



BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

DELOITTE & TOUCHE INC.

2007 ANNUAL REPORT

FRESH WATER SUPPLY DAM BREACH PROJECT FARO MINE, YUKON

FINAL

PROJECT NO.: 0257-043-01
DATE: FEBRUARY 6, 2008

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Project No. 0257-043-01

February 6, 2008

Mr. Doug Sedgwick
Deloitte & Touche Inc., as Interim Receiver for Anvil Range Mining Corporation
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**RE: 2007 ANNUAL REPORT
FRESH WATER SUPPLY DAM BREACH PROJECT, FARO MINE, YUKON**

Dear Mr. Sedgwick:

Please find attached our final report on the Fresh Water Supply Dam Breach Project (FWSB) at Faro Mine. This report contains an assessment of the physical performance of the breach, a report on the success of the re-vegetation activities and a report on the aquatic environment.

If there are any questions regarding this report, or if you require any other services, please contact the undersigned at your convenience.

Yours truly,
BGC Engineering Inc.
per:

Gerry Ferris, M.Sc., P.Eng.
Geotechnical Engineer

encl.: Final Report

GWF/sf

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LIMITATIONS OF REPORT

BGC Engineering Inc. (BGC) prepared this report for the account of Deloitte and Touche Inc., as Interim Receiver for Anvil Range Mining Corporation. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of report preparation. Any use which a third party makes of this report, or any reliance on decisions to be based on it are the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

As a mutual protection to our client, the public, and ourselves, all reports and drawings are submitted for the confidential information of our client for a specific project. Authorization for any use and/or publication of this report or any data, statements, conclusions or abstracts from or regarding our reports and drawings, through any form of print or electronic media, including without limitation, posting or reproduction of same on any website, is reserved pending BGC's written approval. If this report is issued in an electronic format, an original paper copy is on file at BGC Engineering Inc. and that copy is the primary reference with precedence over any electronic copy of the document, or any extracts from our documents published by others.

1.0 INTRODUCTION

1.1 Background

The Fresh Water Supply Dam Breach (FWSB) Project was undertaken in November/December 2003, in accordance with the terms and conditions provide in Yukon Water Licence QZ03-058 (the Licence). The Licence is in effect until December 31, 2008 and provides details on reporting, effluent quality standards, monitoring and surveillance required for this project.

The 2007 Annual Report provided herein has been prepared in accordance with the provisions of Part A, Sections 13 and 14 of that Licence. This report provides a summary of the performance of the breached FWS Dam at the Faro Mine site. In addition to commentary related to the physical performance of the engineered breach section, this report provides details regarding the re-vegetation of the reservoir and the aquatic life in the South Fork Rose Creek channel, tributaries within the former reservoir and the downstream channel. Deloitte & Touche Inc. (Deloitte) is the Interim Receiver for Anvil Range Mining Corporation (ARMC) and currently manages the site activities. This report was prepared by BGC Engineering Inc. (BGC) based on information collected by BGC staff, ARMC site staff, and Laberge Environmental Services (Laberge).

This report presents water quality monitoring results as required by Part C, Section 25 and Part D, Section 33 of the Licence. The field work required for the water quality monitoring presented in this report was gathered by ARMC staff. The physical monitoring program required in Part C, Section 33 of the Licence was performed by BGC personnel.

The annual inspection and assessment of the re-vegetation work undertaken in the former reservoir and the breach, required in Part C, Section 34, was performed by Laberge and is attached to this report.

An assessment of the riparian conditions, availability of spawning and rearing habitat and fish sampling performed by Laberge is attached to this report. The need for assessment was outlined in the original design report (SRK et al. 2003) and the Environmental Management Plan (EMP) prepared as part of the Water Licence application.

1.2 Scope of Services

BGC provided a proposal (No. 07-031) for the preparation of this Annual Report. The scope of work described in the proposal was:

1. Provide input, review and interpretation of monitoring data collected by site staff at the FWSB project site. Prepare and submit monthly reports on the monitoring activities to the Water Board (as per Part A, Section 15 of the Licence).
2. Perform a May site visit to examine site conditions at the FWSB and K8 Creek project sites following the spring freshet.

3. Perform a September site visit to examine conditions near the end of the open water season.
4. Prepare and submit the Annual Report for the FWSB project.

Authorization to proceed with the work was provided by Mr. Doug Sedgwick of Deloitte via a letter dated May 29, 2007.

2.0 FACILITY OVERVIEW

Faro Mine is located in the central Yukon, approximately 200 km north-northeast of Whitehorse. The mine site is situated approximately 22 km north of the Town of Faro, as shown in Figure 1. The former FWS Dam and reservoir are located south of the main access road to the Faro Mine, approximately 5 km from the mine guard house.

The FWS Dam was constructed in 1968 on the south fork of Rose Creek. The FWS Dam was a zoned earth fill dam used to store fresh water for mine-processing operations during the operational life of the mine. The FWS Dam was approximately 410 m long, 20.5 m high at its highest point and 6 to 7 m wide at the crest. The slope of the downstream face of the dam was approximately 2H:1V and the slope of the upstream face of the dam was approximately 2.6H:1V. A 30 m wide, 3.2 m deep concrete spillway is located at the north abutment of the breached dam. The crest of the FWS Dam is at a nominal elevation of 1099.3 m above mean sea level (amsl), based on the geodetic survey conducted in 2002.

The FWS Dam was breached in a controlled manner in November/December 2003, in accordance with a design and regulatory requirements prepared for that project. Design for the breach of the dam was presented in a Final Design Report (SRK et al. 2003). Information related to the construction activities during the breach was presented in an as-built construction report (SRK & BGC 2004).

The main elements of the dam breach design included (SRK et al. 2003):

- An engineered breach through the body of the dam along the approximate alignment of the original creek channel.
- Re-establishment of the pre-construction creek through the reservoir.

The design approach for the breach included the concept of adaptive management for the former reservoir and in the channel downstream of the construction area. Adaptive management in this case meant that the re-forming channel in the former reservoir and the remaining portion of Fresh Water channel would not be engineered per se as part of the breach work, but evaluated and remediated on an as-needed basis.

The breach and channel construction completed in 2003 consisted of a 315 m long section through the former footprint of the dam, as shown in Figure 2. The main components of the breach works are as follows:

- the floodplain (20 m wide),
- the channel (8 m wide),
- the erosion protection along the edge of the floodplain,
- the inlet structure and
- the five riffles within the channel.

3.0 MONITORING RESULTS

Monitoring of the flow quantity and total suspended solids (TSS) in the South Fork Rose Creek is required as part of the Licence. Two sampling points are specified in the licence: FWSB#1 is located at the gun club bridge approximately 1.5 km upstream of the limit of the reservoir and FWSB#5 is located downstream of the limits of the 2003 construction area, as shown on Figure 1. These sample points were monitored twice per month during the period of April through August. Yearly water quality monitoring is required at FWSB#6, which is located adjacent to the potential acid generating (PAG) spoil pile, as shown on Figure 1. The results of this monitoring program were submitted in a series of monthly reports to the Yukon Water Board; copies of the monthly reports are included in Appendix A.

A summary of the monitoring results obtained for FWSB#1 is contained in Table 1. Flow measurements were not collected in April and the first reading in May of 2007 due to ice cover which made conditions unsafe to access. This data is also plotted in Figure 3, where higher TSS values are recorded during the higher flow periods and minimal TSS during low flow periods. The results for FWSB#5 are contained in Table 2 and are plotted in Figure 4. Similar to the results for FWSB#1, the higher TSS values correspond to the higher flow period. Again, flow measurements were not made in April and the beginning of May 2007 due to ice cover.

A comparison of the TSS measurements collected during 2007 is contained in Figure 5. This figure shows that during the spring and early summer, the measured TSS is higher downstream of the former reservoir than upstream. Later during the year, during lower flow periods, there is almost no difference between the measured TSS values. The North Tributary was identified as the major source of the increased TSS in the former reservoir (Laberge 2008). As discussed in Section 4 and Laberge (2008), a portion of the North Tributary is continuing to experience erosion as the channel reforms itself following the breach of the dam. The results indicate that the majority of the sediment is being generated in the North Tributary, but only during periods of high flow.

A comparison of the flow measured during 2007 is provided in Figure 6. This data indicates that measured flow at FWSB#5 was higher than at FWSB#1, as would be expected.

The chemical testing results for water collected at FWSB#6, the run-off from the potentially acid generating (PAG) spoil area (Figure 1), are shown in Table 3. Included on this table are the maximum discharge criteria provided in the Licence. Based on the grab sample tested, the run-off water did not exceed any of the License criteria.

4.0 GEOTECHNICAL INSPECTION

BGC staff members were on-site two times during 2007 to undertake visual inspections of the FWS Dam breach and former reservoir. Mr. J. Cassie, P.Eng., visited the Faro Mine site during the periods of June 13 to 14 and September 24 to 26, 2007. Both the June and September inspections corresponded with the annual inspection visit for other facilities at Faro Mine. Thus the conditions at the FWS Dam breach project area were inspected both following the spring freshet and at the end of the open water season, during low flow.

On both occasions, the facilities were inspected during a walking tour. A camera and Dictaphone were used to record conditions and observations. The photographs, along with recorded observations, are compiled into a Field Record Summary that is kept in BGC's files. The observations made during the site visits are summarized within this section of the report. The observations of the more recent September visit took precedent over observations made in June.

The purpose of the site inspections was to examine the facilities in detail for evidence of deficient performance, to provide a basis for possible adjustment to the frequency of monitoring and to review points of immediate concern which require maintenance with site representatives. Upon return to the office, an inspection memo was prepared that outlined the status of the various structures inspected, highlighted items of concern and items requiring immediate attention. Copies of the inspection memos are attached in Appendix B.

Two different views of the FWSB project area are shown in Figure 7, an aerial view from 2004 and a panoramic view from the crest of the dam from June 2007. Both photographs give an overview of the breach area, showing the floodplain, channel and control structures (inlet and riffles). Shown on the 2004 aerial view are four areas of concern: the slough, tension cracks, erosion gullies, and flow around Riffle 3. The flow around Riffle 3 was repaired in 2004 and the remaining concerns were monitored until 2007, when some minor grading and re-vegetating were completed at the slough. A view of the slough, tension crack location in June 2007 is included in the bottom photograph. An additional feature in 2007 is the progression of the rill erosion on the side slopes of the breach, especially in the former dam core material.

In general, the channel section through the breach has worked as designed. The majority of the creek flow is concentrated in the channel section, even during a higher flow period (June), as shown in Figure 8. During lower flow conditions (September), all of the flow is contained within the channel (Figure 9). During the high flow period, erosion of some of the soil at the downstream limit of construction occurred which has created another riffle zone, within the area monitored as part of the adaptive management plan for the area.

The constructed breach section is performing as designed (Figure 9) with some movement of the riprap at the crest of the riffles (particularly Riffle 4). No remediation is currently proposed. There is minor erosion noted on channel sections, as was the design intent.

A slough developed on the south valley wall in 2004, just upstream from the south abutment (left) of the breached dam. The slough appears to be driven by seepage from the valley wall. Initially, monitoring of the slough was recommended, and very little changes to the slough occurred after about 2005. During August 2007, site staff undertook some minor remedial work at the slough area, consisting of hand re-grading and re-seeding of the disturbed area. A view of the completed work at the slough is shown in Figure 10.

Small erosion gullies were first noted on the right bank of the breach between the inlet structure and Riffle 1 in 2004. Monitoring of the performance of these erosion gullies was instituted. Now the size and extent of these gullies has increased, as shown in Figure 10, to the point that some remedial measures should be undertaken to limit future erosion.

Rill erosion is continuing to occur in the side slopes of the breach, especially in the former core of the dam. This is mostly due to the lack of vegetation on the compact fine grained material, as shown in Figure 7 and 10. No remedial measures are currently recommended for these rill erosion locations, but monitoring should continue.

In 2004, riprap was placed within the K8 Creek tributary in a location where significant erosion was occurring (BGC 2004). In 2005, some minor repairs were carried out following some minor movement of the riprap (BGC 2006). The steep section of K8 Creek (the side of the borrow pit) appears to be performing adequately, as shown in Figure 11. A delta of material has formed as the creek enters the borrow pit, see Figure 11. At the outlet of the borrow pit, the channel is mostly formed, although a portion of the channel becomes overland flow and continues to actively erode in the spring as it forms a distinct channel. This continued erosion leads to sediment within the South Fork of Rose Creek (see details in Laberge 2008), no remedial measures are currently recommended for this area.

Bank erosion, within Reach 2 (see Appendix D for definition of Reach 2), was identified in 2006 as a concern. Erosion of the outside bank (see Figure 12) is occurring at the first major bend of the channel within the base of the former reservoir. This area was specifically monitored by BGC and Laberge during 2007. Further bank erosion continued at this location in 2007, (see Appendix D for details), but no remedial measures are recommended at the current time. Continued monitoring and measurement of the erosion at this location should continue in 2008.

5.0 RE-VEGETATION

Observations of the re-vegetation efforts in the reservoir area were made by BGC in both June and September. Photos of the re-vegetated areas are shown in Figure 12, and additional photos are contained in Appendix C.

The re-vegetation monitoring program described in Part E of the License was performed in 2007 by Laberge; their full report is included as Appendix C. The Laberge report covers two aspects:

1. An assessment of the re-vegetation undertaken by Arctic Alpine Seed Ltd. in 2003 and 2004, as well as natural re-vegetation, and
2. A description of any evidence of erosion.

The evaluation of the re-vegetation success was undertaken for the five different phases of planting:

- Phase I and II were assessed as one vegetation zone in 2007 as the two zones did not have a distinct separation as in previous years. Phase I planting occurred between Elevations 1096 and 1090 m amsl in June 2003 and Phase II planting occurred between Elevations 1090 and 1086 m amsl in September 2003. In July 2007, both areas had an overall vegetative cover up to 100%. These areas experienced a dominant, dense growth of Sheep Fescue. Due to the growth of Sheep Fescue, Wheatgrass and Ticklegrass struggle to compete and have a lesser prominence in the area. The natural colonization of the area is hindered by the previous years litter mat (predominantly Sheep Fescue).
- Phase III planting occurred in September 2003 and consisted of the planting of willows in the riparian zone as a trial to show the success of the proposed planting methodology. The survival rate of about 80% at the time of the 2007 assessment is the same as the 2006 assessment.
- Phase IV planting occurred on the exposed base of the former freshwater reservoir in June and July 2004. In July 2007, this area had an overall vegetative cover greater than 90% in most areas. The re-vegetation is patchy in this area but is dominated mostly by Tufted Hairgrass with Sheep Fescue found on the higher levels of the valley bottom. The colonization by Willows was more prominent in 2007 than 2006 in the bottom of the former reservoir.

- Phase V planting occurred at the dam area, the disturbed area downstream of the dam, and the floodplains adjacent to the breach and was completed in September and October 2004. In July 2007, this area had an overall vegetative cover varying from 20% to 70%, similar to the cover observed during the 2006 survey.

The floodplains adjacent to the dam breach had a vegetative cover of approximately 20% to 40%, with some dense areas of about 70%.

The northwest (downstream) wall and the southeast (upstream) wall of the breached dam showed good natural growth of willows and a few alders. A moderate (40% to 60%) cover of seeded grass species was also observed on the southeast wall. The side slopes of the breach had a 5% to 20% vegetative cover. The cover on the breach had a considerably greater re-vegetation than in 2006 of approximately 80%. The re-vegetation consists of both the seeded species, as well as natural re-vegetation.

