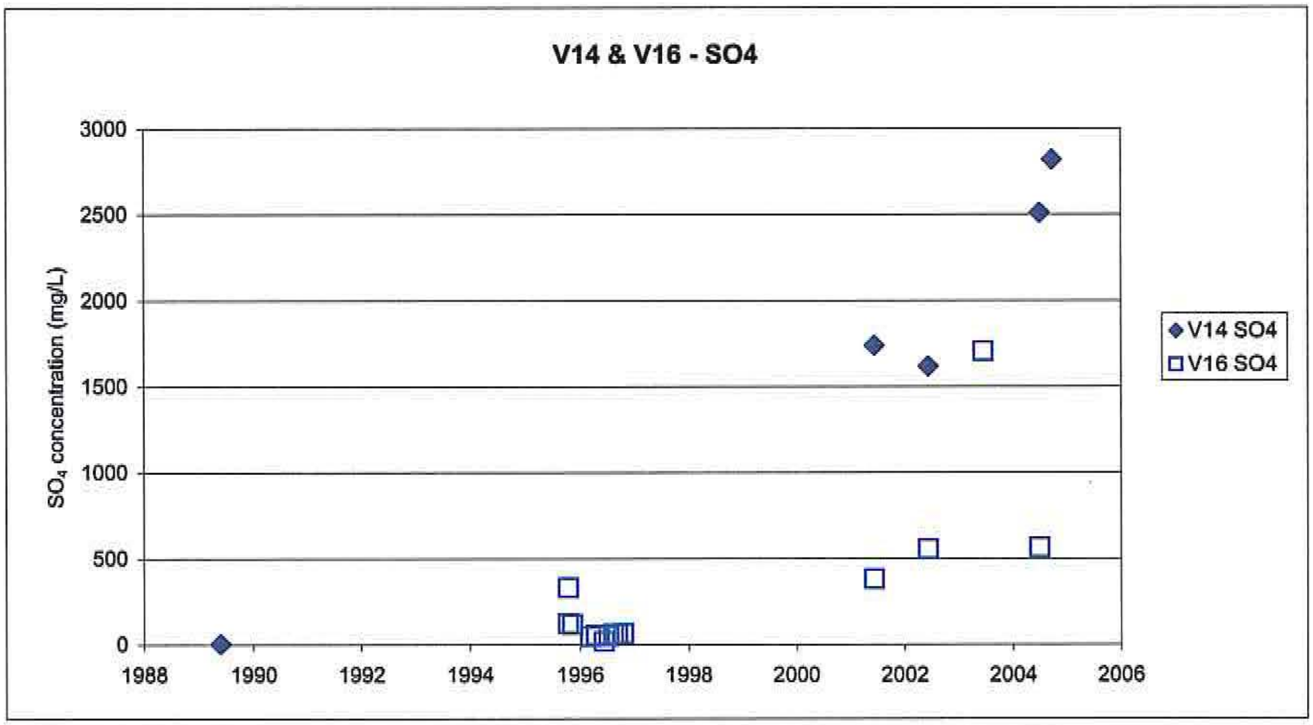

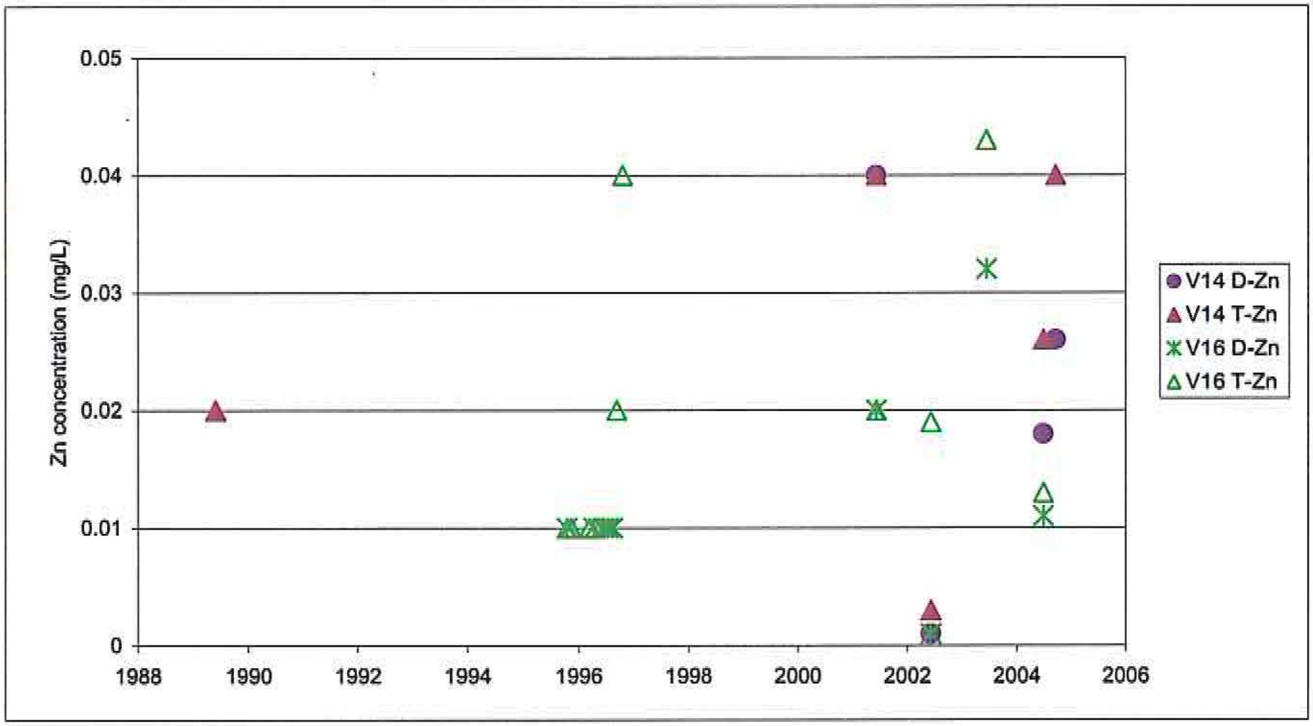

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AMP Event #4 Response:
Status Report

Zinc and Sulphate Concentrations at V14 and V16

Project	Date	Approved	Figure
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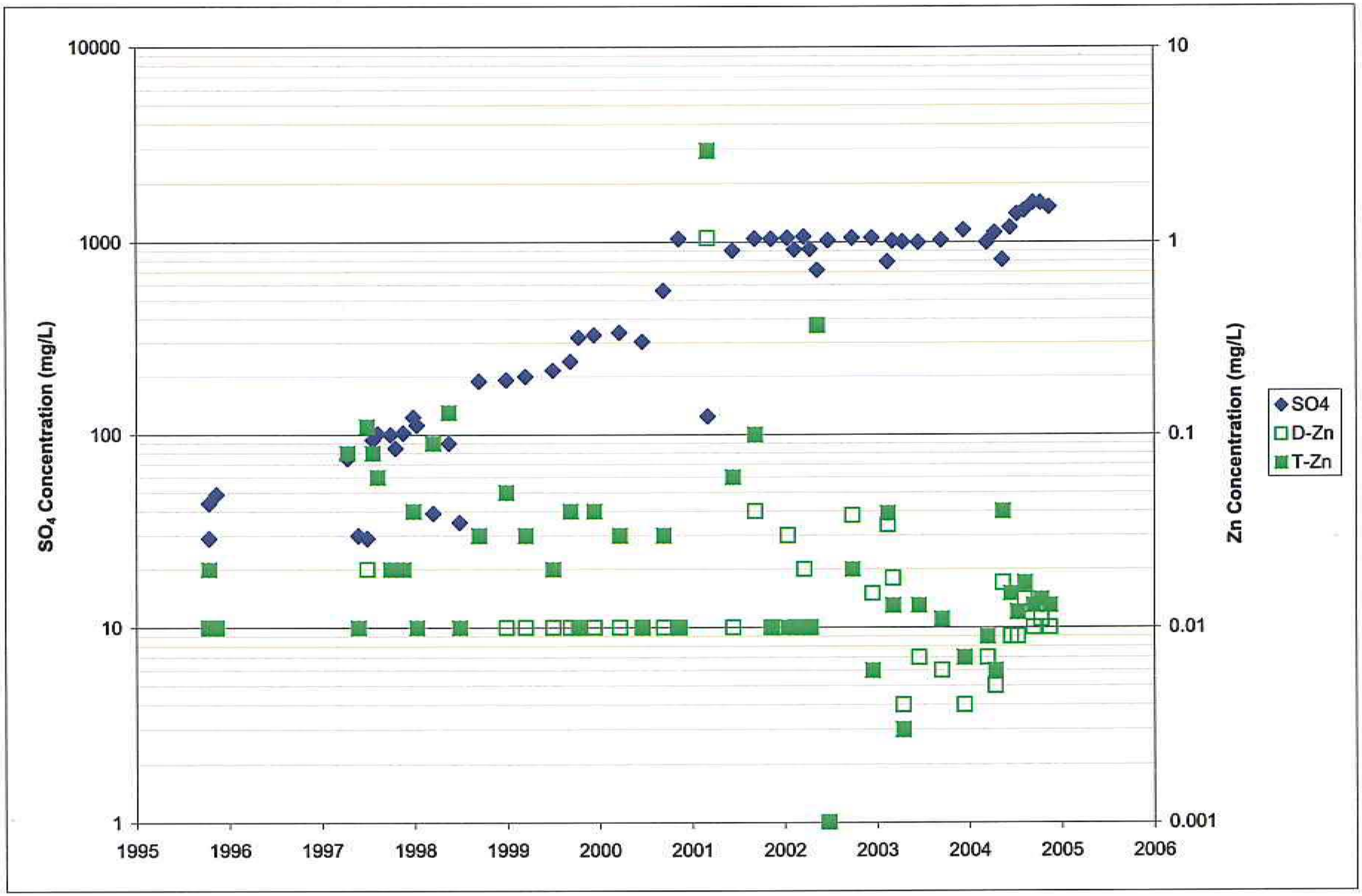

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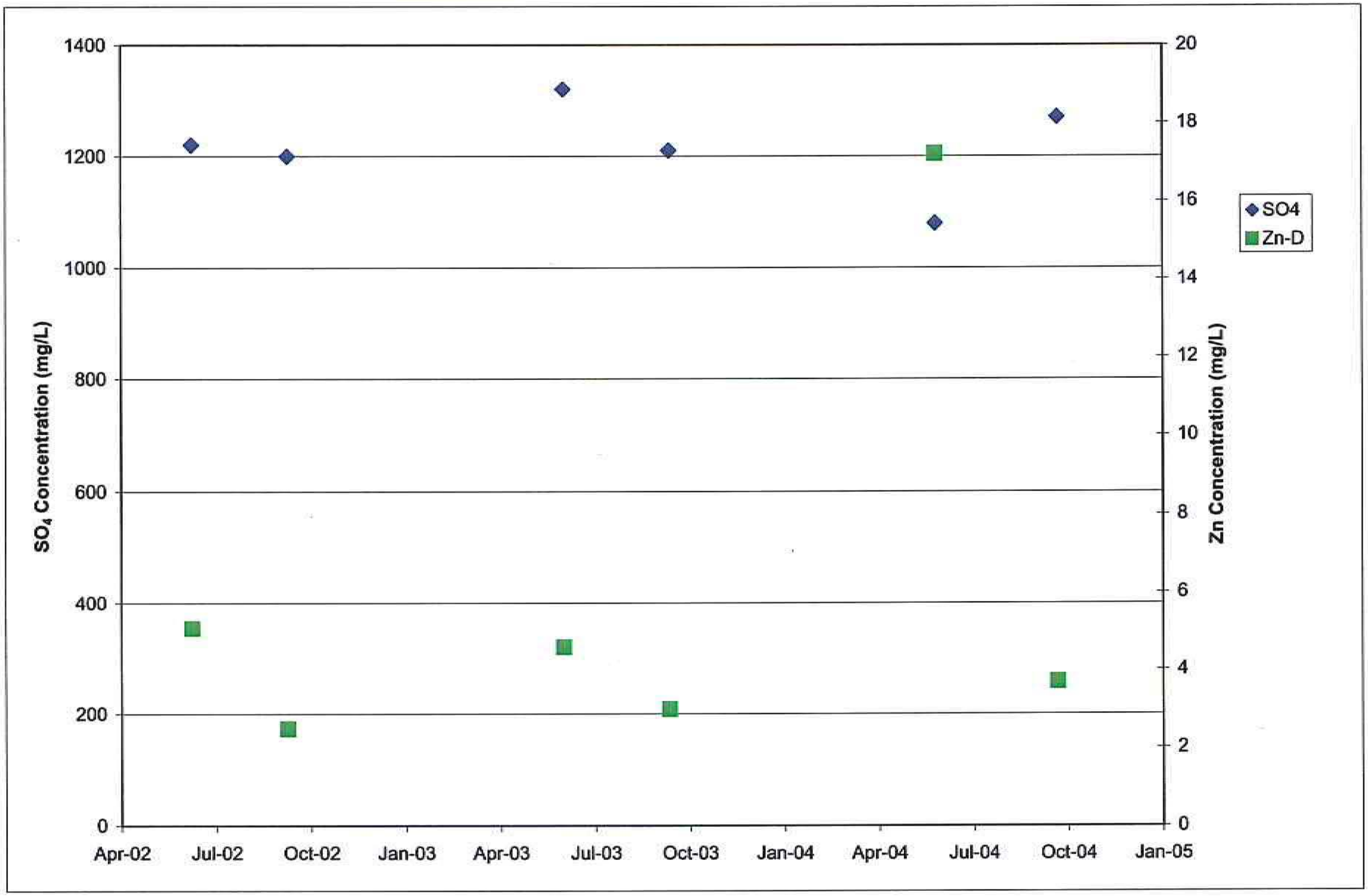
AMP Event #4 Response:
Status Report

Zinc and Sulphate Concentrations at V15

PROJECT	DATE	APPROVED	FIGURE
1D003.063.0100	February 2005		3.7



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AMP Event #4 Response:
Status Report

Zinc and Sulphate Concentrations at SRK_GD01

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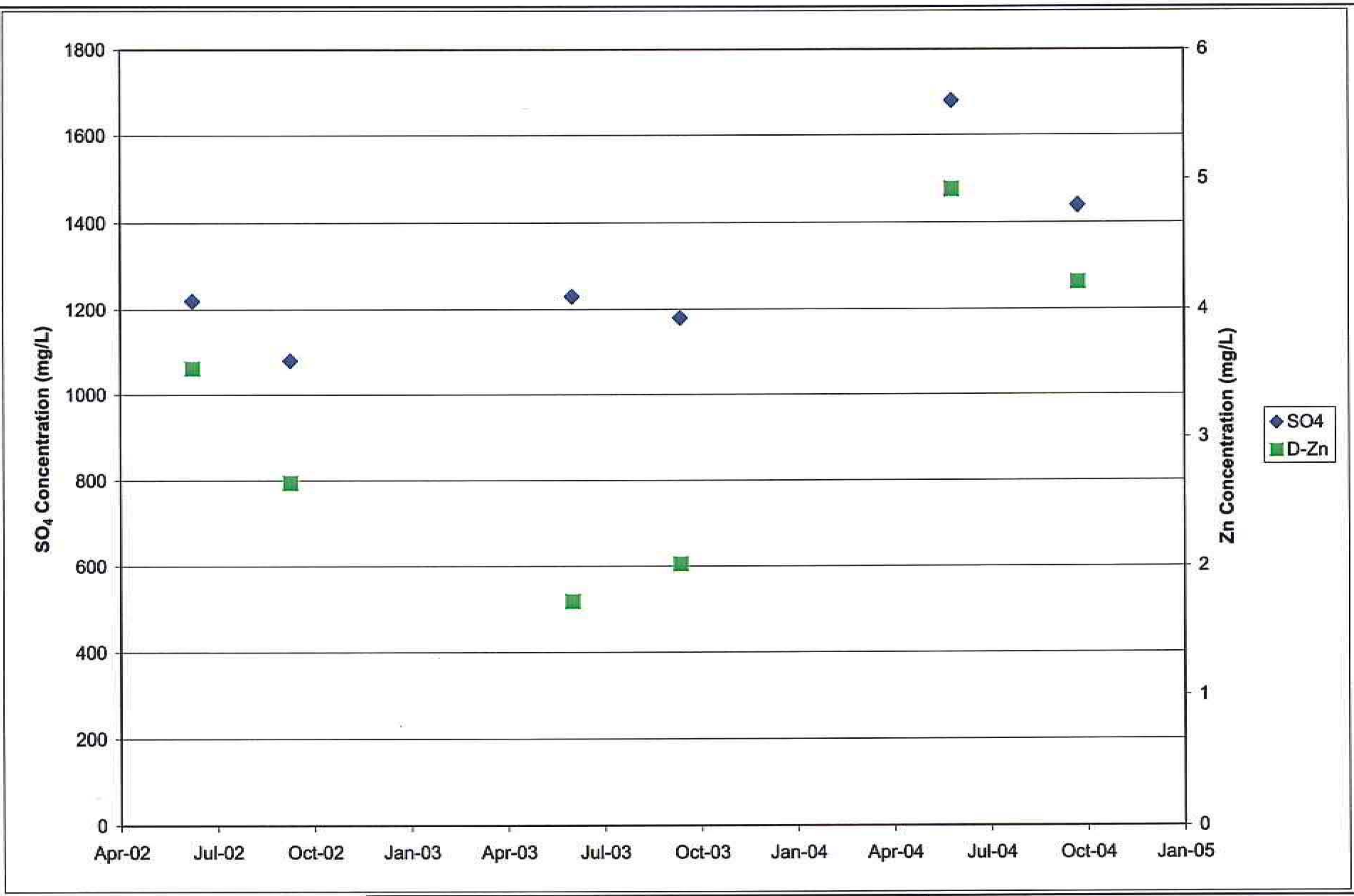
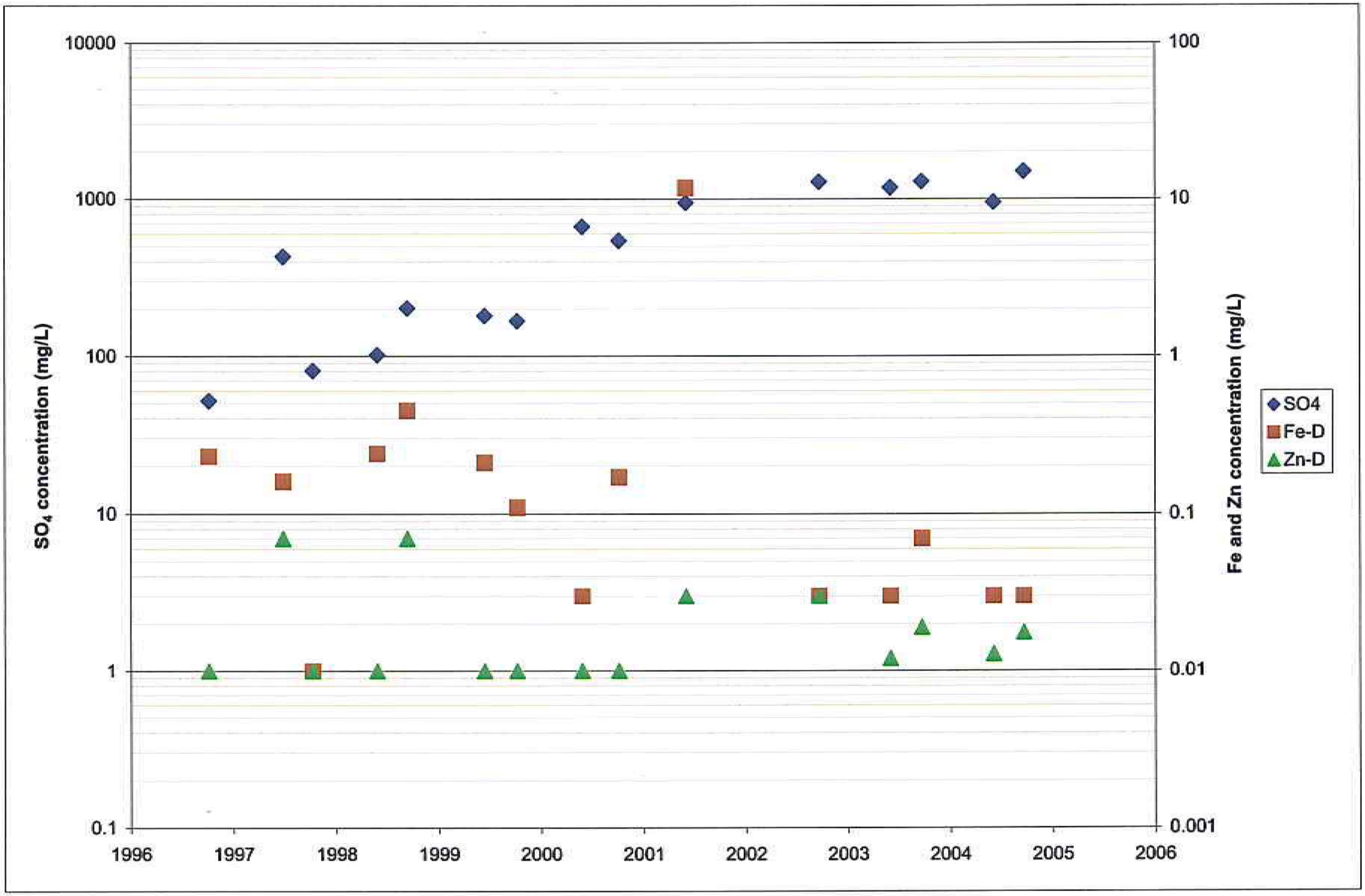