In addition to the above mentioned seeding that occurred in 2003 and 2004, the riparian area was planted, except for a small portion of the northeast tributary where the final channel location was not yet established. Evaluation of these sites in July 2007 indicated the staked willows on the floodplains upstream and downstream of the dam breach had a survival rate of 50% to 90%. A much lower survival rate of 5% to 30% was observed for the willows staked along the upper tributaries, similar to the observations made in 2006.

The assessment of the re-vegetation performed in 2007 indicated that the site is performing very well. Continued monitoring of the re-vegetation performance and bank erosion along Rose Creek and its tributaries is recommended (Laberge 2007, Appendix C).

6.0 AQUATIC ENVIRONMENT

An evaluation of the aquatic environment, as described in SRK et al. 2003 and the EMP for the project, was completed by Laberge. Their full report is attached in Appendix D.

Laberge presented information related to fish species and habitat conditions within the five reaches covering the former reservoir, the breach section and a reach downstream from the breach construction area. This study also covered a short reach of Rose Creek downstream from the lower limit of the Rose Creek Diversion Canal and upstream from Station X14. A full description of the reaches, including justification for the reach breaks, is contained in the Laberge report. Assessments were conducted during the spring (between June 4 and June 6) and summer (between August 13 and 16, 2007).

The study made the following conclusions concerning habitat and fish utilization in the study areas:

- Reach 1 has a low profile with fast and turbulent water cover for small fish in the form of boulders and scour pools; this reach seems to be stable. One Arctic Grayling, no Burbot and seven Slimy Sculpin's were encountered during the electro-fishing.
- Reach 2 has relatively deep residual pools that provide excellent habitat for adult Arctic Grayling. The reach has experienced some bank erosion within the first meander of the reach. Stakes were placed in 2006 to help in monitoring the erosion along this meander (see Laberge's report for details). However, TSS levels do not indicate any active erosion. One Arctic Grayling, no Burbot and 26 Slimy Sculpin's were encountered during the electro-fishing.
- Reach 3 also has deep residual pools with primarily vertical banks. Unlike the upstream reaches this reach has finer-grained materials in the banks and the bed of the reach. This reach is experiencing some unstable sections of bank and the substrate is characteristically sandy. Ten Arctic Grayling, no Burbot and 17 Slimy Sculpin's were encountered during the electro-fishing.
- In Reach 4 (the construction area), the gradient is steep and has required the utilization of stream elevation controls called riffles. Pools have created just upstream of the riffles and are being filled in with fines. The shallow depth of these pools limit the cover for adult Arctic Grayling but the boulders within the reach are especially suited for juvenile fish and sculpin. Six Arctic Grayling, one Burbot and three Slimy Sculpin's were encountered during the electro-fishing.
- In Reach 5, boulders are suited for juvenile fish and sculpin. Pools within the reach are shallow and are not well suited for Arctic Grayling. Subdominant cover includes undercut banks and overhanging vegetation. Eight Arctic Grayling, no Burbot and five Slimy Sculpin's were encountered during the electro-fishing.
- Fish cover is abundant at location X-14. This included deep pools and shallow gravel riffles. Six Arctic Grayling, one Burbot and two Slimy Sculpin's were encountered during the electro-fishing.

A comparison of the electro-fishing results (for all years since the 2004 breach) is included as Table 4. This table compares the catch effort (catch per 100 sec), instead of total fish caught. It should be noted that the 2007 utilized a simple pass electro-fishing methodology rather than the double pass used in previous years (see Laberge 2008 in Appendix D).

The conclusions of the fish utilization study were:

- Arctic Grayling:
 - The occurrence of adults, juveniles and fry within the Fresh Water Reservoir, particularly in Reach 3, is indicative of the presence of spawning, rearing and nursery habitat. Reaches 2, 3 and X-14 have deeper pools which provide cover for adult Grayling. With the exception of Reach 1, where Grayling continue to be in a low abundance. Their presence in other reaches suggests little change in distribution or abundance from previous electro-fishing assessments.
- Burbot:
 - Burbot juveniles were represented in modest catch numbers throughout the former Fresh Water Reservoir. The lack of mature adults and fry suggest a lack of spawning habitat within the Reservoir and likely Burbot instead spawn downstream. If this is the case, the juveniles migrate upstream to rear in the upstream reaches. Their wide distribution and low catch numbers, as was the case in previous assessments, suggest continued stability in use as rearing habitat of juvenile populations in the assessment area.
- Slimy Sculpin:
 - The occurrence of fry within Reaches 1, 3, 4, and X-14 indicates some spawning success. The highest density were found in Reach 2, while the lowest densities were in Reaches 4, 5, and X-14. It was noticed within Reach 3 that few were found below the confluence with the North Tributary. The high sediment from the North Tributary has likely affected the occurrence of Slimy Sculpin downstream of the confluence. However, their continued wide distribution throughout the reaches and similar catch statistics compared to previous assessments suggest some stability of Slimy Sculpin populations in the assessment area.

Overall, the former Fresh Water Reservoir has good quality fish habitat throughout. The best pool habitat was found to be within reach 3 as evidenced by the occurrences of adult, juvenile and fry Arctic Grayling. Reaches 1 to 4 show utilization of the habitat for three different fish species, suggesting that even though the reaches were relatively recently constructed, they exhibit excellent colonization. The occurrence of Arctic Grayling and Sculpin fry suggests habitat for spawning within the Reservoir. While fish densities have remained relatively low based on fish capture results over several years of fish monitoring at these sites, there has been little change in the distribution of species or assemblage between reaches.

7.0 RECOMMENDATIONS

The following section provides summary recommendations with respect to routine inspections, monitoring, maintenance and annual inspections for 2008.

7.1 Routine Inspections and Monitoring

The following routine inspection and monitoring should be performed by site staff, as part of good practice and in order to comply with the Licence:

- Monitor the flow quantity and TSS at FWSB#1 and FWSB#5 twice per month between April and August (inclusive).
- Monitor and sample the run-off from FWSB#6 for acidity and metals, once per year.
- Perform twice monthly visual inspections of the performance of the side slopes and constructed creek elements. The four areas of concentration should be:
 - the slough near the south abutment of the dam,
 - the erosion gullies near the inlet on the north side of the breach,
 - the rill erosion occurring in the core of the dam, and
 - the tension cracks occurring on the left bank of the constructed breach in the core of the dam and immediately upslope of the installed erosion protection.
- Perform twice monthly visual inspection of the portion of the fresh water channel that was not modified as part of the breach construction (part of the adaptive management).
- Perform monthly visual inspection of South Fork of Rose Creek and tributaries through the former reservoir area, checking for channel blockage.

This data should be collected and reviewed as part of the annual review of the performance of the breach and to validate the adaptive management approach taken.

Any change in condition that is noted as a consequence of this program of routine inspection must be brought immediately to the attention of the inspector's superiors. BGC should also be notified so that the condition can be evaluated and to provide any necessary geotechnical advice related to the concern at hand. Photos of any changed condition should be taken.

7.2 Annual Reviews

The purpose of annual reviews is to provide a record of the performance of the facilities. The annual inspection of the physical performance of the breach and K8 creek area should be performed in May/June and September of 2008. The annual inspection of the re-vegetation and aquatic life/habitat should be performed in July / August 2008.

The May/June inspection should be timed so that it coincides with the spring freshet as closely as possible. Continued monitoring of the first meander bend in the upper reach of the former reservoir should continue. This monitoring should include visual inspection, collection of photographs (to allow comparison between years), and measurement of bank erosion.

7.3 Recommendations for Remedial Actions

The following recommendations for remedial actions are made:

- A swale should be constructed on the surface of the upstream seepage blanket to limit the erosion that is occurring as water flows from the blanket into the constructed breach. The swale should extend from the upstream face of the dam body to the upstream limit of the upstream seepage blanket, have a gentle slope (0.5% minimum) and be approximately 1.5 m in width. This project will be a field fit upon completion the newly disturbed area should be re-vegetated.
- Additionally some coarser gained fill should be deposited into the erosion gullies.

8.0 CLOSURE

This report summarizes the physical conditions as observed by BGC and Laberge and the water testing results as collected by site staff. Thank you for the opportunity to be of service to Deloitte and Touche and Faro Mine. Should you have any questions on this report, please contact BGC at your convenience.

Respectfully submitted,
BGC Engineering Inc.
per:

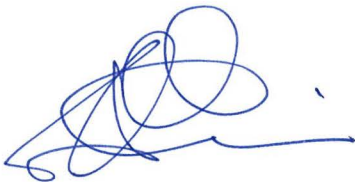


Gerry Ferris, M.Sc., P.Eng.
Geotechnical Engineer

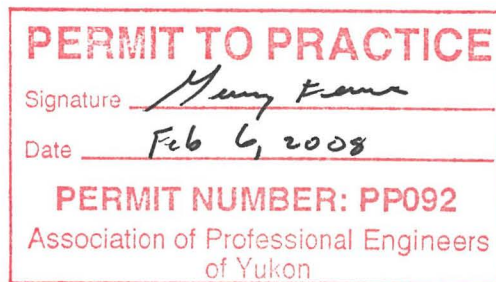


Ashton Friesen, EIT
Mining Engineer

Reviewed by:



James W. Cassie, M.Sc., P.Eng.
Specialist Geotechnical Engineer



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TABLES

Table 1 - Monitoring Results for FWSB#1

Date	TSS	Flow (m ³ /s)	Comments
April 12, 2007	<1	-	refer to Note 1
April 24, 2007	1	-	refer to Note 1
May 8, 2007	1	-	refer to Note 1
May 30, 2007	9	1.039	
June 7, 2007	17	2.505	
June 28, 2007	1	0.825	
July 11, 2007	<1	0.648	
July 25, 2007	1	0.567	
August 15, 2007	<1	0.582	
August 29, 2007	1	0.551	
<p>Note 1: The creek was ice covered and collection of reliable flow data was not possible.</p>			

Table 2 - Monitoring Results for FWSB#5

Date	TSS	Flow (m ³ /s)	Comments
April 12, 2007	3	-	refer to Note 1
April 24, 2007	6	-	refer to Note 1
May 8, 2007	8	-	refer to Note 1
May 30, 2007	21	2.022	
June 7, 2007	46	3.135	
June 28, 2007	2	1.246	
July 11, 2007	1	0.880	
July 25, 2007	1	0.736	
August 15, 2007	<1	0.839	
August 29, 2007	1	0.625	

Note 1: The creek was ice covered and collection of reliable flow data was not possible.

Table 3 - Laboratory Test Results for Run-off from PAG Spoil Area (FWSB#6)

Parameter	May 29, 2007 Results (mg/L unless noted)	Laboratory Detection Limit (mg/L)	Maximum Allowable Concentration (mg/L) ²
Temperature	11.6 °C		
pH ¹	8.1		
Total Suspended Solids	2	1	
Total Dissolved Solids	254	10	
Sulphate	132	0.5	
Conductivity	334 µS/cm	1 µS/cm	
Total Alkalinity	66.9	0.5	
Total Hardness	182	1	
Total Antimony (Sb)	<0.001	0.001	0.1
Total Arsenic (As)	<0.001	0.001	0.05
Total Barium (Ba)	0.057	0.023	1
Total Cadmium (Cd)	<0.0002	0.0002	0.02
Total Copper (Cu)	0.002	0.001	0.2
Total Lead (Pb)	0.001	0.001	0.2
Total Mercury (Hg)	<0.02 µg/L	0.02 µg/L	0.005
Total Molybdenum (Mo)	0.0011	0.0005	0.5
Total Nickel (Ni)	<0.001	0.001	0.5
Total Selenium (Se)	<0.001	0.001	0.05
Total Silver (Ag)	<0.00025	0.00025	0.1
Total Zinc (Zn)	0.01	0.005	0.5

¹ pH does not have units of mg/L.

²Maximum Allowable Concentrations from Water Licence QZ03-058

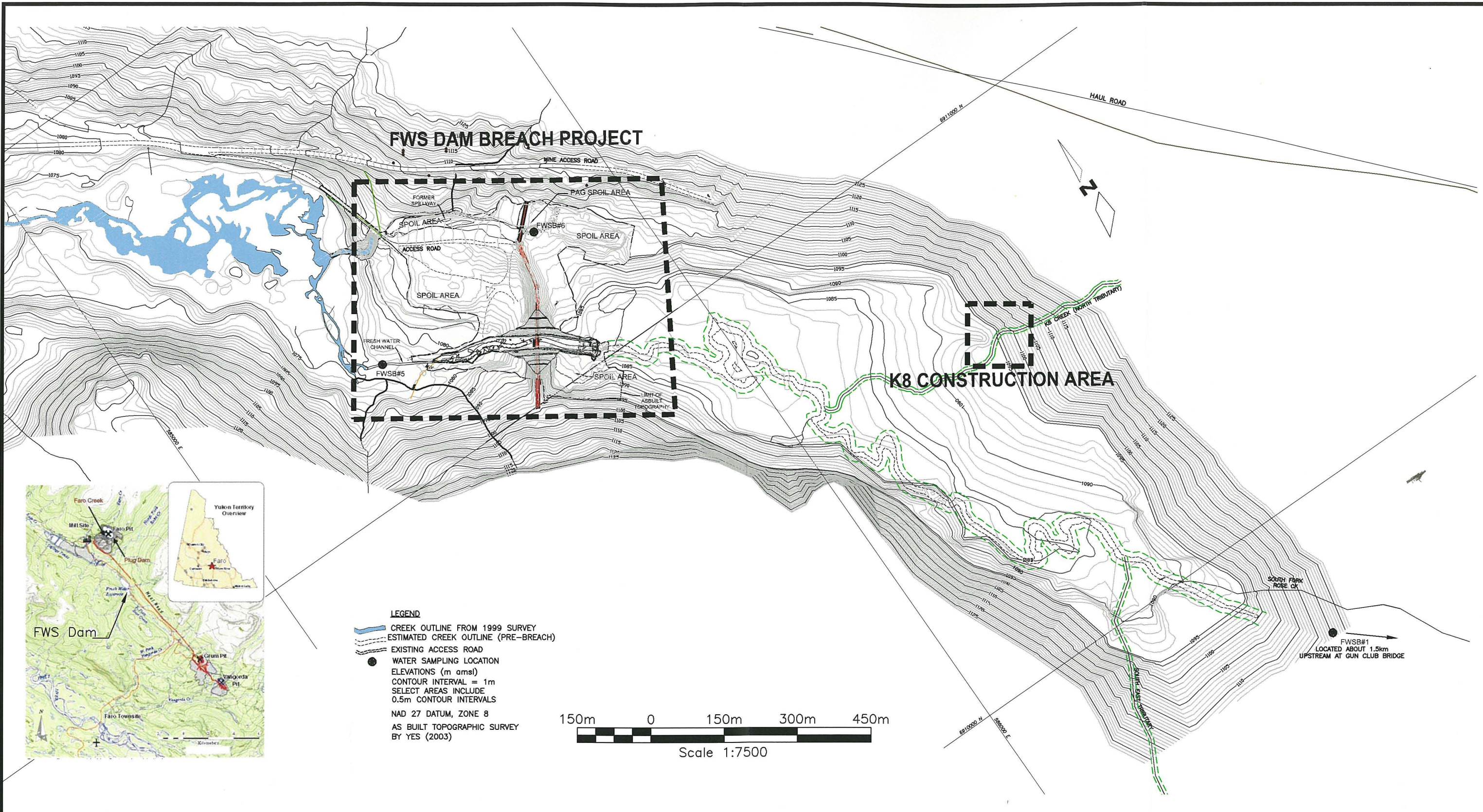
Table 4 - Electro-Fishing Results (After Laberge 2008)

Reach	Fish Type	Total Catch (capture/100 sec)			
		2004*	2005*	2006*	2007†
1	Arctic Grayling	1.00	1.84	0.30	0.14
	Burbot	0.36	0.12	0.10	0.00
	Slimy Sculpins	0.68	0.86	0.64	0.98
2	Arctic Grayling	0.23	0.24	0.00	0.14
	Burbot	0.00	0.00	0.00	0.00
	Slimy Sculpins	1.28	3.30	7.11	3.59
3	Arctic Grayling	0.26	0.07	0.00	1.34
	Burbot	0.58	0.21	0.03	0.00
	Slimy Sculpins	2.02	5.50	4.22	2.28
4	Arctic Grayling	1.28	0.28	0.06	0.75
	Burbot	0.37	0.14	0.06	0.13
	Slimy Sculpins	0.64	0.14	0.49	0.40
5†	Arctic Grayling	2.96	5.13	2.00	1.12
	Burbot	0.23	0.00	0.00	0.00
	Slimy Sculpins	0.56	1.84	3.41	0.70
	Chinook Salmon	0.00	0.00	0.00	0.00
	Round Whitefish	0.00	0.17	0.41	0.00

* Based on 2 pass block net, electro-fishing technique.