SRK Consulting Engineers and Scientists	AMP Event #4 Response: Status Report
	Zinc and Sulphate Concentrations at SRK_GD05
DELOITTE & TOUCHE INC.	PROJECT 1D003.063.0100 / DATE February 2005 / APPROVED / FIGURE 3.9



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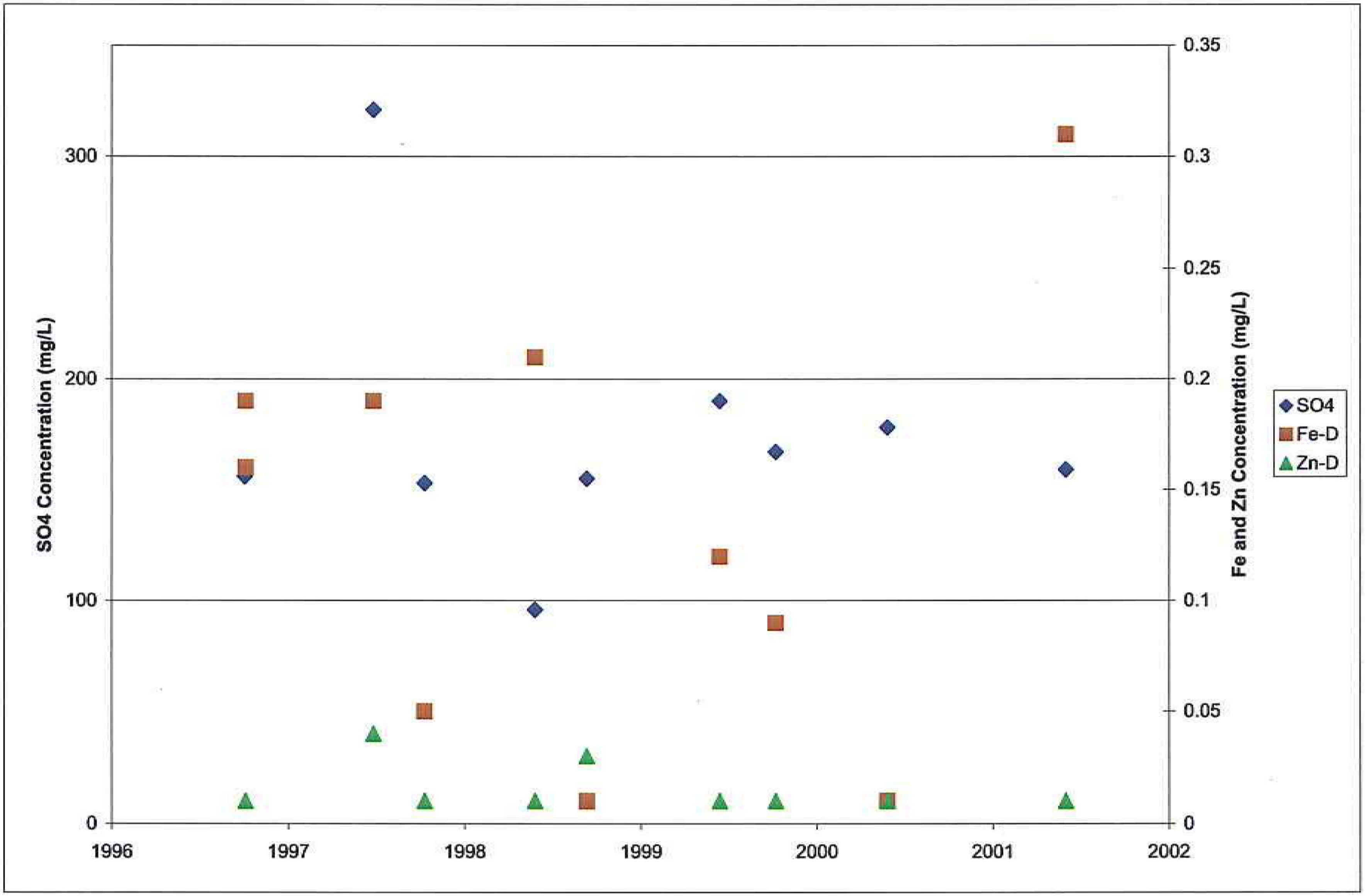
AMP Event #4 Response:
Status Report

Zinc and Sulphate Concentrations at P96-9A

PROJECT	DATE	APPROVED	FIGURE
1D003.063.0100	February 2005		3.10

AMP Water Quality Figures.xls



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AMP Event #4 Response:
Status Report

Zinc and Sulphate Concentrations at P96-9B

PROJECT	DATE	APPROVED	FIGURE
1D003.063.0100	February 2005		**3.11**

AMP Water Quality Figures.xls

APPENDICES

APPENDIX A

Interim Grum Creek Water Level Monitoring Equipment Installation Report

ACCESS CONSULTING GROUP

- Access Mining Consultants Ltd.
- Access Field Services Ltd.
- Access Oil & Gas Services

#3 Calcite Business Centre, 151 Industrial Road, Whitehorse, Yukon Y1A 2V3
PHONE (867) 668-6463 FAX (867) 667-6680
www.accessconsulting.ca

November 17, 2004

SRK Consulting Ltd.
Suite 800
580 Hornby St.
Vancouver B.C. V6C 3B6
Via email: phealey@srk.com

Attention: Mr. Peter Healy, P.Eng., Mining Project Engineer

Re: Interim Report Regarding the Water Level Monitoring Station Installation in Grum Creek at the Faro Mine Site

Dear Mr. Healy:

Please accept this brief interim report on the installation of the water level monitoring station on Upper Grum Creek in October 2004. A full report will be provided to you upon the installation and commissioning of the water level monitoring instrument and the completion of our contract in the spring of 2005.

The following outlines the tasks completed during our visit to the site in October of this year:

- Installed stilling well and two (2) metre staff gauge in Grum Creek, upstream of the existing weir.
- Conducted site survey by Stadia surveying methodology and established semi-permanent benchmark on nearby tree. Survey includes elevations of staff gauge zero mark, stilling well base, weir v-notch, and nearby haul road intersection with another haul road all relative to the established benchmark;
- Measured instantaneous flow in existing weir.

The following plates depict the installation results. Table 1 presents the results of the flow measurements at the weir.