† Based on 1 pass electro-fishing technique.

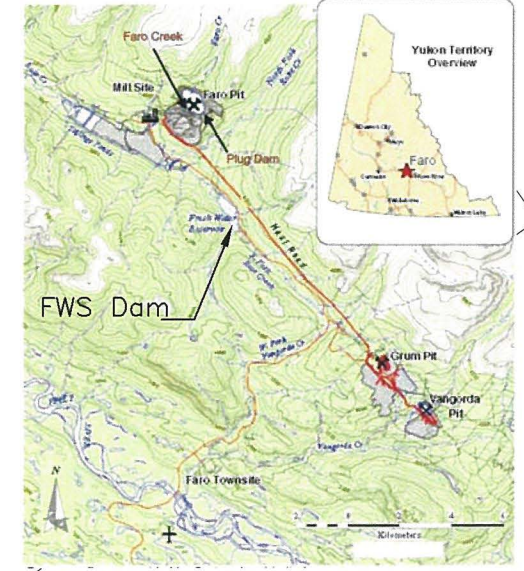
FIGURES



LEGEND

- CREEK OUTLINE FROM 1999 SURVEY
- ESTIMATED CREEK OUTLINE (PRE-BREACH)
- EXISTING ACCESS ROAD
- WATER SAMPLING LOCATION

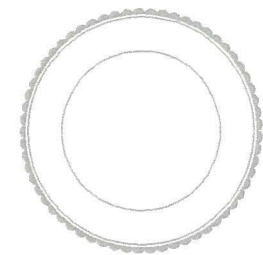
ELEVATIONS (m amsl)
 CONTOUR INTERVAL = 1m
 SELECT AREAS INCLUDE 0.5m CONTOUR INTERVALS
 NAD 27 DATUM, ZONE 8
 AS BUILT TOPOGRAPHIC SURVEY BY YES (2003)



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REV.	DATE	REVISION NOTES	DRAWN	CHECK	APPR.

SCALE	AS SHOWN
DATE	DEC 2007
DRAWN	JL
DESIGNED	ALF
CHECKED	GWF
APPROVED	JWC

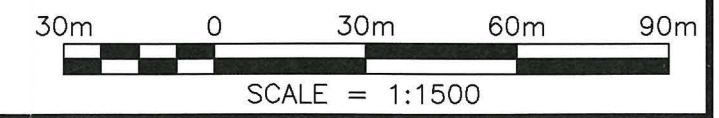
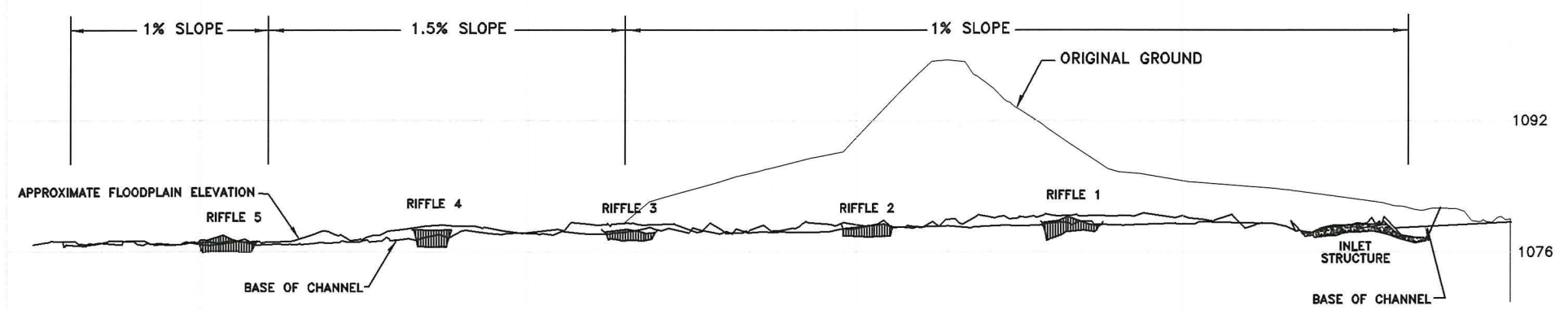
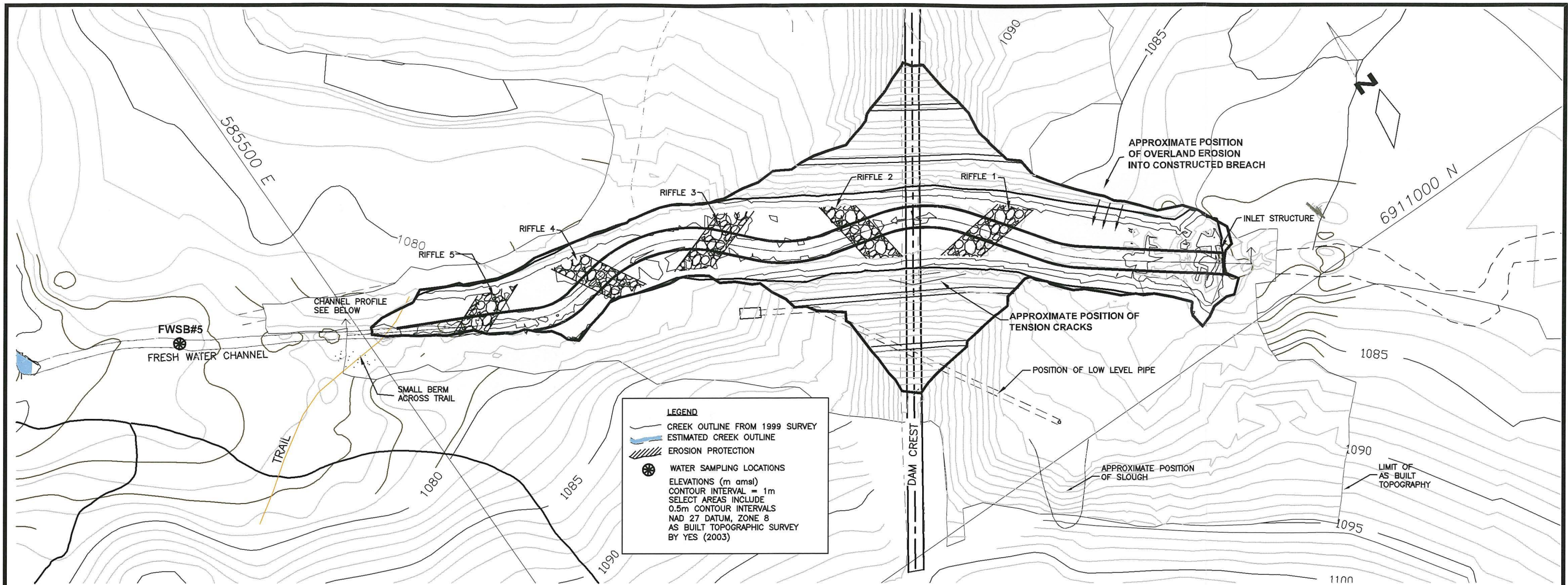


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 AN APPLIED EARTH SCIENCES COMPANY
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Deloitte & Touche

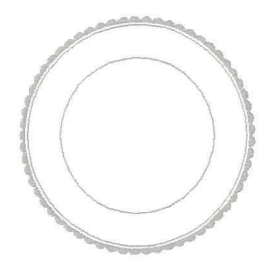
PROJECT 2007 ANNUAL REPORT, FWSB		
TITLE LOCATION PLAN		
PROJECT No. 0257-043-01	FIG No. 1	REV. 0

0257-043-01 FIGURE 1.dwg



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SCALE	AS SHOWN
DATE	DEC 2007
DRAWN	JL
DESIGNED	ALF
CHECKED	GWF
APPROVED	JWC



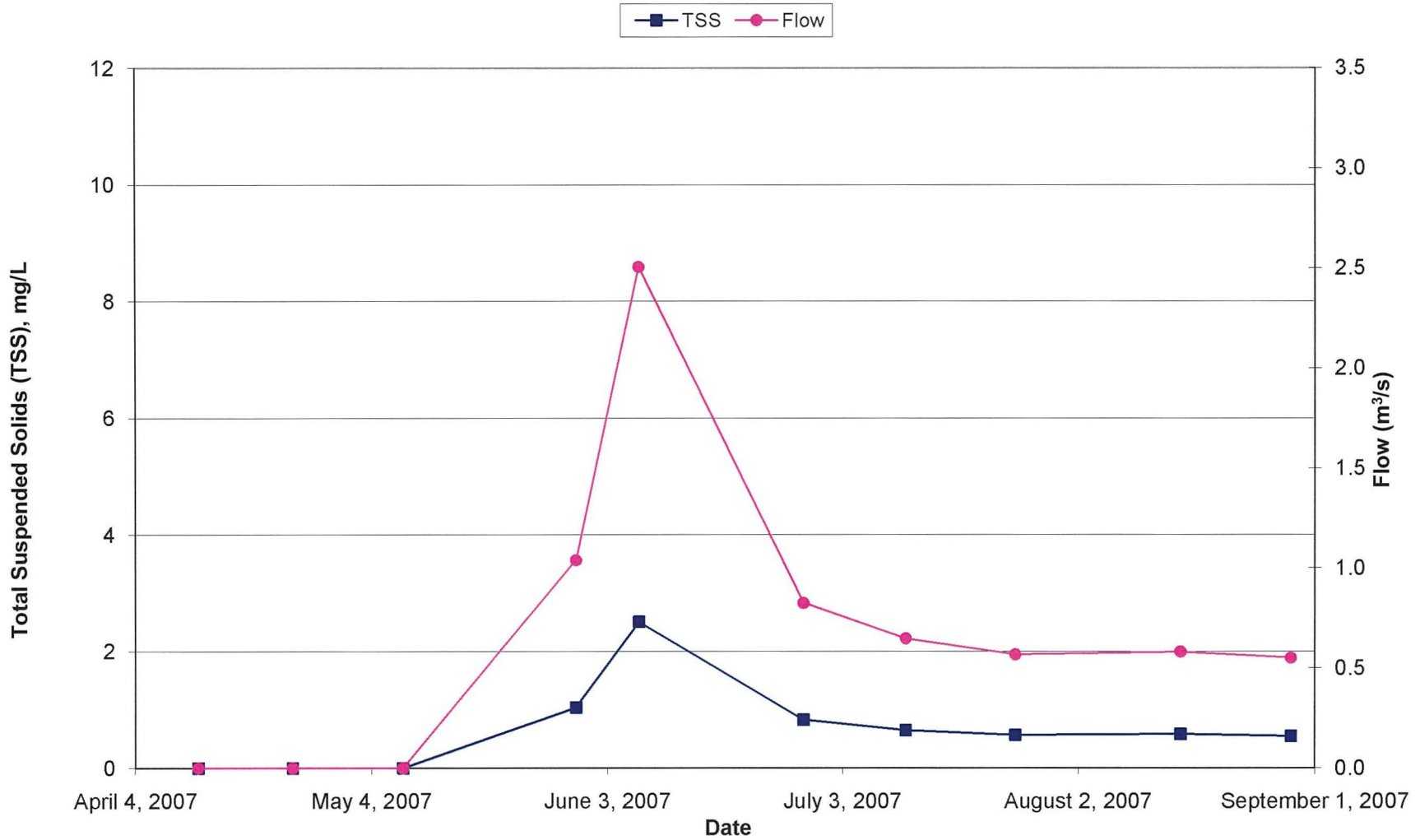
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AN APPLIED EARTH SCIENCES COMPANY

Calgary, AB Phone: (403) 250 5185

CLIENT
Deloitte & Touche

PROJECT 2007 ANNUAL REPORT, FWSB		
TITLE AS-BUILT FWSB PLAN AND PROFILE		
PROJECT No. 0257-043-01	FIG. 2	REV. 0

0257-043-01 FIGURE_2.dwg



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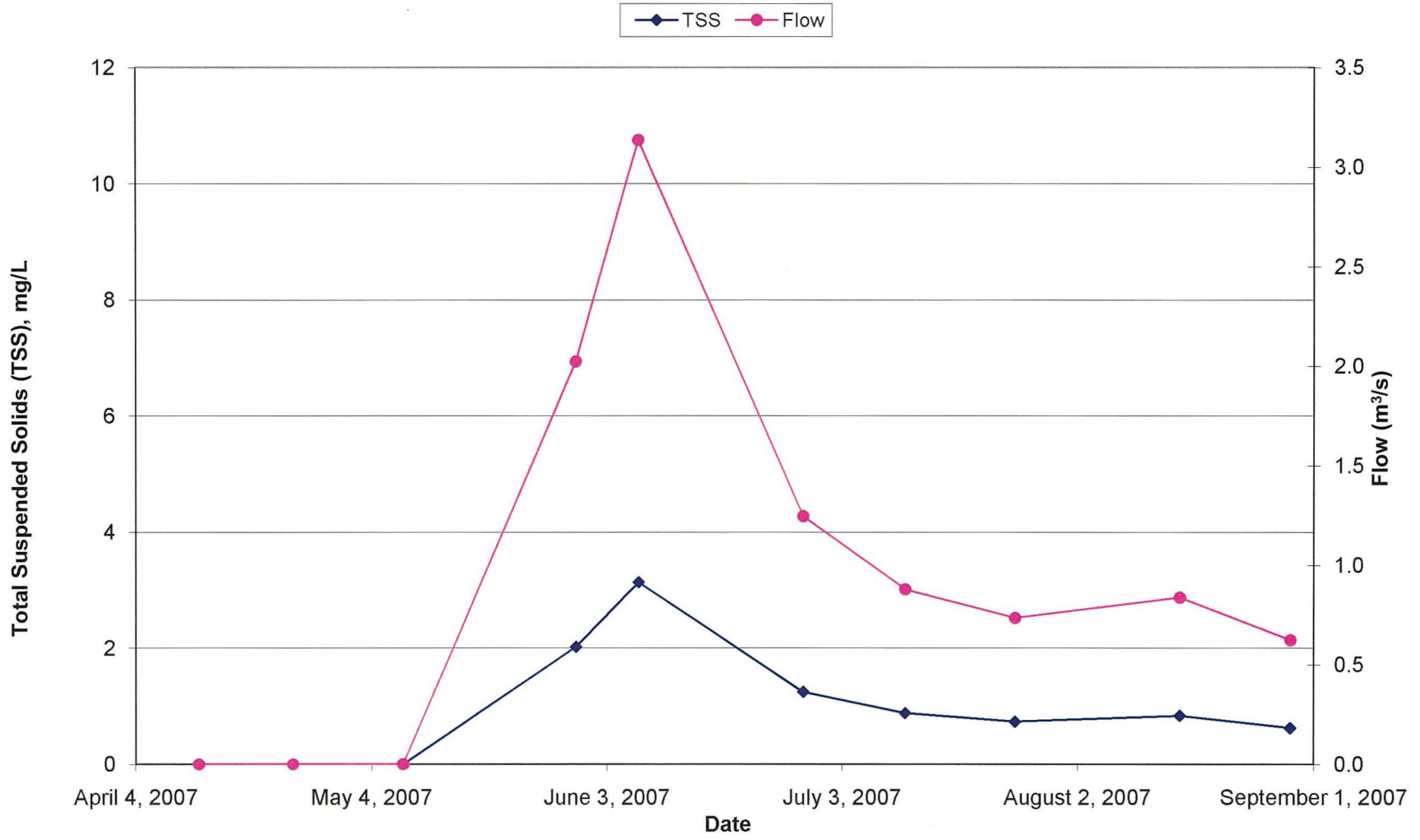
BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY
Calgary, Alberta Phone: (403) 250-5185

Client: **Deloitte & Touche**

Project: 2007 ANNUAL REPORT, FW SB

Title: MONITORING RESULTS FOR FW SB #1

Project #: 0257-043-01	Date: JAN 2008	Scale: NA	Drawn: SLF	Approved: JWC	Figure: 3
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AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.