Plate 1 Stilling Well and Staff Gauge Installed Up-Stream of Weir (Looking Upstream)

Plate 2 Stilling Well and Staff Gauge Installed Up-Stream of Weir (Looking Upstream)

Note: Well is suspended between three posts and posts are anchored together. The well will be leveled in the spring during the water level monitoring instrument installation.

Plate 3 Staff Gauge Install (Water Level = 0.36m)

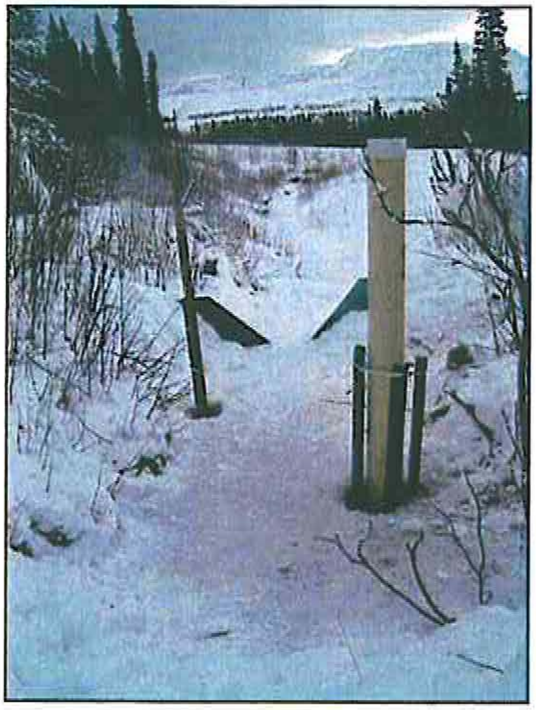


Plate 4 Stilling Well and Staff Gauge Installed Up-Stream of Weir (Looking Downstream)

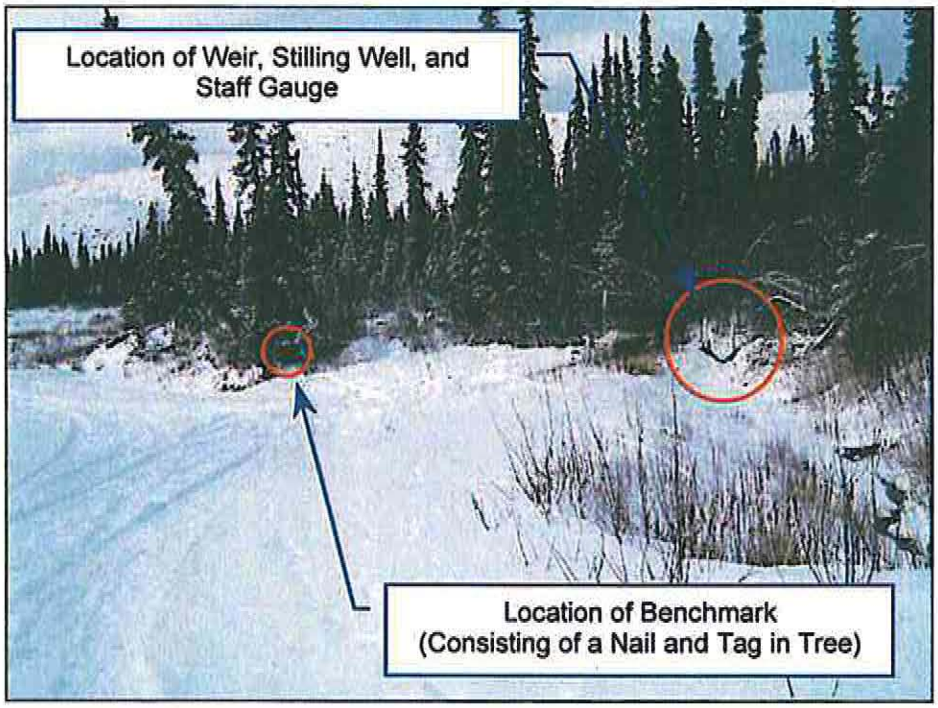


Plate 5 Overview of Monitoring Location and Survey Benchmark

Table 1 Grum Creek Weir Bucket Flow Measurements and Water Level Calculations

Time (s)	Volume (L)	Estimated Flow (L/s)
1.18	2	1.69
2.07	2	0.97
1.47	2	1.36
1.56	2	1.28
1.44	2	1.39
Average flow (L/s) = **1.34**		
Depth of water in V-notch at weir (within drawdown) = **5.8 cm**		
Depth of water at Staff Gauge = **36 cm**		
Difference in elevation between bottom of v-notch and bottom (zero) of staff gauge = **29.25 cm**		
Corrected Water level for weir measurement = **6.75 cm**		

Note: Ice was present on the surface of the pond behind the weir.

Certification

ACG trusts that this interim report meets your needs at this time. Should you have any questions, please contact the undersigned at (867) 668-6463.

Sincerely,
ACCESS CONSULTING GROUP – A TRADE NAME FOR ACCESS MINING CONSULTANTS LTD.

Travis Ritchie, B.Sc., P. Biol., CEPIT
Project Environmental Scientist

APPENDIX B

2004 Water Quality Results

APPENDIX B.1

2004 Water Quality Results-
Downgradient of Moose Pond

Appendix B.1- Water Quality Results Downgradient of Moose Pond

Sample ID	MP03	MP03	MP03	MP01	MP02
Date Sampled	09/15/2003	5/28/2004	9/22/2004	9/22/2004	9/22/2004
Field Parameters					
pH	7.61	7.79	7.32	6.70	7.06
Conductivity (uS/cm)	1310	465	1573	619	846
Temperature (C)	3.4	3.6	6.4	5.9	4.5
ORP (mV)	406	167	48	51	33
Flow (L/min)	1	Trace	1	Trace	1.4
Physical Tests					
Conductivity (uS/cm)	1280	1120	1540	561	842
pH	8.2	8.08	8.08	8.20	8.28
Dissolved Anions					
Acidity (to pH 8.3) CaCO3	5	5.2	5.4	2.0	<1.0
Alkalinity-Total CaCO3	288	236	296	150	244
Chloride Cl	1.5	1.52	<5.0	<2.5	<2.5
Sulphate SO4	522	427	728	147	248
Dissolved Metals					
Aluminum D-Al	<0.2	<0.2	<0.2	<0.20	<0.20
Antimony D-Sb	<0.2	<0.2	<0.2	<0.20	<0.20
Arsenic D-As	<0.2	<0.2	<0.2	<0.20	<0.20
Barium D-Ba	0.05	0.057	0.078	0.074	0.159
Beryllium D-Be	<0.005	<0.005	<0.006	<0.0050	0.0063
Bismuth D-Bi	<0.2	<0.2	<0.2	<0.20	<0.20
Boron D-B	<0.1	<0.1	<0.1	<0.10	<0.10
Cadmium D-Cd	<0.01	<0.01	<0.01	<0.010	<0.020
Calcium D-Ca	174	157	235	69.3	146
Chromium D-Cr	<0.01	<0.01	<0.01	<0.010	<0.010
Cobalt D-Co	<0.01	<0.01	<0.01	<0.010	<0.010
Copper D-Cu	<0.01	<0.01	<0.01	<0.010	<0.010
Iron D-Fe	<0.03	<0.03	<0.03	<0.030	<0.030
Lead D-Pb	<0.05	<0.05	<0.05	<0.050	<0.050
Lithium D-Li	<0.01	<0.01	<0.01	<0.010	<0.010
Magnesium D-Mg	72.9	62.6	97.6	25.2	31.6
Manganese D-Mn	<0.005	<0.005	<0.005	<0.0050	<0.0050
Molybdenum D-Mo	<0.03	<0.03	<0.03	<0.030	<0.030
Nickel D-Ni	<0.05	<0.05	<0.05	<0.050	<0.050
Phosphorus D-P	<0.3	<0.3	<0.3	<0.30	<0.30
Potassium D-K	2	2.1	2.1	<2.0	<2.0
Selenium D-Se	<0.2	<0.2	<0.3	<0.20	<0.20
Silicon D-Si	4.84	4.38	5.45	4.97	5.02
Silver D-Ag	<0.01	<0.01	<0.02	<0.010	<0.010
Sodium D-Na	7	6.1	7.8	12.6	4.8
Strontium D-Sr	0.491	0.453	0.679	0.568	0.522
Thallium D-Tl	<0.2	<0.2	<0.2	<0.20	<0.20
Tin D-Sn	<0.03	<0.03	<0.03	<0.030	<0.030
Titanium D-Ti	<0.01	<0.01	<0.01	<0.010	<0.010
Vanadium D-V	<0.03	<0.03	<0.03	<0.030	<0.030
Zinc D-Zn	0.006	<0.005	0.0064	0.0094	<0.0050