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AN APPLIED EARTH SCIENCES COMPANY
Calgary, Alberta Phone: (403) 250-5185

Client:

Deloitte & Touche

Project:

2007 ANNUAL REPORT, FW SB

Title:

MONITORING RESULTS FOR FW SB #5

Project #:

0257-043-01

Date:

JAN 2008

Scale:

NA

Drawn:

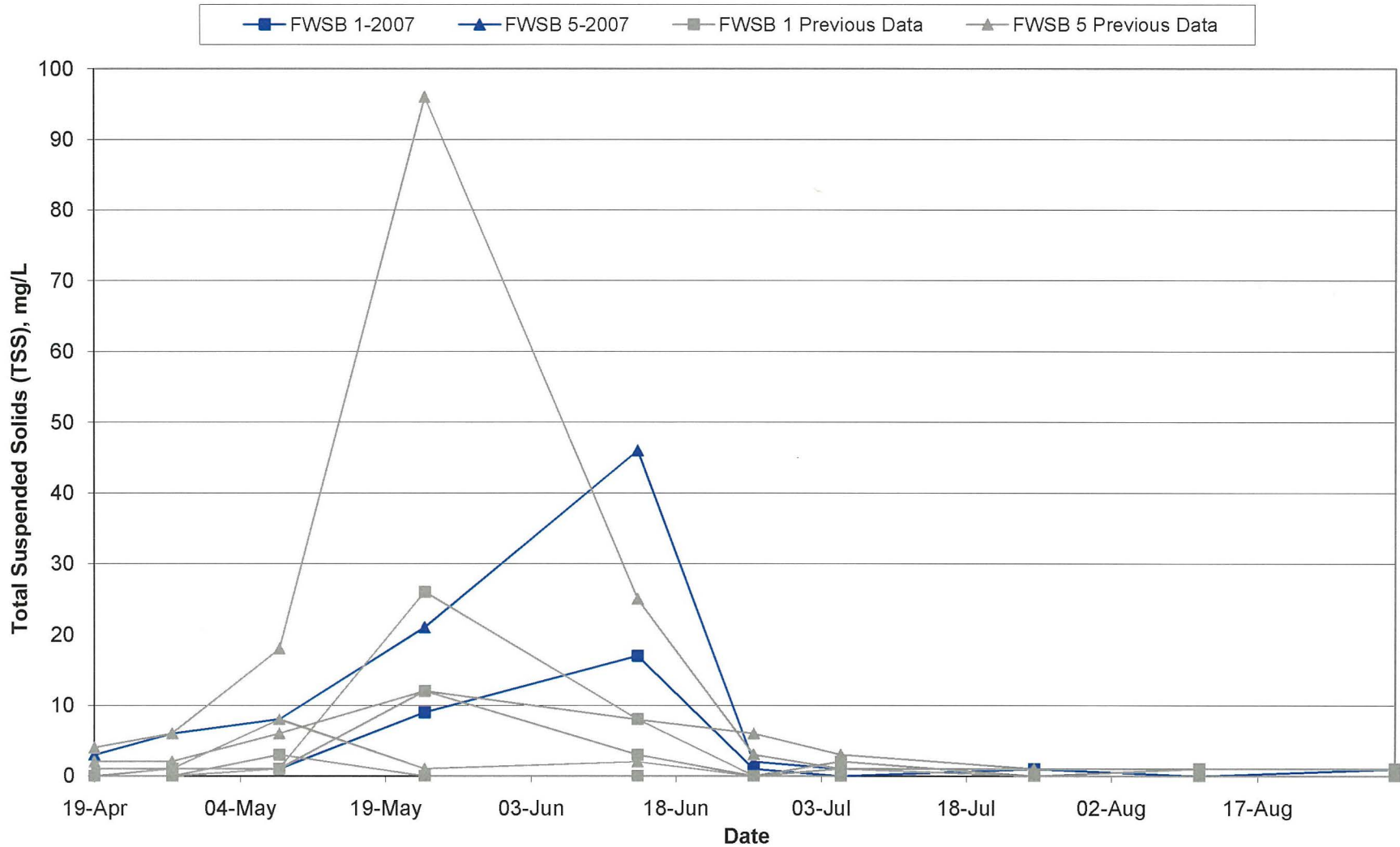
SLF

Approved:

JWC

Figure:

4



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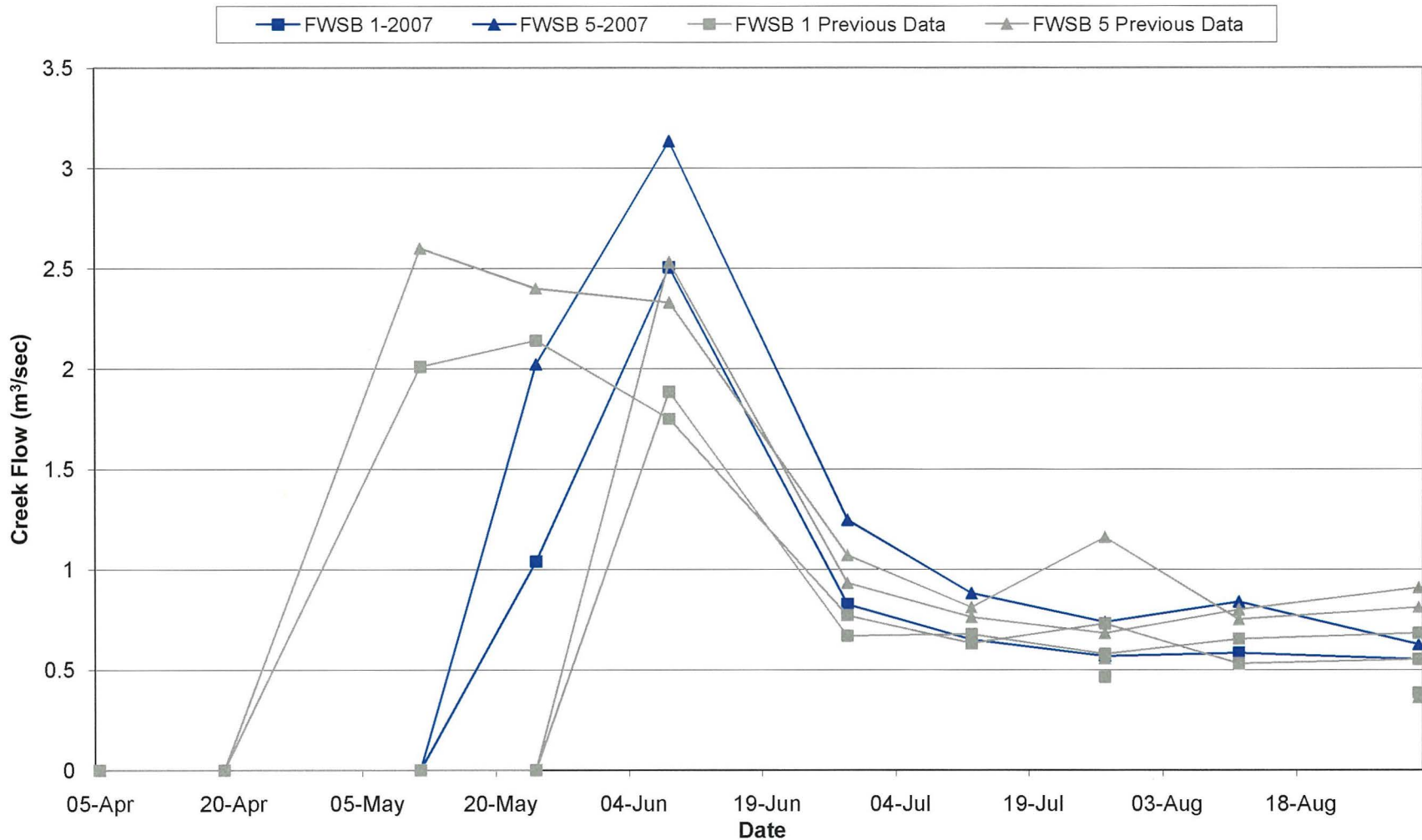
BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY
Calgary, Alberta Phone: (403) 250-5185

Client: **Deloitte & Touche**

Project: 2007 ANNUAL REPORT, FWSB

Title: COMPARISON OF TSS RESULTS, FWSB #1 AND FWSB #5

Project #: 0257-043-01	Date: DEC 2007	Scale: NA	Drawn: SLF	Approved: JWC	Figure: 5
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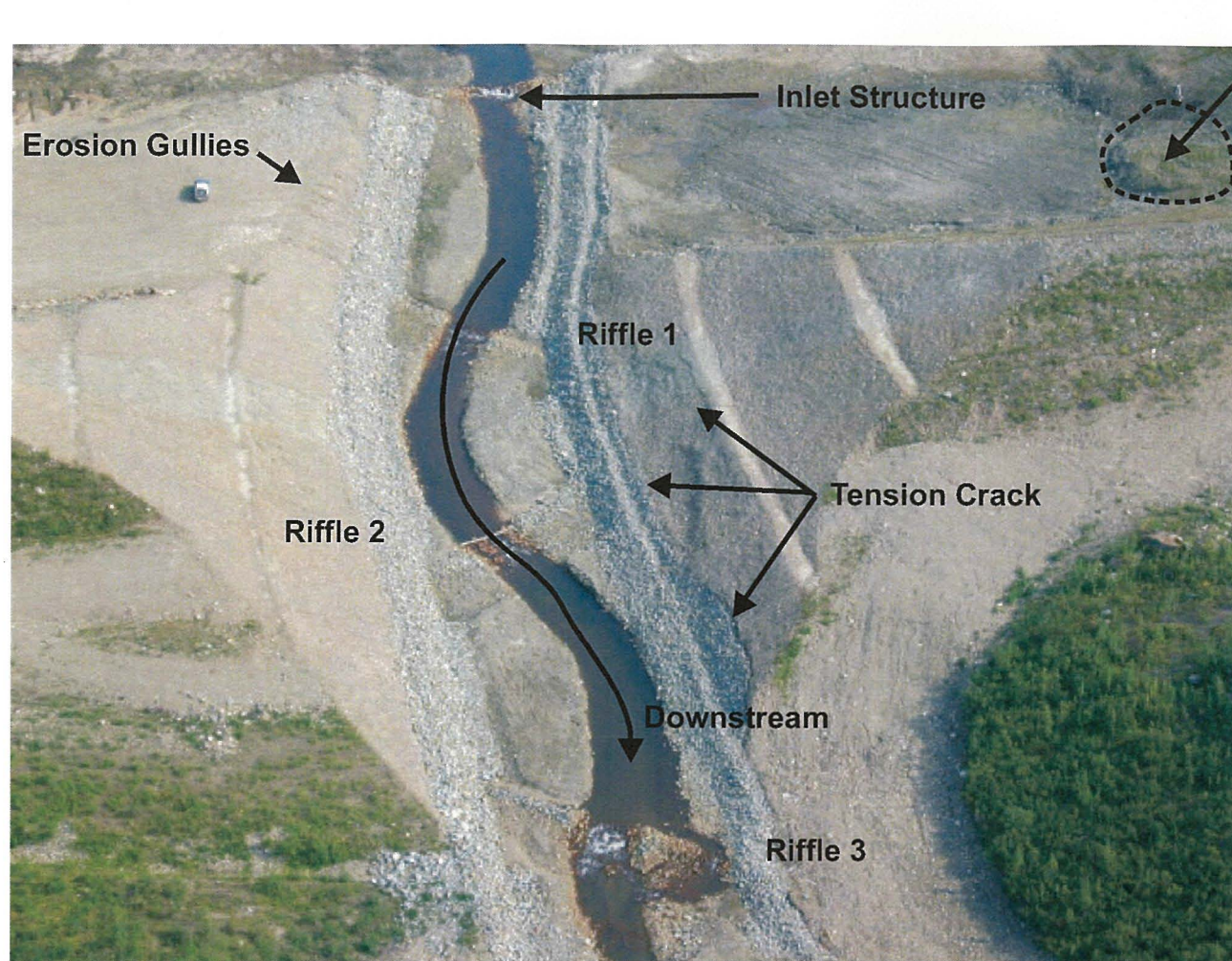
BGC ENGINEERING INC.
 AN APPLIED EARTH SCIENCES COMPANY
 Calgary, Alberta Phone: (403) 250-5185