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

APPENDIX B.2

2004 Water Quality Results-Downgradient of Grum Creek diversion

Sample ID	GC01	GC02
Date Sampled	9/22/2004	9/23/2004
Field Parameters		
pH	7.36	6.25
Conductivity (uS/cm)	1272	1252
Temperature (C)	4.9	3.8
ORP (mV)	53	125
Flow (L/min)	37.3	90
Physical Tests		
Conductivity (uS/cm)	1260	1240
pH	8.11	8.15
Dissolved Anions		
Acidity (to pH 8.3) CaCO3	3.9	3.3
Alkalinity-Total CaCO3	281	287
Chloride Cl	<5.0	<5.0
Sulphate SO4	492	487
Dissolved Metals		
Aluminum D-Al	<0.20	<0.20
Antimony D-Sb	<0.20	<0.20
Arsenic D-As	<0.30	<0.20
Barium D-Ba	0.120	0.175
Beryllium D-Be	<0.010	<0.0050
Bismuth D-Bi	<0.20	<0.20
Boron D-B	<0.10	<0.10
Cadmium D-Cd	<0.010	<0.010
Calcium D-Ca	198	193
Chromium D-Cr	<0.010	<0.010
Cobalt D-Co	<0.010	<0.010
Copper D-Cu	<0.010	<0.010
Iron D-Fe	<0.030	<0.030
Lead D-Pb	<0.050	<0.050
Lithium D-Li	<0.010	<0.010
Magnesium D-Mg	66.5	60.5
Manganese D-Mn	<0.0050	<0.0050
Molybdenum D-Mo	<0.030	<0.030
Nickel D-Ni	<0.050	<0.050
Phosphorus D-P	<0.30	<0.30
Potassium D-K	<2.0	2.7
Selenium D-Se	<0.20	<0.20
Silicon D-Si	5.34	5.62
Silver D-Ag	<0.020	<0.010
Sodium D-Na	7.2	8.7
Strontium D-Sr	0.638	0.699
Thallium D-Tl	<0.20	<0.20
Tin D-Sn	<0.030	<0.030
Titanium D-Ti	<0.010	<0.010
Vanadium D-V	<0.030	<0.030
Zinc D-Zn	0.0439	<0.0050

Footnotes:

APPENDIX B.3

2004 Water Quality Results-
West of Tributary A

Sample ID	GD05 DS	SHEEP SEEP	WGD01	WTA01	WTA02
Date Sampled	9/23/2004	9/23/2004	9/23/2004	9/23/2004	9/23/2004
Field Parameters					
pH	6.9	8.02	7.71	8.03	8.05
Conductivity (uS/cm)	2430	571	1115	2260	450
Temperature (C)	4.3	4.1	6.8	4.3	5.0
ORP (mV)	69	76	64	114	69
Flow (L/min)	2.25	4.5	2	90	1
Physical Tests					
Conductivity (uS/cm)	2390	580	1120	2180	447
pH	8.07	8.36	8.18	8.10	8.39
Dissolved Anions					
Acidity (to pH 8.3) CaCO3	8.0	<1.0	2.6	7.4	<1.0
Alkalinity-Total CaCO3	434	268	277	418	232
Chloride Cl	<5.0	<2.5	<5.0	<5.0	<2.5
Sulphate SO4	1300	59.5	384	1030	18.0
Dissolved Metals					
Aluminum D-Al	<0.20	<0.20	<0.20	<0.20	<0.20
Antimony D-Sb	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic D-As	<0.20	<0.20	<0.20	<0.20	<0.20
Barium D-Ba	0.060	0.171	0.165	0.071	0.093
Beryllium D-Be	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bismuth D-Bi	<0.20	<0.20	<0.20	<0.20	<0.20
Boron D-B	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium D-Cd	<0.010	<0.010	<0.010	<0.010	<0.010
Calcium D-Ca	330	89.0	172	336	81.3
Chromium D-Cr	<0.010	<0.010	<0.010	<0.010	<0.010
Cobalt D-Co	<0.010	<0.010	<0.010	<0.010	<0.010
Copper D-Cu	<0.010	<0.010	<0.010	<0.010	<0.010
Iron D-Fe	<0.030	<0.030	<0.030	<0.030	<0.030
Lead D-Pb	<0.050	<0.050	<0.050	<0.050	<0.050
Lithium D-Li	0.013	<0.010	0.012	<0.010	<0.010
Magnesium D-Mg	192	19.7	54.1	152	9.52
Manganese D-Mn	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Molybdenum D-Mo	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel D-Ni	<0.050	<0.050	<0.050	<0.050	<0.050
Phosphorus D-P	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium D-K	2.6	<2.0	<2.0	<2.0	<2.0
Selenium D-Se	<0.20	<0.20	<0.20	<0.20	<0.20
Silicon D-Si	6.06	4.61	5.09	6.03	4.40
Silver D-Ag	<0.010	<0.010	<0.010	<0.010	<0.010
Sodium D-Na	11.7	2.4	3.8	9.6	<2.0
Strontium D-Sr	1.21	0.364	0.957	1.14	0.291
Thallium D-Tl	<0.20	<0.20	<0.20	<0.20	<0.20
Tin D-Sn	<0.030	<0.030	<0.030	<0.030	<0.030
Titanium D-Ti	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium D-V	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc D-Zn	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Footnotes:

Results are expressed as milligrams per litre except where noted.

< = Less than the detection limit indicated.

APPENDIX C

Groundwater Well SRK04-5

APPENDIX C.1

SRK04-5: Borehole and Installation Log

BOREHOLE LOG

PROJECT: Faro Mine Seepage Investigation
LOCATION:
FILE No: FARO (1CD003.053)
BORING DATE: 2004-09-06 **TO** 2004-09-09
DIP: 90.00 **AZIMUTH:**
COORDINATES: N E **DATUM:**

BOREHOL
PAGE: 1
DRILL TYP
DRILL: A
CASING: 6"

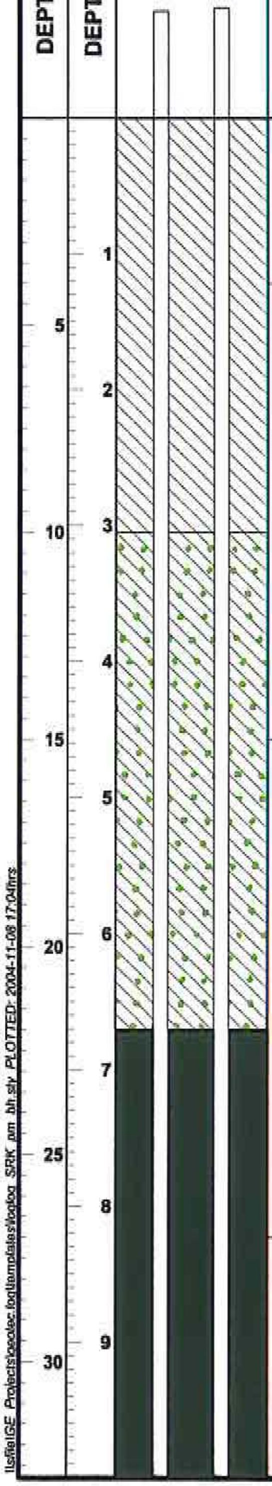
GENERAL COMMENTS:

WELL PLUG MATERIAL LEGEND

▨	Bentonite
▨	Cuttings
■	Grout
░	Sand

LABORATORY AND IN SITU

pH	Rinse pH
Cond	Rinse conductivity
ABA	Acid Base Accounting
Metals	Metal ICP



ELEVATION - m / DEPTH - m	DESCRIPTION	SYMBOL	TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS	W
0.00								
0.00	Organics, Alluvium Stickup Heights: 0.81m (shallow), 0.78m (deep).							
-1.22 1.22	Fine to coarse sand with sub-angular to sub-rounded gravel plus TRC silt or clay. Wells are 2" Sched. 40 PVC							
-4.57 4.57	Clay with fine to coarse sand and minor gravel.							
-8.23 8.23	Fine to coarse sand with fine to coarse gravel.							

SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: Faro Mine Seepage Investigation
LOCATION:
FILE No: FARO (1CD003.053)
BORING DATE: 2004-09-06 **TO** 2004-09-09
DIP: 90.00 **AZIMUTH:**
COORDINATES: N E **DATUM:**

BOREHOLE: SRK04-05
PAGE: 2 **OF** 3
DRILL TYPE: ODEX 6"
DRILL: Air Rotary
CASING: 6"

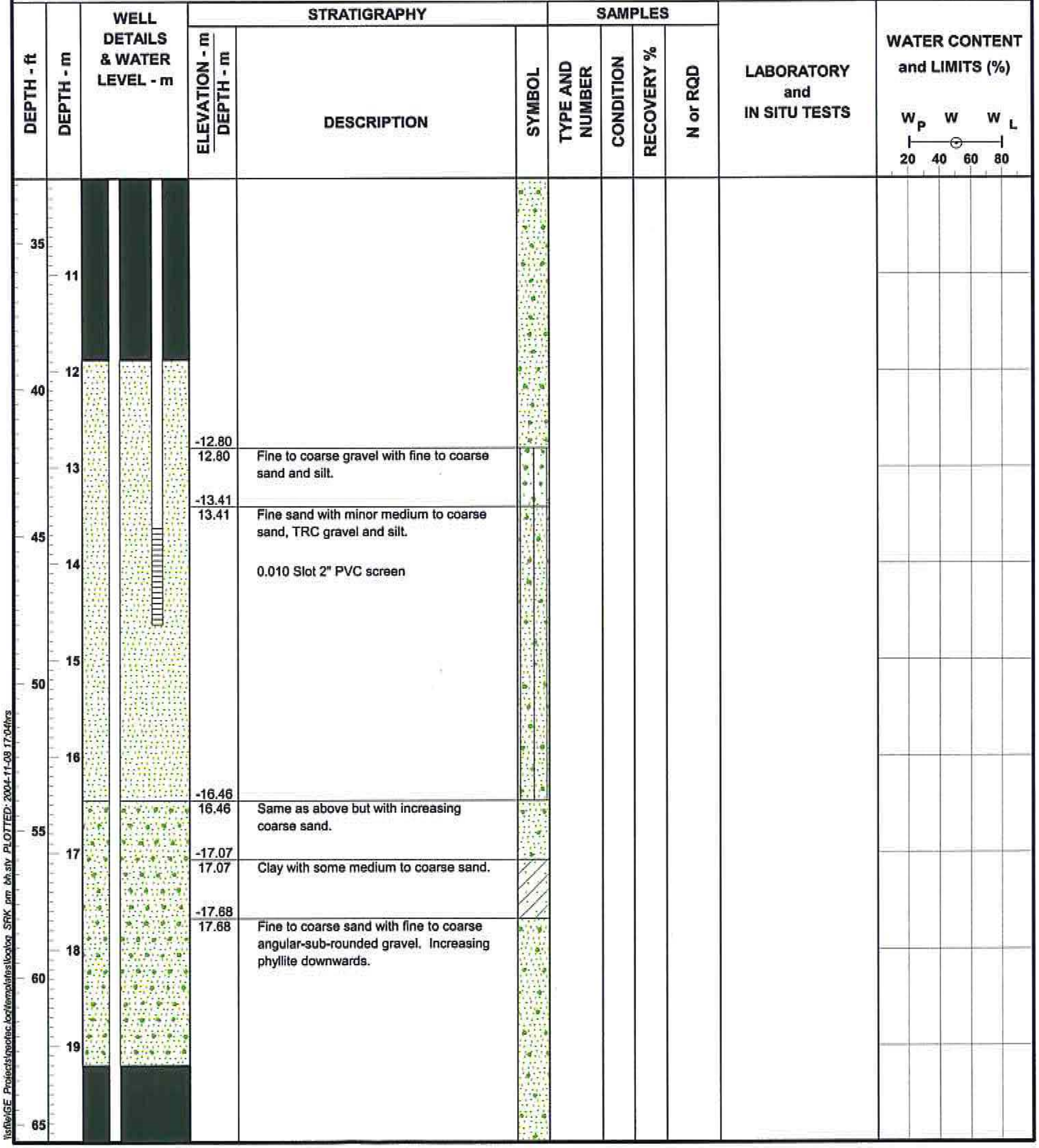
GENERAL COMMENTS:

WELL PLUG MATERIAL LEGEND

▨	Bentonite
▩	Cuttings
■	Grout
░	Sand

LABORATORY AND IN SITU TESTS

pH	Rinse pH
Cond	Rinse conductivity
ABA	Acid Base Accounting
Metals	Metal ICP
LE	Extraction



ELEVATION - m / DEPTH - m	DESCRIPTION
-12.80 12.80	Fine to coarse gravel with fine to coarse sand and silt.
-13.41 13.41	Fine sand with minor medium to coarse sand, TRC gravel and silt. 0.010 Slot 2" PVC screen
-16.46 16.46	Same as above but with increasing coarse sand.
-17.07 17.07	Clay with some medium to coarse sand.
-17.68 17.68	Fine to coarse sand with fine to coarse angular-sub-rounded gravel. Increasing phyllite downwards.

SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: Faro Mine Seepage Investigation
LOCATION:
FILE No: FARO (1CD003.053)
BORING DATE: 2004-09-06 **TO** 2004-09-09
DIP: 90.00 **AZIMUTH:**
COORDINATES: N E **DATUM:**

BOREHOLE: SRK04-05
PAGE: 3 **OF** 3
DRILL TYPE: ODEX 6"
DRILL: Air Rotary
CASING: 6"

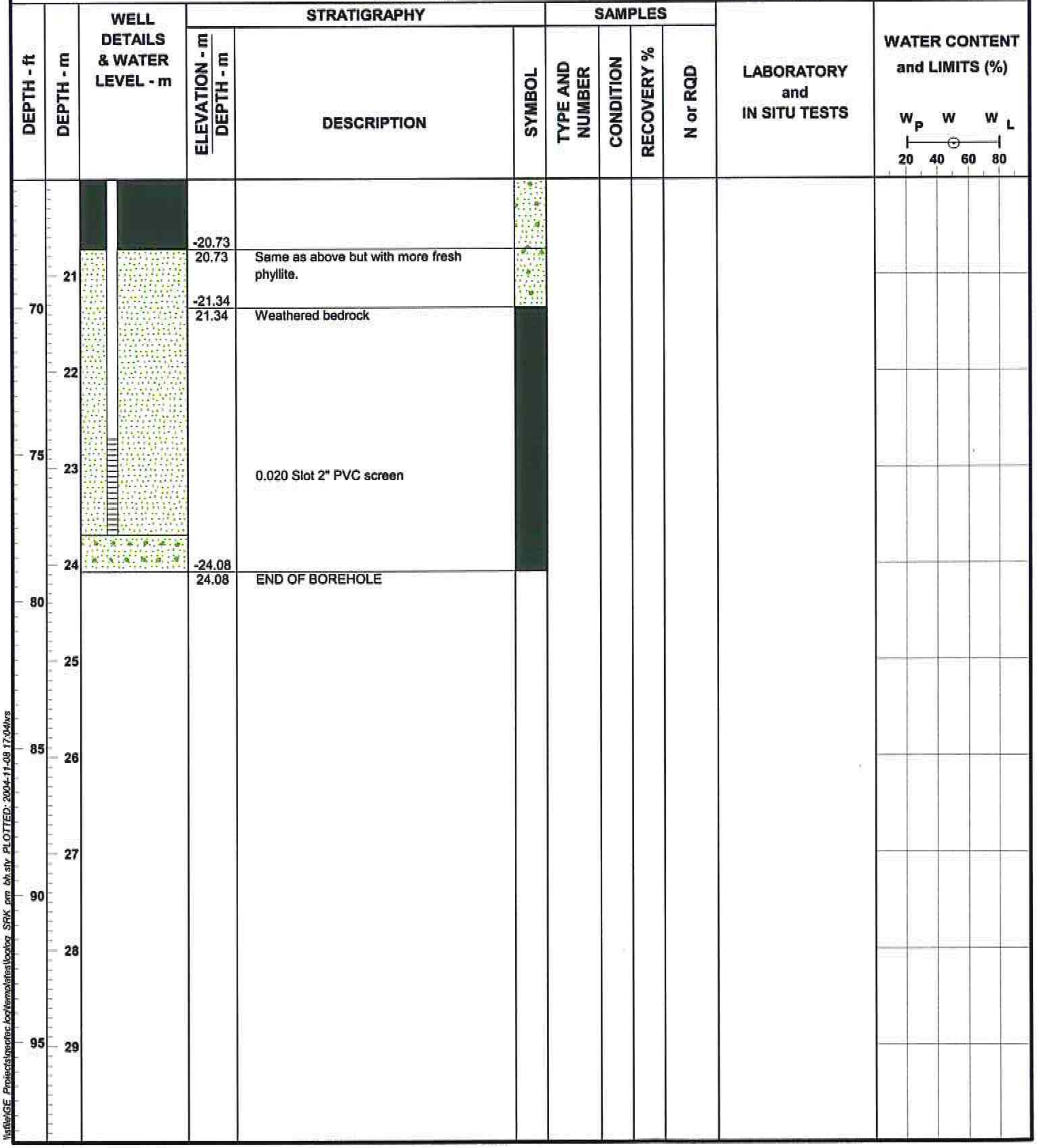
GENERAL COMMENTS:

WELL PLUG MATERIAL LEGEND

▨	Bentonite
🟩	Cuttings
■	Grout
░	Sand

LABORATORY AND IN SITU TESTS

pH	Rinse pH	LE	Extraction
Cond	Rinse conductivity		
ABA	Acid Base Accounting		
Metals	Metal ICP		



ELEVATION - m / DEPTH - m	DESCRIPTION
-20.73 20.73	Same as above but with more fresh phyllite.
-21.34 21.34	Weathered bedrock
	0.020 Slot 2" PVC screen
-24.08 24.08	END OF BOREHOLE

\\srfile\GE_Projects\srsotec.log\templates\loglog_SRK_pm_bh.sty PLOTTED: 2004-11-09 17:04hrs

APPENDIX C.2

SRK04-5a and -5b: Initial Water Quality Results

Appendix C.2- Water Quality Results: SRK04-5

Sample ID		SRK04-5B	SRK04-5A
Date Sampled		9/25/2004	9/25/2004
Time Sampled			
ALS Sample ID		80	81
Nature		Water	Water
Physical Tests			
Conductivity	(uS/cm)	450	459
Hardness	CaCO3	185	198
pH		8.31	8.34
Dissolved Anions			
Alkalinity-Total	CaCO3	138	140
Sulphate	SO4	100	108
Dissolved Metals			
Aluminum	D-Al	<0.010	<0.010
Antimony	D-Sb	0.00088	0.00068
Arsenic	D-As	0.0120	0.0079
Barium	D-Ba	0.058	0.046
Beryllium	D-Be	<0.0050	<0.0050
Boron	D-B	<0.10	<0.10
Cadmium	D-Cd	<0.000050	<0.000050
Calcium	D-Ca	51.1	54.2
Chromium	D-Cr	<0.00050	<0.00050
Cobalt	D-Co	<0.00050	<0.00050
Copper	D-Cu	<0.0010	<0.0010
Iron	D-Fe	0.316	0.272
Lead	D-Pb	<0.0010	<0.0010
Lithium	D-Li	<0.050	<0.050
Magnesium	D-Mg	14.1	15.3
Manganese	D-Mn	0.069	0.063
Mercury	D-Hg	<0.00020	<0.00020
Molybdenum	D-Mo	0.0236	0.0186
Nickel	D-Ni	<0.0050	<0.0050
Selenium	D-Se	<0.0010	<0.0010
Silver	D-Ag	<0.000050	<0.000050
Sodium	D-Na	18.6	17.7
Thallium	D-Tl	<0.00020	<0.00020
Titanium	D-Ti	<0.050	<0.050
Uranium	D-U	0.00727	0.00489
Vanadium	D-V	<0.030	<0.030
Zinc	D-Zn	0.0154	0.0081