Client: **Deloitte & Touche**

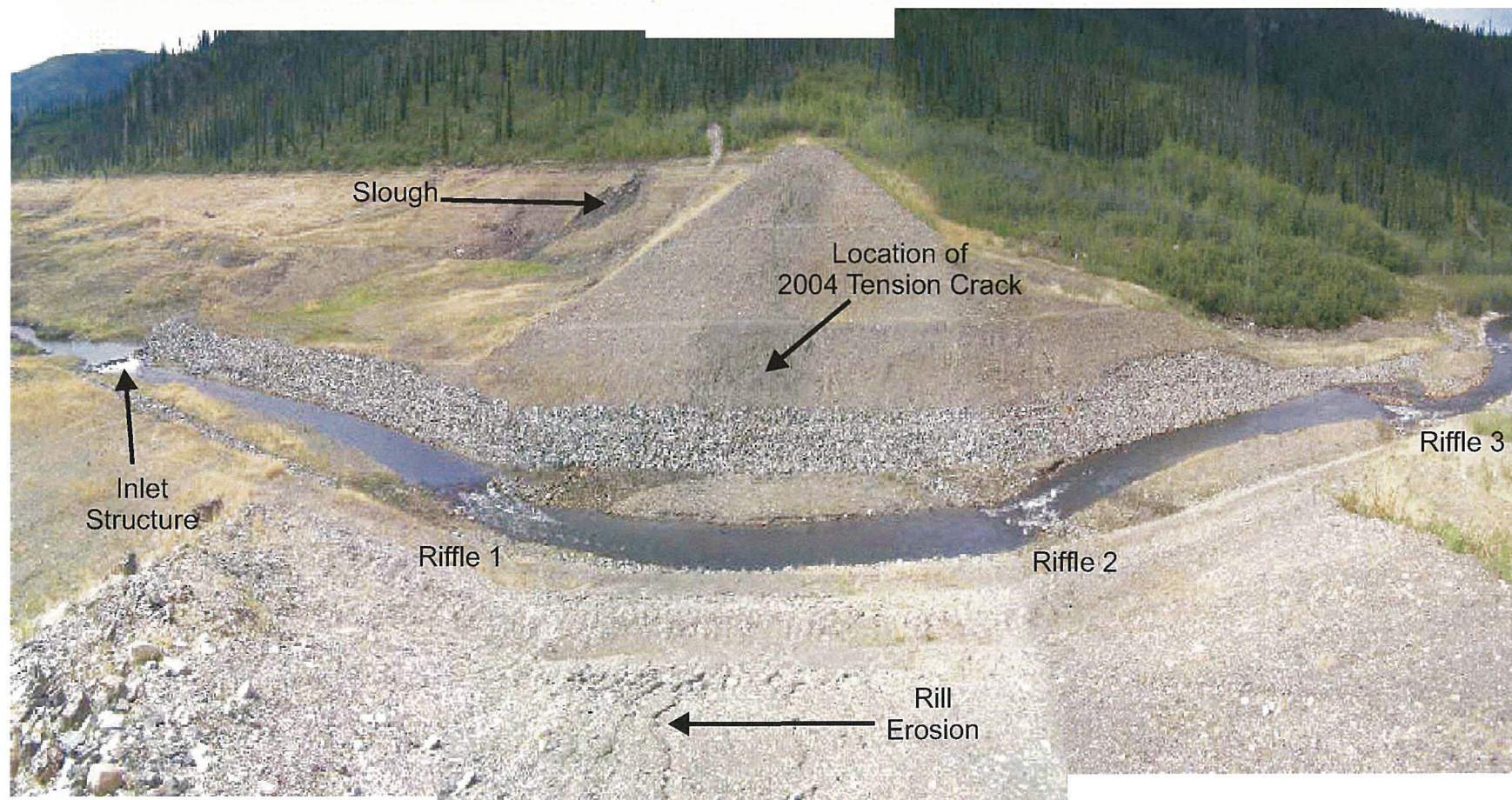
Project: 2007 ANNUAL REPORT, FWSB

Title: COMPARISON OF FLOW RESULTS, FWSB #1 AND FWSB #5

Project #: 0257-043-01	Date: JAN 2008	Scale: NA	Drawn: SLF	Approved: JWC	Figure: 6
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August 2004: An aerial view of the breach section. This overview of the project shows the location of the breach and channel. Also shown is the slough on the former reservoir wall, the erosion gullies, the tension crack located between Riffle 1 and 2. The water flowing around the left side of Riffle 3 shown in this photo was repaired in September 2004.



June 2007: Shows a current view of the breach project area; showing the slough and position of the 2004 tension cracks. Also note the appearance of rill erosion in the former dam core.

CLIENT:

Deloitte & Touche

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REV.	DATE	REVISION NOTES	DRAWN	CHECKED	APPROVED
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SCALE:	N/A
DATE:	JANUARY 2008
DRAWN:	SLF
DESIGNED:	ALF
CHECKED:	GWF
APPROVED:	JWC

PROJECT	2007 ANNUAL REPORT, FWBS	
TITLE	2004 TO 2007 COMPARISON OF FWS DAM BREACH	
PROJECT No.	Figure	REV.
0257-043-01	7	0

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Calgary Alberta Phone: (403) 250-5185



June 2007: The breached channel looking in the downstream direction.



June 2007: Riffle 4 is shown here. This riffle has experienced some riprap movement which has lengthened the riffle and made it less distinct. No remedial action is recommended.



June 2007: Riffle 1 showing the nature of flow in this area. Some backwater effects and sediment deposition.



June 2007: Riffle 3 during high flow conditions.

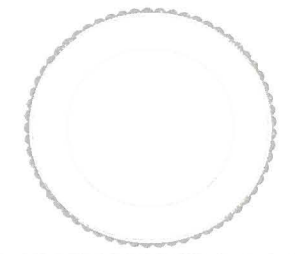
CLIENT:

**Deloitte
& Touche**

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REV.	DATE	REVISION NOTES	DRAWN	CHECKED	APPROVED
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SCALE:	N/A
DATE:	JANUARY 2008
DRAWN:	SLF
DESIGNED:	ALF
CHECKED:	GWF
APPROVED:	JWC



PROJECT	2007 ANNUAL REPORT, FWBS	
TITLE	CHANNEL SPRING FLOW PHOTOS	
PROJECT	Figure	REV.
0257-043-01	8	0



September 2007: The constructed channel at Riffle 4. Note that some riprap movement has occurred.



June 2007: Riffle 5 in high flow conditions. Note some silt and sand overbank deposition in the foreground of the photo.



September 2007: View of Riffle 3 with the majority of flow in the center with minor flow on the left bank.



June 2007: South fork of Rose Creek, upstream of the inlet structure.

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& Touche**

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REV.	DATE	REVISION NOTES	DRAWN	CHECKED	APPROVED
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SCALE:	N/A	
DATE:	JANUARY 2008	
DRAWN:	SLF	
DESIGNED:	ALF	
CHECKED:	GWF	
APPROVED:	JWC	

PROJECT	2007 ANNUAL REPORT, FW SB		
TITLE	CHANNEL AND FLOODPLAIN DURING FALL INSPECTION		
PROJECT No.	Figure	REV.	
0257-043-01	9	0	



September 2007: View of the erosion gullies forming between the inlet structure and riffle on the right bank.



June 2007: A close-up view of some of the rill erosion that have been formed into the cut face of the dam.



September 2007: A two shot panoramic showing the erosional gullies which has formed on the edge of upstream blanket on the upstream side. These gullies have been encountered since 2004, but have shown deterioration in 2007, which should be repaired.



September 2007: Shows the slough within the former reservoir. The photo shows the condition following some minor hand powered grading and seeding of the slough performed by site staff in August 2007.

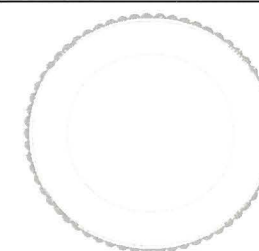
CLIENT:

**Deloitte
& Touche**

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REV.	DATE	REVISION NOTES	DRAWN	CHECKED	APPROVED
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SCALE:	N/A
DATE:	JANUARY 2008
DRAWN:	SLF
DESIGNED:	ALF
CHECKED:	GWF
APPROVED:	JWC



PROJECT	2007 ANNUAL REPORT, FW SB	
TITLE	EROSION AND SLOUGHING FEATURES	
PROJECT No.	Figure	REV.
0257-043-01	10	0

BGC

BGC Engineering Inc.
AN APPLIED EARTH SCIENCES COMPANY

Calgary Alberta

Phone: (403) 250-5185



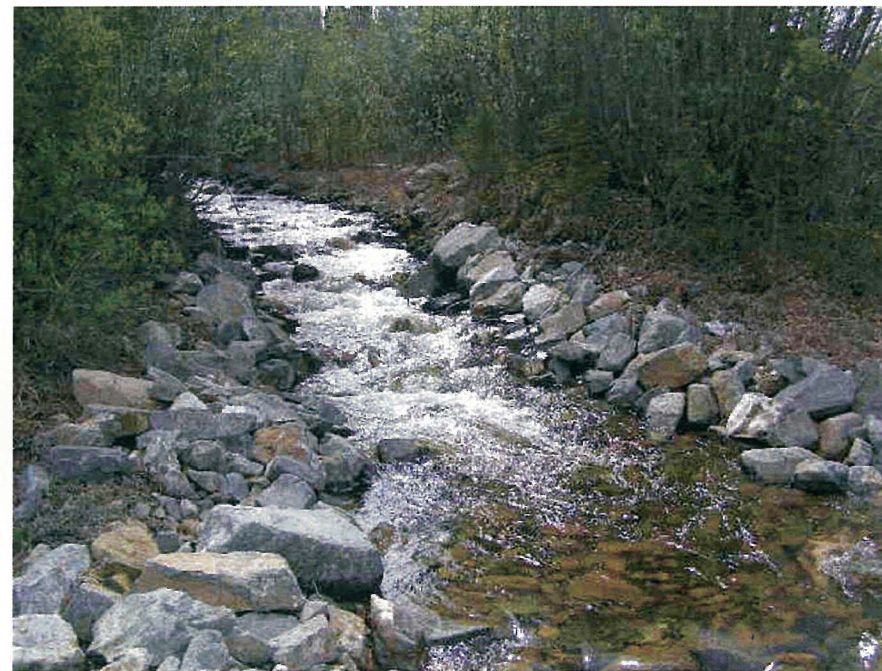
September 2007: Looking downstream along K8 Creek as it enters the borrow pit.



June 2007: Looking upstream at the entrance of K8 Creek into the borrow pit.



June 2007: K8 Creek as it exits the borrow pit. Note that in the foreground of this photo, a distinct channel has formed. In the background, the channel becomes less distinct and an area of erosion occurs as the channel forms.



June 2007: Looking at the upstream limit of the riprap placement of K8 Creek.

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& Touche**

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REV.	DATE	REVISION NOTES	DRAWN	CHECKED	APPROVED
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SCALE:	N/A	
DATE:	JANUARY 2008	
DRAWN:	SLF	
DESIGNED:	ALF	
CHECKED:	GWF	
APPROVED:	JWC	

PROJECT		
2007 ANNUAL REPORT, FWSB		
TITLE		
K8 CREEK OBSERVATIONS		
PROJECT No.	Figure	REV.
0257-043-01	11	0



June 2007: A general overall view of the revegetation in the reservoir area looking towards the breached dam in the background.

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**Deloitte
& Touche**

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REV.	DATE	REVISION NOTES	DRAWN	CHECKED	APPROVED
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-



June 2007: Shows the main channel in Reach 1 looking in the downstream direction. This photo was taken just where the tributary comes in from the far south side of the reservoir.



June 2007: Shows a view looking in the downstream direction at the first major bend in the creek. Erosion has occurred on this outside bank of the channel.

SCALE:	N/A	
DATE:	JANUARY 2008	
DRAWN:	SLF	
DESIGNED:	ALF	
CHECKED:	GWF	
APPROVED:	JWC	

PROJECT	2007 ANNUAL REPORT, FWBS		
TITLE	RE-VEGETATION OBSERVATIONS		
PROJECT No.	Figure	REV.	
0257-043-01	12	0	

APPENDIX A – MONTHLY REPORTS

0257-043-01
April 25, 2007

Yukon Territory Water Board
Suite 106 - 419 Range Road
Whitehorse, Yukon
Y1A 3V1
Fax (867) 456-3890

RE: APRIL MONTHLY SAMPLING RESULTS FOR QZ03-058, FARO MINE, YUKON

Dear Board:

This letter report fulfills the monthly reporting requirement (item 15) for Water License QZ03-058 for the month of April 2007. I trust that this information is self-explanatory. However, if you have any questions please do not hesitate to contact us.

Table 1 Summary of Monthly Sampling Results, April 2007

Date	Sample	TSS (mg/L)	Flow (m ³ /s)	Comments
April 12	FWSD-1	<1	note 1	Creek was ice covered
April 12	FWSD-5	3	note 1	Creek was ice covered
April 24	FWSD-1	1	note 1	Creek was ice covered
April 24	FWSD-5	6	note 1	Creek was ice covered

Note: 1: The creek was ice covered and collection of reliable flow data was not possible. Flow measurements will commence once it is safe to do so.

Yours truly,
BGC Engineering Inc.
Per:

Gerry Ferris, M.Sc., P.Eng.
Geotechnical Engineer

GWF/sf

0257-043-01
June 1, 2007

Yukon Territory Water Board
Suite 106 - 419 Range Road
Whitehorse, Yukon
Y1A 3V1
Fax (867) 456-3890

RE: MAY MONTHLY SAMPLING RESULTS FOR QZ03-058, FARO MINE, YUKON

Dear Board:

This letter report fulfills the monthly reporting requirement (item 15) for Water License QZ03-058 for the month of May 2007. I trust that this information is self-explanatory. However, if you have any questions please do not hesitate to contact us.

Table 1 Summary of Monthly Sampling Results, May 2007

Date	Sample	TSS (mg/L)	Flow (m³/s)	Comments
May 8	FWSD-1	1	note 1	Note 1. Creek was ice covered
May 8	FWSD-5	8	note 1	Note 1. Creek was ice covered
May 31	FWSD-1	9	1.04	
May 31	FWSD-5	21	2.02	

Note 1: The creek was ice covered and collection of reliable flow data was not possible. Flow measurements will commence once it is safe to do so.

Yours truly,
BGC Engineering Inc.
Per:

Gerry Ferris, M.Sc., P.Eng.
Geotechnical Engineer

GWF/sf

0257-043-01
July 9, 2007

Yukon Territory Water Board
Suite 106 - 419 Range Road
Whitehorse, Yukon
Y1A 3V1

Fax (867) 456-3890

RE: JUNE MONTHLY SAMPLING RESULTS FOR QZ03-058, FARO MINE, YUKON

Dear Board:

This letter report fulfills the monthly reporting requirement (item 15) for Water License QZ03-058 for the month of June 2007. I trust that this information is self-explanatory. However, if you have any questions please do not hesitate to contact us.

Table 1 Summary of Monthly Sampling Results, June 2007

Date	Sample	TSS (mg/L)	Flow (m ³ /s)	Comments
June 7	FWSD-1	17	2.50	
June 7	FWSD-5	46	3.24	Estimated based on water depth and velocity of flow, due to high velocities making it unsafe to enter creek
June 28	FWSD-1	1	0.82	
June 28	FWSD-5	2	1.25	

Yours truly,
BGC Engineering Inc.
Per:

Gerry Ferris, M.Sc., P.Eng.
Geotechnical Engineer

GWF/sf

0257-043-01
August 1, 2007

Yukon Territory Water Board
Suite 106 - 419 Range Road
Whitehorse, Yukon
Y1A 3V1

Fax (867) 456-3890

RE: JULY MONTHLY SAMPLING RESULTS FOR QZ03-058, FARO MINE, YUKON

Dear Board:

This letter report fulfills the monthly reporting requirement (item 15) for Water License QZ03-058 for the month of July 2007. I trust that this information is self-explanatory. However, if you have any questions please do not hesitate to contact us.