Footnotes:

APPENDIX D

Correspondence

APPENDIX D.1

Letter of Notification

SRK Consulting
Engineers and Scientists

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July 15, 2004
Project Number 1CD008.56

Department of Environment
Government of Yukon
Box 2703
Whitehorse, Yukon
Canada Y1A 2C6

Attention: Tony Polyck, Manager Water Inspections Section

Dear Tony:

AMP Event #4, Seepage Water Quality from Grum Rock Dump, Anvil Range Mine, Yukon

SRK Consulting (Canada) Inc. (SRK) has been retained by Deloitte and Touche (DT) to provide technical input to the long-term management of water and facilities at the Anvil Range Mine, Yukon Territory, which will be integrated into the 2008 Final Closure and Reclamation Plan (FCRP). SRK has also been retained to address short-term water management issues that may arise prior to the completion of the 2008 FCRP. This letter has been prepared in accordance with the requirements of the Anvil Range Mine Adaptive Management Plan (AMP) that was submitted to the Yukon Water Board on June 30, 2004.

The AMP provides a statistically based threshold that if achieved, triggers the initiation of a management response. Review of the water quality data from 1998 to 2003 indicated that there was a statistically increasing trend in the concentration of sulphate in the surface water at station V2 below the Grum waste rock dump. This letter serves as a notification to the YG that this threshold has been crossed and that within 30 days, SRK will prepare an appropriate response plan to address this issue.

Please contact me if you have any questions

Yours truly,

SRK Consulting (Canada) Inc.

Healey

Peter Healey P.Eng
Principal

1CD008.46_Grum Dump Seepage_Letter of Notification_20040711.doc

Group Offices:
Africa
Asia
Australia
North America
South America
United Kingdom

North American Offices:	
Denver	303.985.1333
Elko	775.753.4151
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Reno	775.828.6800
Toronto	416.601.1445
Tucson	520.544.3668

APPENDIX D.2

AMP Event #4 Response Plan

SRK Consulting
Engineers and Scientists

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August 12, 2004
1CD003.53

Department of Environment
Government of Yukon
Box 2703
Whitehorse, Yukon
Canada Y1A 2C6

Attention: Tony Polyck, Manager Water Inspections Section

Dear Tony:

AMP Event #4, Seepage Water Quality from Grum Rock Dump, Anvil Range Mine, Yukon

SRK Consulting (Canada) Inc. (SRK) has been retained by Deloitte and Touche (DT) to provide technical input to the long-term management of water and facilities at the Anvil Range Mine, Yukon Territory, which will be integrated into the 2008 Final Closure and Reclamation Plan (FCRP). SRK has also been retained to address short-term water management issues that may arise prior to the completion of the 2008 FCRP. This letter has been prepared in accordance with the requirements of the Anvil Range Mine Adaptive Management Plan (AMP) that was submitted to the Yukon Water Board on June 30, 2004.

The AMP currently provides a number of statistically-based thresholds that, if achieved, trigger the initiation of a management response to degraded seepage water quality at Grum Dump. Thresholds were derived from specific indicators (total copper, total zinc, and total sulphate concentrations) at routine monitoring station V2 (Figure 1) over a reference period of 1998 to 2002. Two specific statistical thresholds were defined that, if exceeded, trigger the implementation of the AMP, as follows:

- three consecutive monitoring results at V2 that exceed the upper 75th percentile of the reference period for any of the specific indicators; and
- a statistically significant trend in monitoring results for specific indicators at V2 which, when extrapolated forward three years, would result in values greater than the upper 75th percentile of the reference period for any of the specific indicators.

Review of the available water quality data from 1998 to present indicated that both thresholds have been exceeded for total sulphate at station V2 below the Grum waste rock dump, and that concentrations were within a stable range from 2000 onward. The apparent increase in sulphate concentrations following the reference period resulted in an immediate triggering of the AMP as of the date of implementation, July 1, 2004. This letter serves as a notification to the Government of Yukon of the response plan that has been developed to address this issue.

Group Offices:
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Asia
Australia
North America
South America
United Kingdom

North American Offices:

Denver	303.985.1333
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Fort Collins	970.407.8302
Reno	775.828.6800
Toronto	416.601.1445
Tucson	520.544.3668

BACKGROUND INFORMATION AND DISCUSSION

Current understanding of impacts of loading

Increased sulphate concentrations at V2 are indicative of oxidation of sulphides and transport of oxidation products from within the Grum Dump. An increase in sulphate concentrations was therefore fully expected. The reason this was selected as a trigger was that it provides the first indication that oxidation is occurring in the dump, and that increased monitoring and surveillance is now required. Rising sulphate concentrations at V2, in isolation, do not represent an ecological threat to Vangorda Creek. Current zinc and copper loading to Vangorda Creek from Tributary A (sampled at V2) is low; there is insufficient information to evaluate metal loading to Vangorda Creek from other Grum Dump pathways at this time.

Receiving water quality criteria

Monitoring of water quality downgradient of Grum Dump is intended to ensure protection of aquatic resources in Vangorda Creek. An indication of impacts to Vangorda Creek from Grum Dump can be made by a more accurate determination of the incremental loading from Grum Dump.

Water quality guidelines have been established by the Canadian Council of Ministers of the Environment (CCME) for the protection of freshwater aquatic life that serve as a useful starting point for the determination of acceptable water quality in Vangorda Creek. Table 1 shows the available CCME guidelines for the specific indicators for V2.

Table 1. CCME GUIDLEINES FOR SPECIFIC INDICATORS FOR PROTECTION OF AQUATIC LIFE

Parameter	Total Copper	Total Zinc	Total Sulphate
Concentration (mg/L)	0.002	0.03	no guideline

Source: CCME Canadian Environmental Quality Guidelines, Summary Table, Update 2002.

Water quality monitoring has been carried out for reference purposes at a station (V1, not shown) upstream of the mine site in Vangorda Creek since 1988. Results show exceedances of CCME guidelines for total copper and, less frequently, total zinc in Vangorda Creek *upstream* of the mine. Clearly, with background water quality near or exceeding CCME criteria, these guidelines represent a starting point only for the determination of acceptable water quality criteria downstream of the mine. Nevertheless, for the purposes of analysis of the impacts of trigger activation at V2 on the receiving environment, the CCME guidelines will initially be used as a basis for discussion of impacts to Vangorda Creek from Grum Dump.

Evaluation of contaminant loading

The potential importance of Grum Dump contaminant loads to Vangorda Creek was acknowledged prior to the trigger of AMP Event #4 and is currently the subject of several ongoing or planned investigations, in addition to the routine monitoring required by the site water licence. The investigations that were under way or in preparation prior to the trigger of the AMP are as follows.

- Grum Dump toe seep survey. This investigation, started in Spring 2002, is currently in its third year, and consists of sampling surveys conducted each spring and fall at all points along the dump toe where seepage is observed. Figure 1 shows the locations along the southern toe of the Grum Dump where samples have been collected to date. This investigation is ongoing.
- Collection of surface water and seeps downgradient of the dump toe. This investigation was begun in 2003 to begin assessing seep and surface water quality between the southern toe of Grum Dump and Vangorda Creek. Figure 1 shows the locations where downgradient samples have been collected. This investigation is ongoing.
- Evaluation of options for collecting seepage south and southeast of Grum Dump. Work to date is summarized in a draft report, 'Design Options for Seepage Collection, Grum Waste Rock Dump', produced by SRK in December 2003. This work included review of historical subsurface investigation logs, excavation of several test pit near the southern dump toe, and inspection of

exposed soils in historical test pits and road cuts. This design options report is to be finalized this year.

- Installation of groundwater monitoring wells south of Grum Dump. This activity is planned for September 2004, and is described herein under the heading 'Groundwater monitoring well installation'.

RESPONSE PLAN

The response plan outlines a staged approach to investigating increased sulphate concentrations at V2 and is intended to be adaptive in nature, in keeping with the philosophy of the AMP. The following outlines the initial stages of the response plan in terms of specific actions to be undertaken.

Collection of routine water quality samples

Water quality samples will continue to be collected at routine monitoring stations as specified in the Water Licence with respect to location and sampling frequency. From July 1, 2004 onward, samples will be collected at Reference Water Quality (RWQ) Stations as outlined in the AMP (Figure 1). Monitoring of RWQ Stations going forward will provide an additional set of information to that has not been available to this point. As the recommendations of the AMP are currently in the process of being implemented, the historical water quality record for many of the RWQ stations is incomplete, with many data gaps. Comprehensive monitoring of these stations going forward is expected to improve the understanding of sources of contaminant load from Grum Dump to V2 and to Vangorda Creek.

Review of existing water quality record

The existing water quality record will be reviewed to ensure that all available conclusions regarding water quality and contaminant sources have been identified. A re-assessment of conclusions regarding trends in contaminant concentrations over time will be conducted to ensure that geochemical conditions are being appropriately evaluated.

In addition, data quality issues associated with the existing water quality record will be addressed. To the extent possible, the existing historical data will be verified and deficiencies will be identified and corrected.

Once the record has been verified, a comprehensive summary of existing water quality data related to Grum Dump loading will be compiled. This compilation will also include all available data for upstream and downstream stations on Vangorda Creek, and will facilitate assessment of the proportion of total contaminant load in Vangorda Creek that originates in Grum Dump.

Detailed contaminant pathway survey

There is uncertainty regarding the contribution of Grum Creek to water quality at station V2. In addition, the importance of contaminant pathways downgradient of Grum Dump, other than Grum Creek/ Tributary A, has received relatively little attention to date. A surface water and seepage survey will be carried out to better define the influence of Grum Creek water on water quality at V2, and to provide information on other contaminant pathways. The following areas will be inspected for surface flows and seepage:

- Downgradient of the Grum Dump toe access road, between the road and Tributary A. This is the original Grum Creek channel; Grum Creek water is currently being diverted along unlined ditch to an infiltration basin (Moose Pond). Survey here will assess any identified seepage and surface flow for influence of leakage from unlined ditch.

- Downgradient of Moose Pond, between Moose Pond and Vangorda Creek. Seepage and flowing surface water has been identified at several locations. Limited water quality information is available from sampling events during the most recent spring and fall sampling rounds. A comprehensive seepage/ surface water survey will provide an indication of the degree of attenuation occurring between Moose Pond and Vangorda Creek.

- West flank of Tributary A. No attempts have been made to identify inflows into Tributary A from the west. A seepage/ surface water survey in this area will provide information on potential loading from the minimally-characterized area to the west, both upstream and downstream of V2.
- West of Tributary A catchment. Three streams are mapped to the west of Tributary A that are downgradient of Grum Dump. Limited water quality information is available for two of these streams from sampling events during the most recent spring and fall sampling rounds. A detailed seepage/ surface water survey of the Grum Dump catchment west of Tributary A will better define contaminant loading to Vangorda Creek from this minimally-characterized area.

A detailed surface water and seepage survey will be conducted downgradient of the Grum Dump toe access road to assess contaminant loadings to Tributary A from Grum Creek via surface and seepage water. As part of this survey, detailed investigations downgradient of Moose Pond and station V2A will also be carried out. Stations V15 and V2 will be monitored as part of this program to allow mass balance calculations.

Installation of flow monitoring station on Grum Creek

A flow monitoring station will be established on Grum Creek to allow accurate determinations of discharge, and, when coupled with water chemistry, contaminant loads in Grum Creek. The proposed location is immediately upstream of the intersection of the main stem of Grum Creek with the Grum Dump toe access road (Figure 1). This location will allow flow monitoring above the small tributary to the northeast; in addition, this location is upgradient of the unlined ditch section that is currently suspected to experience seepage loss.

Groundwater monitoring well installation

As part of a broader study looking at the requirement for and feasibility of interception of groundwater downgradient of Grum dump, installation of monitoring wells is currently planned for summer 2004 (Figure 1). The only currently available information on groundwater quality is from BH96-9A and B. A multilevel installation is planned at the intersection of main stem Grum Creek and the Grum Dump toe access road. A shallow screened interval will allow sampling and piezometric measurements in the shallow overburden, while a deeper screened interval will test conditions in shallow fractured bedrock. A single well will be sited to replace P96-9B, which is no longer functional. A second multilevel installation will be sited on a topographic high west of P96-9 to test the hypothesis that seepage is controlled by topography. One well will be screened in the shallow overburden, with a second well screened to allow samples to be taken and piezometric levels to be recorded from shallow fractured bedrock.

Reporting

Within 90 days of installation of groundwater monitoring wells, a status report will be prepared summarizing the findings of the AMP response to that point. The key aspect of the response with respect to impacts on Vangorda Creek will be the load balance that is derived from information collected during response activities. The estimates of loading from Grum Dump will be compared to background loads in Vangorda Creek to provide an initial indication of the relative loading.

A review of the specific thresholds established in the AMP will be included as part of the initial status report. The AMP provides for the assessment of the adequacy and appropriateness of the specific thresholds for each event. The current statistically-based trigger has served as a signal that contaminant loading from Grum Dump should be assessed in greater detail. However, the specific thresholds which trigger the need for additional water management measures need to be re-evaluated based on ecologically-based thresholds along the lines of the CCME guidelines, and a suitable factor of safety.

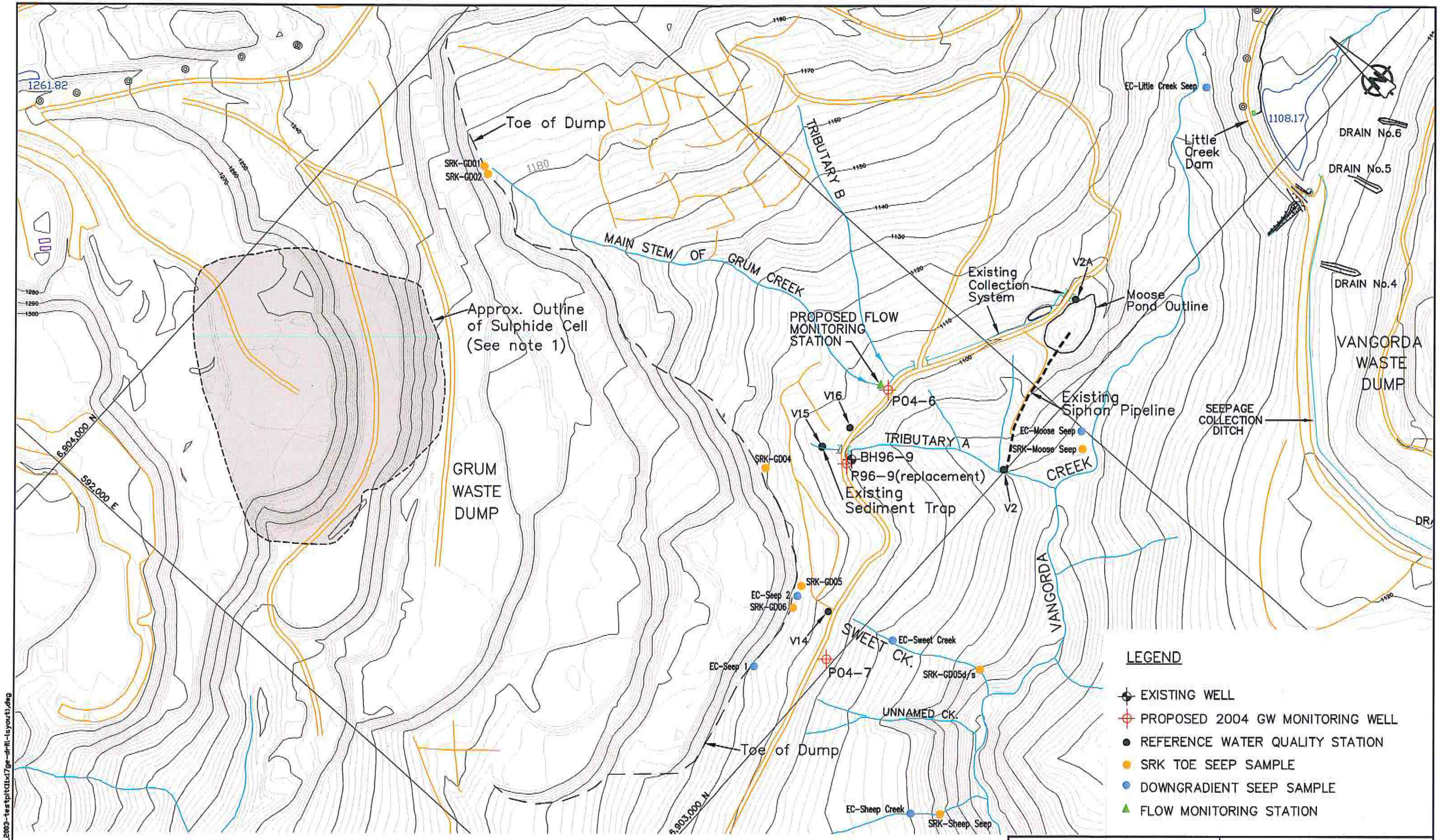
Closing comments

The AMP response plan to elevated sulphate in Grum Dump drainage at station V2 as outlined above is intended to provide a staged evaluation of causes of increased contaminant concentrations over the reference period specified in the AMP. As sulphate levels have remained within a constant range over the period of late 2000 to present, the staged approach is considered to pose little incremental risk. The short term strategy is therefore to accelerate the assessment of longer term options, rather than to implement emergency measures to collect and treat water in the absence of a longer term plan. A longer term plan will developed on the basis of the findings of the activities outlined in this response plan and other ongoing closure studies.

Yours truly,

SRK Consulting (Canada) Inc.

Peter Healey, P.Eng.
Principal



Map Scale: 1:5000
Contour Interval: 2m
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

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

SRK Consulting
Engineers and Scientists

Deloitte & Touche

AMP EVENT #4 RESPONSE PLAN

SOUTH GRUM DUMP
SITE LAYOUT AND
PROPOSED MONITORING WELLS

PROJECT NO.	DATE	APPROVED	FIG.
1CD003.53	Aug. 2004		1

File Ref: site_plan_2003-testpit(11x17ge-drill-layout).dwg