Table 1 Summary of Monthly Sampling Results, July 2007

Date	Sample	TSS (mg/L)	Flow (m ³ /s)	Comments
July 11	FWSD-1	>1	0.65	
July 11	FWSD-5	1	0.88	
July 25	FWSD-1	1	0.57	
July 25	FWSD-5	1	0.74	

Yours truly,

BGC Engineering Inc.

Per:

Gerry Ferris, M.Sc., P.Eng.
Geotechnical Engineer

GWF/sf

0257-043-01
September 17, 2007

Yukon Territory Water Board
Suite 106 - 419 Range Road
Whitehorse, Yukon
Y1A 3V1

Fax (867) 456-3890

RE: AUGUST MONTHLY SAMPLING RESULTS FOR QZ03-058, FARO MINE, YUKON

Dear Board:

This letter report fulfills the monthly reporting requirement (item 15) for Water License QZ03-058 for the month of August 2007. I trust that this information is self-explanatory. However, if you have any questions please do not hesitate to contact us.

Table 1 Summary of Monthly Sampling Results, August 2007

Date	Sample	TSS (mg/L)	Flow (m ³ /s)	Comments
August 15	FWSD-1	>1	0.58	
August 15	FWSD-5	>1	0.84	
August 29	FWSD-1	1	0.55	
August 29	FWSD-5	1	0.65	

Yours truly,

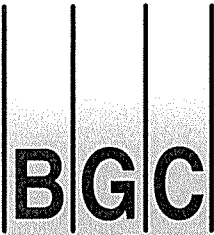
BGC Engineering Inc.

Per:

Gerry Ferris, M.Sc., P.Eng.
Geotechnical Engineer

GWF/sf

APPENDIX B – SITE INSPECTION MEMOS



BGC ENGINEERING INC.

AN APPLIED EARTH SCIENCES COMPANY

1605, 840 – 7 Avenue S.W., Calgary, Alberta, Canada. T2P 3G2
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PROJECT MEMORANDUM

To:	Anvil Range Mining / Deloitte & Touche	Fax No.:	By email
Attention:	Dana Haggar / Doug Sedgwick	CC:	By email
From:	Jim Cassie, P.Eng.	Date:	June 21, 2007
Subject:	June Site Inspection Conditions Selected Facilities, Faro Mine, YT		
No. of Pages (including this page):	3 Pages	Project No:	0257-042-02 0257-043-01

Mr. Jim Cassie, P.Eng., from BGC Engineering Inc.(BGC), undertook a visual inspection of selected facilities at Faro Mine on June 13 and 14, 2007. During this inspection the items contained in this memo were discussed on site with Mr. Dana Haggar, Mine Manager. This memo summarizes the conditions observed, along with any required maintenance or monitoring:

FWSD Breach Project

- Slough at the south abutment appears to be pseudo-stable from the sloughed material; no significant seepage noted.
- Channel flow is passing around the edges of selected riffles. Evidence of backwater pooling in areas proximal to riffles. Very minor erosion noted on channel section.
- Some minor erosional noted on channel sections close to the tributary confluence.
- Minor erosional gullies located along the edge of the seepage control blanket.
- No concerns or maintenance required.

K8 Creek Rehab.

- Possible small slump of the rip rap of the left side (looking downstream) of the channel.
- Otherwise, channel appears in satisfactory condition.

Cross Valley Dam

- Centre of crest crack evident on the dam again; monitor but will probably close up as thaw progresses.
- Crest vegetation to be removed.
- Appears in satisfactory condition.

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Intermediate Dam

- No crest cracking or toe seepage noted.
- Crest vegetation to be removed.
- Downstream face displays only minor rilling erosion.
- Approximately 11 small (1 to 5 m diameter) surficial slough features noted at the toe of the downstream face. Visually monitor to ensure they do not increase in extent.
- Appears in satisfactory condition.

Secondary Impoundment Dam

- No visual concerns were noted on the dam crest.
- Crack and associated settlement trough within toe berm/access road should be graded over.

Rose Creek Diversion Channel (backslope and canal dike crest).

- No new sloughs noted on the backslope.
- No signs of cracking or settlement noted on the canal dike crest.
- Channel appears in satisfactory condition.

North Fork Rose Creek Rock Drain

- Rock drain appears to be discharging water with no signs of instability.
- Continue with monitoring program provided by Gerry Ferris.

North Valley Wall Interceptor Ditch – Outfall Section (near CV Dam)

- Channel and culvert were inspected and found to be flowing properly.
- Appears in satisfactory condition.

Faro Creek Diversion Channel

- Recent slough displaced some overburden material into the channel. Reslope oversteeped slope near slough and armour to prevent further erosion.
- Toe seepage occurring at May seepage location. Two test pits excavated for investigation. Geotextile and armour rock placed on the downstream slope of the canal dike. Refer to separate memo on the FCDC seepage rehabilitation (under separate cover).
- Noted two new staff gauges installed in creek by Laberge Environmental Services last month. These gauges should be read every two weeks or so.
- Channel appears to be performing in a satisfactory manner.

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BGC Project Memorandum

To: Dana Hagggar / Doug Sedgwick

From: Jim Cassie

Date: June 21, 2007

Subject: June Site Inspection Summary, Selected Facilities at Faro Mine

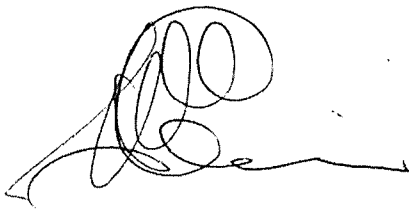
Proj. No: 0257-042-02/-043-01

In general, the inspected facilities appear in satisfactory condition and only some minor maintenance and monitoring is required. Please contact the undersigned should you have any questions or comments.

Respectfully submitted,

BGC Engineering Inc.

per:



James W. Cassie, M.Sc., P.Eng.
Specialist Geotechnical Engineer

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Cross Valley Dam

- No concerns noted.

Secondary Impoundment Dam

- No concerns noted.

Rose Creek Diversion Canal

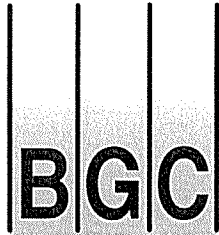
- Some 25 seepage points observed at the toe of the Canal Dike, in the area of previously noted seepage.
- No concerns noted with dike crest, backslope or the weir sections.

Faro Creek Diversion Channel

- A total of 5 seepage points were noted at the dike toe below the FCDC. All seepage points were running clear. BGC will forward the GPS waypoints under separate cover. Monitoring should continue over the winter in terms of quantity and clear nature of these seeps.
- A small buttress of geotextile/rockfill should be placed at the toe of Seepage Point #4 (taped off area that sloughed in May 2007). This will provide some protection in case the seepage velocity increases next spring.
- No others concerns noted, but almost 20 cm of snow cover in the area.

North Fork Rock Drain

- No concerns noted.



BGC ENGINEERING INC.

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PROJECT MEMORANDUM

To:	Anvil Range Mining Corp.	Fax No.:	By email
Attention:	Glen Craig / Dana Haggar	CC:	Gerry Ferris
From:	Jim Cassie	Date:	September 26, 2007
Subject:	Summary of Site Conditions on Selected Structures Fall Visit, Faro Mine, YT		
No. of Pages (including this page):	2	Project No:	0257-042

Mr. Jim Cassie, P.Eng. from BGC Engineering Inc. (BGC) undertook the fall geotechnical inspection site visit from September 24 to 26, 2007. Snowfall occurred at the site during the period which covered over some of the surface features. Following is a brief summary off the conditions, concerns and maintenance for the inspected facilities:

FWS Dam Breach

- Some riffles are “disturbed” but no significant concerns.
- Slough at south abutment appears “stable”.
- Some 5 to 6 erosional gullies have formed on the north cut-slope (down the breach channel) on the upstream side of the dam. These gullies should either be flattened to prevent further erosion or erosional protection rockfill placed.
- No other concerns noted.

K8 Creek Rehabilitation

- No concerns noted.

Intermediate Dam

- Grade the small ridge (0.3 to 0.5 m high) formed by the rip rap on the upstream edge of the crest; ensure a smooth crest edge.
- No other concerns noted.

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K:\Projects\0257 D&T\043 2007 FWS Annual\01 All Tasks\Report\Appendix B - Summary Reports\Faro Fall 07 Inspection Memo.doc

Cross Valley Dam

- No concerns noted.

Secondary Impoundment Dam

- No concerns noted.

Rose Creek Diversion Canal

- Some 25 seepage points observed at the toe of the Canal Dike, in the area of previously noted seepage.
- No concerns noted with dike crest, backslope or the weir sections.

Faro Creek Diversion Channel

- A total of 5 seepage points were noted at the dike toe below the FCDC. All seepage points were running clear. BGC will forward the GPS waypoints under separate cover. Monitoring should continue over the winter in terms of quantity and clear nature of these seeps.
- A small buttress of geotextile/rockfill should be placed at the toe of Seepage Point #4 (taped off area that sloughed in May 2007). This will provide some protection in case the seepage velocity increases next spring.
- No others concerns noted, but almost 20 cm of snow cover in the area.

North Fork Rock Drain

- No concerns noted.

**APPENDIX C – RE-VEGETATION REPORT
REPORT PREPARED BY
LABERGE ENVIRONMENTAL SERVICES**

2007 Revegetation Assessment
Dewatered Freshwater Reservoir
South Fork of Rose Creek, Yukon

Assessment Report Prepared for:

Deloitte & Touche Inc.

Laberge
ENVIRONMENTAL SERVICES

December 2007



ENVIRONMENTAL SERVICES
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Letter of Transmittal

December 31, 2007

Doug Sedgwick
Deloitte & Touche
121 King Street West, Suite 300
Toronto, Ontario
M5H 3T9

Dear Doug:

Re: **2007 Revegetation Assessment Dewatered Freshwater Reservoir
South Fork of Rose Creek, Yukon**

We are pleased to submit herewith, the above report representing the third annual assessment of the dewatered freshwater reservoir as stipulated in Part E Section 35 of Licence Number QZ03-058.

The majority of the planted species are doing very well and natural colonization of most of the areas by pioneering plant species is occurring.

Any questions or comments can be directed to the undersigned.

Sincerely,

ORIGINAL SIGNED BY BONNIE BURNS

Bonnie Burns
Laberge Environmental Services

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Appendix A: Site Photographs, July 2007	
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1.0 Background

The dewatered reservoir on the south fork of Rose Creek was seeded with northern native grass species in several phases during 2003 and 2004 by Arctic Alpine Seeds Ltd. No legumes were seeded and no fertilizer was applied. The stem cuttings of woody species (primarily willows) were staked along the Rose Creek riparian zone, along the upper tributaries, and on the floodplains adjacent to the breached dam. This revegetation work is summarized in a report by Arctic Alpine Seed Ltd (2005).

Under Part E, Section 35 of Water License QZ03-058, an annual inspection and assessment of the success of the revegetation activities is to be undertaken. The first evaluation of the revegetation program was carried out during a survey in July 2005 (Laberge Environmental Services, 2005) and the site was resurveyed in July 2006 (Laberge Environmental Services, 2006). The results of the July 2007 survey are summarized in this report. Selected photographs are presented in Appendix A.

2.0 Grass Seeding Program

2.1 Phase I and Phase II Zones

2.1.1 Phase I and Phase II Seeding Programs

The Phase I zone included 17.2 ha of the newly exposed shoreline between elevations of 1090 m and 1096 m and was seeded in June 2003. The Phase II zone included 17.5 ha of the newly exposed shoreline between elevations of 1086 m and 1090 m and was seeded in September 2003 (Figure 1). Both the Phase I and Phase II zones were seeded by Arctic Alpine Seed Ltd. using the following seed mix (Lacroix 2005):

Sheep Fescue	(<i>Festuca brachyphylla</i>)	25.0 lb/ha	(11.34 kg/ha)
Slender Wheatgrass	(<i>Agropyron trachycaulus</i>)	25.0 lb/ha	(11.34 kg/ha)
Violet Wheatgrass	(<i>Agropyron violaceum</i>)	13.0 lb/ha	(5.89 kg/ha)
Ticklegrass	(<i>Agrostis scabra</i>)	1.0 lb/ha	(0.45 kg/ha)
Alpine Bluegrass	(<i>Poa alpina</i>)	0.5 lb/ha	(0.23 kg/ha)
Tufted Hairgrass	(<i>Deschampsia caespitosa</i>)	0.5 lb/ha	(0.23 kg/ha)
Total		65.0 lb/ha	(29.48 kg/ha)

2.1.2 July 2007 Assessment

During the 2005 and 2006 surveys, the Phase I and II zones were assessed separately as they appeared as two distinct vegetation zones. At the time of the 2007 assessment, the Phase I and Phase II zones appeared as one vegetation zone (the seed mix and seeding rate had been the same for both zones) and were therefore assessed as one zone.

In 2007, much of the Phase I and Phase II seeding zones have up to 100% vegetative cover. This area continues to be dominated by a dense growth of Sheep Fescue. Sheep Fescue occurs in almost pure stands on the steeper southwest face of the old reservoir, while Tufted Hairgrass is found in patches. Alpine Bluegrass also occurs in patches, while there is little growth of Wheatgrass. It is apparent that Wheatgrass cannot compete well on areas with a dense growth of Sheep Fescue. Ticklegrass is

found primarily in wetter areas on the lower slope where the Sheep Fescue is less dense. On the upper slope there is a dense layer of previous years' litter (mostly Sheep Fescue). This litter mat appears to be retarding the encroachment of naturally invading plant species.

The Phase I and II zones on the northeast side of the former reservoir are also dominated by Sheep Fescue, but its growth is more uneven with patches of Alpine Bluegrass and Wheatgrass. Tufted Hairgrass is more prevalent in depressions and Ticklegrass occurs more on the lower slope. Some pure stands of Sheep Fescue result in 100% vegetative cover, while overall cover is about 80-90%. The more compacted area of the Phase I and II zones immediately upstream of the dam have only a 30-40% cover, consisting of Sheep Fescue and Wheatgrass with a little Alpine Bluegrass.

On the eastern portion of the former reservoir, the steep upper slopes on both sides of Rose Creek have a nearly 100% cover comprised totally of Sheep Fescue with a dense layer of litter from previous years' growth. On the less steep slopes, where the litter layer is less dense, Tufted Hairgrass and Alpine Bluegrass make up a significant portion of the vegetative growth. On the far eastern end, where the south fork of Rose Creek enters the former reservoir, there is a good mix of Sheep Fescue, Wheatgrass, Tufted Hairgrass and Alpine Bluegrass, although very little Ticklegrass. The cover here is nearly 100%.

All the seeded grass species observed in the Phase I and II zones in July 2007 were in seed.

The dense cover of seeded grasses has inhibited the encroachment of naturally occurring pioneering plant species in parts of the Phase I and II zones, particularly in areas with a thick layer of grass litter (primarily the previous years' growth of Sheep Fescue). Willows (mostly *Salix pulchra* and *Salix arbusculoides*) are colonizing areas with less dense seeded species. Fireweed (*Epilobium angustifolium*), Common Yarrow (*Achillea millefolium*), Bear Root (*Hedysarum alpinum*), Foxtail Barley (*Hordeum jubatum*), Elegant Hawk's-beard (*Crepis tectorum*), Fleabane (*Erigeron* sp.) and occasional paper birch (*Betula papyrifera*) are found throughout the upper slopes while

Bluejoint (*Calamagrostis canadensis*), Brome Grass (*Bromus* sp.), Bog Rush (*Juncus* spp.), Grass-of Panassus (*Parnassia palustris*), Yellow Cress (*Rorippa palustris*) and Chickweed (*Stellaria* sp.) are found on the lower wetter areas. Dwarf Birch (*Betula glandulosa*) is beginning to colonize the far eastern end of the former reservoir. Broad-leaved Willow-herb (*Epilobium latifolium*) has colonized the banks of the north tributary on the upper slope.

Tansy Mustard (*Descurainia incana*) is not as prevalent a colonizer in the Phase I and II zones in 2007 as it was in previous years (particularly in 2005).

2.2 Phase IV Zone

2.2.1 Phase IV Seeding Program

The Phase IV zone included approximately 17 ha of the exposed bottom of the former freshwater reservoir not seeded as part of Phase I and II, see Figure 1. This area was seeded by Arctic Alpine Seed Ltd. in June and early July 2004.

The seed mix (Lacroix 2005) used for the Phase IV zone included:

Sheep Fescue	(<i>Festuca brachyphylla</i>)	25.0 lb/ha	(11.34 kg/ha)
Slender Wheatgrass	(<i>Agropyron trachycaulus</i>)	25.0 lb/ha	(11.34 kg/ha)
Violet Wheatgrass	(<i>Agropyron violaceum</i>)	13.0 lb/ha	(5.89 kg/ha)
Ticklegrass	(<i>Agrostis scabra</i>)	1.0 lb/ha	(0.45 kg/ha)
Alpine Bluegrass	(<i>Poa alpina</i>)	0.5 lb/ha	(0.23 kg/ha)
Tufted Hairgrass	(<i>Deschampsia caespitosa</i>)	0.5 lb/ha	(0.23 kg/ha)
	Total	65.0 lb/ha	(29.48 kg/ha)

2.2.2 July 2007 Assessment

The vegetative cover by seeded grass species on the valley bottom in 2007 is high, although patchy in areas. The coverage has increased annually and now is greater than 90% on most areas.

The composition of seeded grass species varies across the Phase IV zone. Tufted Hairgrass dominates much of the area, although dense stands of Sheep Fescue with lesser amounts of Wheatgrass and Alpine Bluegrass are found on the higher level areas of the valley bottom. These areas also have a thick layer of litter from previous years' growth. Nearly pure stands of Tufted Hairgrass occur in wetter areas. Other seeded areas have a good mix of Sheep Fescue, Tufted Hairgrass and Alpine Bluegrass with lesser amounts of Wheatgrass. Ticklegrass is found in only a few depressions in the Phase IV zone.

The seeded grasses in the Phase IV zone are well developed and were in seed at the time of the 2007 survey.

The Phase IV zone has many small wetlands and ponds rimmed with sedges (*Carex aquatilis*, *Carex pachystachya* and *Carex brunescens*), Bog Rush (*Juncus castaneus*), Blue-joint Reed-grass (*Calamagrostis canadensis*), Cottongrass (*Eriophorum* spp.) and Mastadon Flower (*Senecio congestus*). Water Buttercup (*Ranunculus aquatilis*) is found in some of the deeper ponds.

The colonization of the bottom of the former reservoir by willows (primarily *Salix pulchra*, *Salix arbusculoides* and *Salix glauca*) was more evident during the 2007 survey than in past surveys. A few alders (*Alnus* sp.) are also appearing in this area.

Yellow Cress (*Rorippa palustris*) and Mastadon Flower (*Senecio congestus*) are also dominant colonizers of the valley bottom. Other plants colonizing this zone include Fireweed (*Epilobium angustifolium*), Broad-leaved Willow-Herb (*Epilobium latifolium*), Grass-of-Parnassus (*Parnassia palustris*), Foxtail Barley (*Hordeum jubatum*), Alpine Milk-vetch (*Astragalus alpinus*), Locoweed (*Oxytropis* sp.) and Common Yarrow (*Achillea millefolium*). Tansy Mustard (*Descurainia incana*) was also found but was not nearly as prevalent as during earlier surveys.

2.3 Phase V Zone

2.3.1 Phase V Seeding Program

The Phase V zone includes the dam area, the disturbed area downstream of the dam, and the floodplains adjacent to the dam breach. These areas were seeded by Arctic Alpine Seed Ltd. in September and October 2004 (Figure 1).

The seed mix (Lacroix 2005) used for the Phase V zone, excluding the floodplains, included:

Sheep Fescue	(<i>Festuca brachyphylla</i>)	25.0 lb/ha	(11.34 kg/ha)
Slender Wheatgrass	(<i>Agropyron trachycaulus</i>)	25.0 lb/ha	(11.34 kg/ha)
Violet Wheatgrass	(<i>Agropyron violaceum</i>)	13.0 lb/ha	(5.89 kg/ha)
Ticklegrass	(<i>Agrostis scabra</i>)	1.0 lb/ha	(0.45 kg/ha)
Alpine Bluegrass	(<i>Poa alpina</i>)	0.5 lb/ha	(0.23 kg/ha)
Tufted Hairgrass	(<i>Deschampsia caespitosa</i>)	0.5 lb/ha	(0.23 kg/ha)
Total		65.0 lb/ha	(29.48 kg/ha)

The seed mix (Lacroix 2005) used for the floodplains included:

Sheep Fescue	(<i>Festuca brachyphylla</i>)	4.00 kg/ha
Violet Wheatgrass	(<i>Agropyron violaceum</i>)	4.00 kg/ha
Ticklegrass	(<i>Agrostis scabra</i>)	1.00 kg/ha
Tufted Hairgrass	(<i>Deschampsia caespitosa</i>)	.00 kg/ha
Total		10.00 kg/ha

2.3.2 July 2007 Assessment

As in previous years, the seeded grass species on the floodplains adjacent to the dam breach in 2007 were predominantly Sheep Fescue and Tufted Hairgrass, with lesser amounts of Wheatgrass and very little Ticklegrass. The vegetative cover generally ranges from 20% to 40%, with a few denser patches up to 70%. Most of these grasses were in seed at the time of the assessment. Blue-joint Reed-grass (*Calamagrostis*

canadensis) has colonized a few wet depressions. Some natural regeneration of willows (*Salix* spp.) is also occurring. Other plant species colonizing the floodplains include Bear Root (*Hedysarum alpinum*), Locoweed (*Oxytropis* sp.), Broad-leaved Willow-herb (*Epilobium angustifolium*), Foxtail Barley (*Hordeum jubatum*), Common Horsetail (*Equisetum arvense*), Yellow Cress (*Rorippa palustris*), Bog Rush (*Juncus castaneus*), Grass-of-Parnassus (*Parnassia palustris*) and Fleabane (*Erigeron* sp.),

The northwest (downstream) wall of the breached dam has a good natural growth of Willows (*Salix* spp.) along with a few mountain alders (*Alnus crispa*). There is little evidence of seeded grass species on this face of the dam.

The southeast (upstream) wall also has good growth of Willows (*Salix pulchra* and *Salix arbusculoides*) with a moderate (40 to 60%) cover of seeded grass species, dominated by Wheatgrass and Sheep Fescue with Alpine Bluegrass in patches. Colonizing species include Bear Root (*Hedysarum alpinum*), Broad-leaved Willow-herb (*Epilobium angustifolium*), Foxtail Barley (*Hordeum jubatum*), Crepis (*Crepis nana*) and Fleabane (*Erigeron* sp.). A strip of sedge (*Carex brunescens*) still occurs at the old water line on the upstream side of the dam.

The sides of the dam breach have a sparse (5 to 20%) vegetative cover. Seeded grass species include Sheep Fescue, Wheatgrass and Alpine Bluegrass. Colonizing species include the occasional Crepis (*Crepis nana*). Due to high compaction, the clay core of the breached dam has almost no vegetation. There are minor erosion channels on these steep compacted surfaces.

At the time of the 2007 survey, the vegetative cover on the areas seeded downstream of the dam was considerably greater than in 2006. Although patchy, the overall cover is now approximately 80%. The seeded species are primarily Sheep Fescue and Wheatgrass, with a little Alpine Bluegrass and Tufted Hairgrass. There are a few dense patches of Sheep Fescue. A few small compacted areas with coarser textured soils remain nearly bare.

Plant species naturally colonizing this area included Felt-leaf Willow (*Salix alaxensis*), Balsam Poplar (*Populus balsamifera*), Locoweed (*Oxytropis* sp.), Broad-leaved Willow-

herb (*Epilobium latifolium*), Bear Root (*Hedysarum alpinum*), Common Yarrow (*Achillea millefolium*) and Foxtail Barley (*Hordeum jubatum*).

2.4 Vitality of Seeded Grass Species

The seeded grass species in all of the seeding zones appeared to have normal growth forms at the time of the 2007 assessment.

The average plant heights were:

Sheep Fescue	55 cm
Tufted Hairgrass	90 cm
Wheatgrass	55 cm
Ticklegrass	35 cm
Alpine Bluegrass	35 cm

All seeded grass species were in seed in each of the seeding zones at the time of the 2007 assessment.

The average rooting depths of the seeded grass species on the valley bottom were:

Sheep Fescue	95 mm
Tufted Hairgrass	330 mm
Wheatgrass	95 mm
Ticklegrass	60 mm
Alpine Bluegrass	125 mm

These rooting depths are similar to those measured during the 2006 survey.

3.0 Shrub Establishment Program

3.1 Shrub Harvest and Establishment

Stem cuttings from locally occurring species of shrubs (primarily willows) were harvested from a site downstream of the breached dam and staked at a number of sites in the

dewatered reservoir (Figure 1). These included a willow transplant test site at the east end of the reservoir (Phase III program, September 2003), willow stem cutting transplants along the riparian zone on the main channel of Rose Creek (part of the Phase IV program, June 2004) and willow stem cutting transplants along the two main tributaries as well as on the floodplains adjacent to the dam breach (Phase V program, September and October 2004).

The shrub species selected were:

Diamond-leaf Willow	(<i>Salix pulchra</i>)
Felt-leaf Willow	(<i>Salix alaxensis</i>)
Scouler's Willow	(<i>Salix scouleriana</i>)
Barclay's Willow	(<i>Salix barclayi</i>)
Trembling Aspen	(<i>Populus tremuloides</i>)
Balsam Poplar	(<i>Populus balsamifera</i>)
Soapberry	(<i>Shepherdia canadensis</i>)
White Spruce	(<i>Picea glauca</i>)

3.2 July 2007 Assessment

The survival rate of the staked shrubs on the floodplains upstream and downstream of the dam breach is variable in 2007, ranging from 50-90%. The most successful species in this area are Diamond-leaf Willow, Felt-leaf Willow and Balsam Poplar. Many of the staked willows have died off at the top but are sprouting vigorously from the ground level.

The staked willows in the Rose Creek riparian zone and the lower reaches of the two tributaries also have a high rate of survival (approximately 80%). Felt-leaf Willows and Diamond-leaf Willows are the most successful of the shrubs staked along the creek.

As noted during earlier surveys, the willows staked along the upper reaches of the two tributaries, and along the upper reach of Rose Creek where it enters the dewatered reservoir, have a much lower rate of survival (5% to 30%) than those willows staked farther downstream.

4.0 Natural Revegetation

As discussed in previous sections, a considerable number of plant species are naturally colonizing the dewatered reservoir. These are pioneering species normally found on disturbed sites in this region. Natural revegetation is occurring on most areas, except those sites that have a dense growth of seeded grasses and a thick layer of vegetative litter from previous years.

Willows (*Salix* spp.) are colonizing all seeding zones. The occurrence of species from the Mustard Family, including Yellow Cress (*Rorippa palustris*) and Tansy Mustard (*Descurainia incana*), has decreased considerably from the previous two years. Mastadon Flower (*Senecio congestus*) is common, along with Blue-joint Reed-grass (*Calamagrostis canadensis*), sedges (*Carex* spp.) and rushes (*Juncus* spp.) in the valley bottom wetlands.

As in previous years, the colonization of the site by undesirable invasive species does not appear to be a problem. The small amounts of non-native grasses observed on the former reservoir, such as Foxtail Barley (*Hordeum jubatum*) and Smooth Brome (*Bromus inermis*), are species commonly found on disturbed areas in this region.

5.0 Evidence of Erosion

The soil erosion site observed on the south side of the reservoir in previous years, just upstream from the breached dam, has not significantly changed. The site appears to be stabilizing and is revegetating with the seeded grass species, Alpine Bluegrass, Tufted Hairgrass and Sheep Fescue. The groundwater seepage into the cut, near the bottom, was estimated to be 250 mL/second at the time of the 2007 survey.

Minor erosion channels are occurring on the steep compacted surfaces of the dam breach.

6.0 Summary

The revegetation of the dewatered freshwater reservoir appears to have been successful in stabilizing the previously submerged lands. Following are a few specific deductions from the July 2007 survey:

- Sheep Fescue continues to be the dominant seeded grass species, particularly on the steeper valley walls.
- With the exception of Ticklegrass, the seeded grass species appear to be well established based on all seeding zones. Ticklegrass appears not to be competing well with the other species.
- Unlike in previous years, the Phase I and Phase II seeding zones now appear as one vegetation zone (the seed mix and seeding rate had been the same for both zones). Visual distinctions between the seeding zones are no longer so evident.
- A dense growth of seeded grasses is now occurring in the valley bottom.
- The growth of seeded grasses on the walls of the dam breach remains sparse. There is some evidence of minor erosion on these highly compacted surfaces.
- A dense growth of seeded grass continues to dominate the upper steep slopes of the reservoir and appears to be creating a zone of successional stagnation. This growth, although somewhat inhibiting the colonization by naturally occurring plant species, is most likely preventing soil erosion. It is suspected that natural colonization into these areas will take some time.
- The soil erosion site noted during the previous assessments has not deteriorated and the seeded grass species continue to gradually revegetate this area.
- Much of the dewatered reservoir is being colonized by pioneering plant species. Willows are now naturally occurring in most areas. These shrubs, although still

small, are an indication of the next successional revegetation phase. Blue-joint Reed-grass, sedges, rushes and Mastadon Flower are common in the valley bottom wetlands. Tansy Mustard is not as common as observed in 2006.

- The invasion of the area by unwanted invasive plant species is not a significant problem.
- The stem cuttings of woody species, particularly willows, are surviving well on the floodplains adjacent to the dam breach, in the Rose Creek riparian zone, and on the lower reaches of the two tributaries. The survival rate of the cuttings staked on the upper reaches of Rose Creek and the two tributaries is lower, however volunteer willow growth is beginning to colonize the area.

7.0 Recommendations

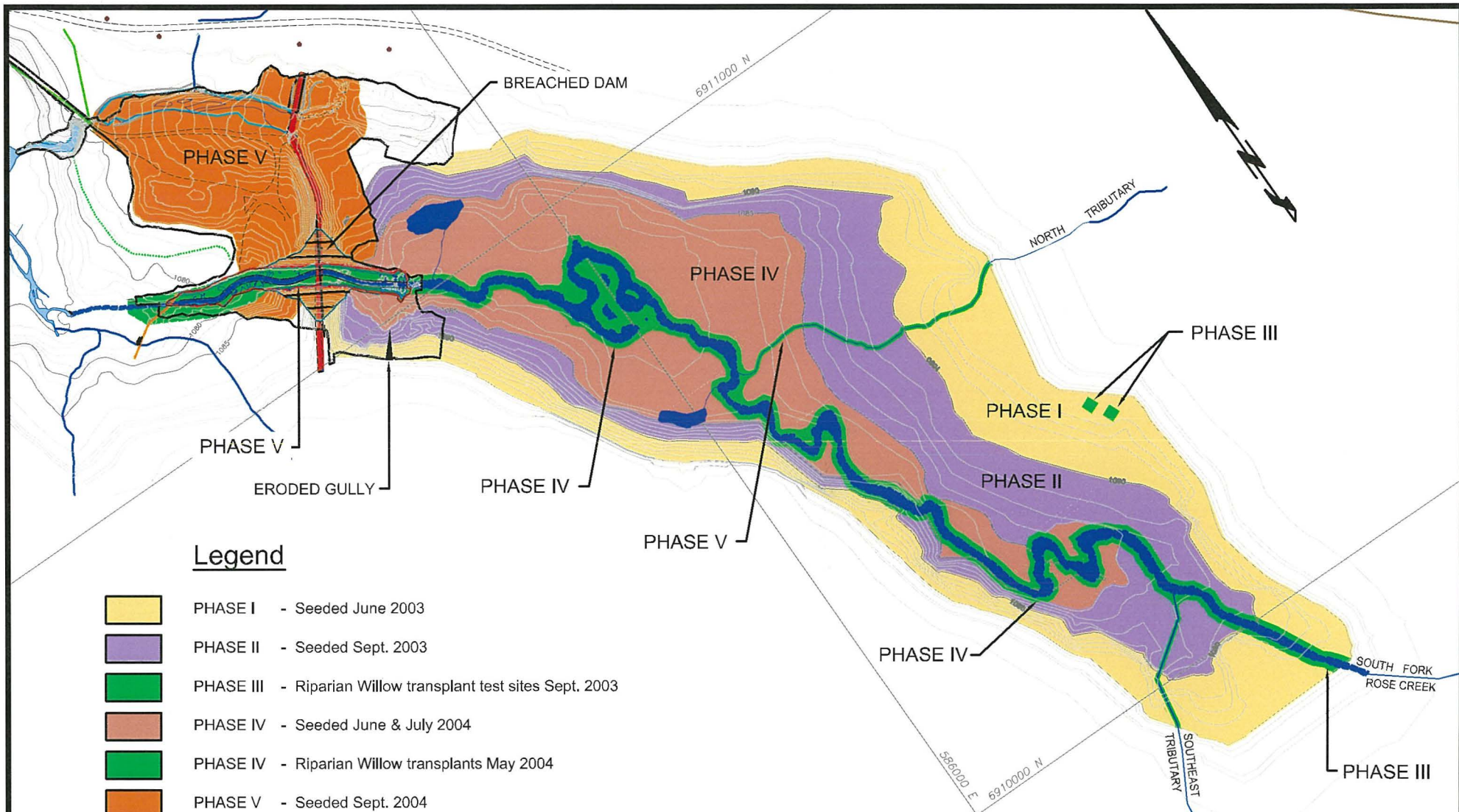
Continued annual monitoring of the progress of natural revegetation on the dewatered reservoir is recommended.

A record of wildlife use (sightings, tracks, nests, etc.) would be useful for evaluating the restoration of the dewatered reservoir's terrestrial habitat.

It is also recommended that vehicle access on the dewatered reservoir remain restricted.

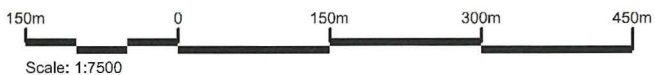
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Alpine Seed Ltd's site manager for the freshwater reservoir revegetation project
during the 2003 and 2004 field seasons).



Legend

- PHASE I - Seeded June 2003
- PHASE II - Seeded Sept. 2003
- PHASE III - Riparian Willow transplant test sites Sept. 2003
- PHASE IV - Seeded June & July 2004
- PHASE IV - Riparian Willow transplants May 2004
- PHASE V - Seeded Sept. 2004
- PHASE V - Riparian Willow transplants, Oct. 2004



<i>Laberge</i> ENVIRONMENTAL SERVICES		
REVEGETATION OF THE DEWATERED FRESHWATER RESERVOIR		
November 29, 2005		Figure 1

APPENDIX A

PHOTOGRAPHS, JULY 2007



The vegetative cover has increased in Phase V, below the spillway area, since the assessment in 2006.



Looking toward the spillway, the coverage of the seeded grasses has increased significantly over the past year.



There has been an increase in the growth of sheep fescue and wheatgrass in Phase V since the assessment in 2006.



Willows and grasses continue to grow and thrive in the riparian zone of the breach.



The south side of the dam breach has increased growth on the downstream side however the compacted core still has sparse vegetative coverage.



The north side of the dam breach has little vegetative cover and minor erosion channels are present on the steep compacted surface of the core.



The eroded gully shows continued sign of revegetating naturally from the seeded species, and appears stable.



The southwest wall of the reservoir where there is dense growth of sheep fescue with some wheatgrass.



Sedges and Mastadon Flower dominate the wetter areas of the valley floor (Phase IV); looking northwest toward the breach.



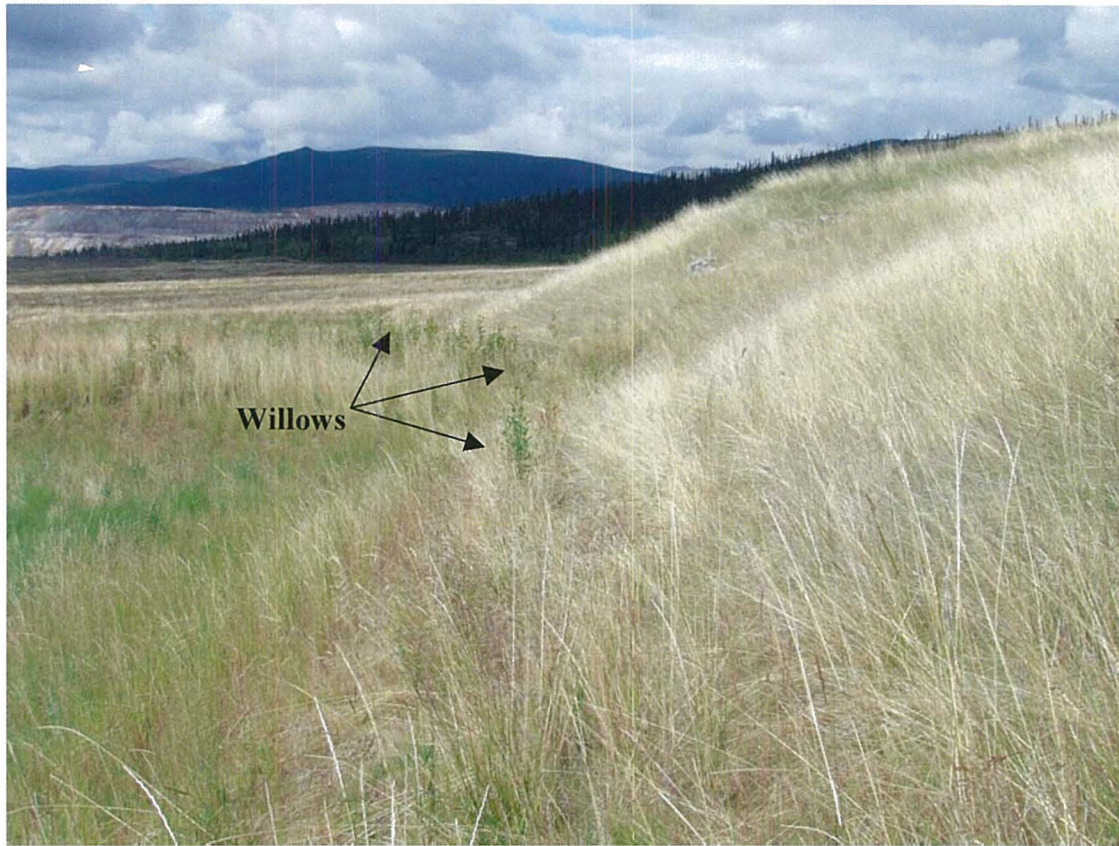
The transplanted willows along the riparian zone of the South Fork of Rose Creek are robust and thriving.



Willow seedlings have begun to naturally colonize the valley floor.



Willow seedlings have also begun to grow along the Southeast Tributary. The majority of the willow transplants died during the first year following planting in this area.



The thick growth of sheep fescue and its resultant litter on the northeast wall of the reservoir is inhibiting the spread of willows up the slope into Phase I and II.



The confluence of the Southeast Tributary with the South Fork of Rose Creek.

**APPENDIX D – AQUATIC REPORT
REPORT PREPARED BY
LABERGE ENVIRONMENTAL SERVICES**

**FRESHWATER RESERVOIR SITE
FISH HABITAT AND UTILIZATION ASSESSMENTS, 2007**

ANVIL RANGE MINE SITE, FARO YUKON

Submitted to:
DELOITTE & TOUCHE INC

Prepared by:

Laberge
ENVIRONMENTAL SERVICES

P.O. Box 21072, Whitehorse Yukon. Y1A 6P7

January 2008

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1.0 INTRODUCTION

1.1 Background

The freshwater reservoir at the Faro Mine Site was permanently de-watered during November and December of 2003 by the breaching of the existing dam, in accordance with the terms and conditions provided in Yukon Water Licence QZ03-058. As part of the adaptive management strategy following the breach project, evaluations of fish habitat and fish distribution in Rose Creek through the reservoir basin are to be conducted annually as committed to in the *Environmental Management Plan for the Breaching of the Fresh Water Supply Dam at the Faro Mine* (Gartner Lee Limited, 2003). Laberge Environmental Services (LES) was contracted to complete the evaluations in 2007. Nick de Graff, a fish biologist with Can-Nic-A-Nick Environmental, assisted in the assessments.

1.2 Scope of Work

Following procedures similar to previous evaluations performed in the past, the following major tasks were completed as part of this study:

- Obtain fish collection permit from DFO;
- Evaluate the site twice over the season; during freshet and in mid August;
- Assess habitat by determining creek width (wet and dry), depth, velocity, bank stability, bottom substrates, available cover and riparian vegetation;
- Assess fish utilization by setting minnow traps, Electro-fishing, angling and through visual observations.

2.0 STUDY AREA

In 1968, a dam was constructed across the South Fork of Rose Creek to create a reservoir with the purpose of supplying the Faro Mine Site with fresh water for the milling process. The reservoir was approximately 1.5 km long with an average depth of eight metres. Following the controlled breach in Nov/Dec 2003 and subsequent dewatering of the reservoir, the South Fork of Rose Creek and its tributaries, for the most part, again flowed in their original channels. Since 2004, fish habitat and fish utilization assessments have been conducted in and along these recently exposed channels.

The watershed within the reservoir was divided into five separate reaches for the purposes of assessment (Figure 1). The general description of each of the reaches is outlined below:

Reach 1: This reach extends approximately 340 metres from 30 metres upstream of the old reservoir basin to just downstream of the confluence with the Southeast Tributary, where the gradient abruptly decreases from 2.5 % to 0.2%.

Reach 2: This reach flows from the end of Reach 1 for approximately 690 metres to the start of Reach 3. The break between these two reaches was set at a point where the slope decreases to 0.1% and the channel becomes deeper and starts to meander.

Reach 3: Reach 3 flows for approximately 950 metres from the downstream end of Reach 2 to the site of the old Coffey dam. The old Coffey dam is located just upstream of the construction activities for the breaching of the dam. The North Tributary debouches into the upper region of Reach 3.

Reach 4: This 265 metre reach consists of the dam breach and the channel construction zone.

Reach 5: The first part of this reach (5a) flows for 220 metres from the downstream limit of the 2003 construction activities through the channel that was built in 1968 as part of the dam construction. Reach 5b extends approximately 75 metres into the unmodified native channel in an area that has received significant sediment depositions over the past few years.

Site X14: This reach extends from the bottom of the diversion canal (approximately seven km downstream of the dewatered reservoir) to the water quality and flow monitoring site of X14. The sample site X14 is located in Rose Creek downstream of the diversion canal and receives all inputs from the diversions and the treated discharge from the tailings facility. Fish salvaged during dewatering in 2003 were released in this reach.

3.0 METHODS

3.1 Spring Assessment

The first assessment was conducted during freshet from June 4th to 6th 2007. The primary purpose of the spring assessment was to document any areas of erosion resulting from the freshet. To pinpoint locations of any sediment loading throughout the system, six total suspended solids (TSS) samples were collected in 500 mL plastic bottles from locations upstream of the reservoir, within the reservoir and downstream of the reservoir. These samples were shipped to Burnaby, BC and analyzed by Cantest Ltd. The samples collected during the spring assessment were used to confirm visual assessment of TSS in the creek channel and the appearance of erosion in the North Tributary.

The study of fish utilisation during the freshet assessment was limited to minnow trapping due to high flows that limited the crew's ability to safely wade Rose Creek. Authorized under collection licence CL-07-15, "Gee" type minnow traps were used to test for the presence of fish in Reaches 1 to 4 and X-14. Six traps were placed in various habitat types within each surveyed reach. Minnow traps were constructed of either 0.32 or 0.63 cm mesh. The smaller mesh traps were to target early life history stages of spring spawning fish (Arctic grayling and slimy sculpin). As in previous survey years, traps were baited with salmon roe of Yukon River origin and suspended in the trap in a perforated bag. All traps were set for an overnight period ranging from 21.0 to 24.5 hours. A total of 30 minnow trap sets were used during the freshet assessment. All captured fish were anaesthetised with a mixture of clove oil and alcohol, identified to species and measured for either a fork or total length (± 1 mm) and weight (± 0.1 gm). Weight was determined using an Ohaus Scout II digital scale. A total length was recorded for burbot and slimy sculpin, fork length for Arctic grayling. All fish were placed in a recovery bucket filled with water and live released into slack water areas of the stream near each capture site.

3.2 Summer Assessment

The summer assessment was conducted from August 13th to 16th, 2007. Measurements of the physical stream and habitat characteristics within each reach were made using methodology described in BC Ministry of the Environment (2001) stream survey methods. Crews were able to wade into Rose Creek during the summer assessment as water levels had greatly receded from the spring. Stream name, site, reach, date, time, weather conditions and crew members were noted for each site assessment. Map sheet (1:50K), datum and a waypoint for each sampling site was recorded using a Garmin 76CS GPS. A 35mm digital SLR camera with a date stamp was used to

take pictures of all reaches and sampling sites. The measurement of the channel characteristics included channel width, wetted width, residual pool depth, bank full channel depth and gradient (%). Gradient was determined using a rod and level. Fish cover descriptions of each reach included the amount and location of small and large woody debris, boulders, undercut banks, deep pools, overhanging vegetation, and instream vegetation. The extent of crown closure and any instream vegetation was noted. The distribution and frequency of large woody debris was subjectively evaluated in addition to the bank texture, slope, stage, and dominant type of riparian vegetation. The dominant and subdominant types of bed material and an estimate of the D and D₉₅ were also determined at sites that were thought representative of the entire reach.

The stream morphology, pattern, presence of islands, bars and position, and confinement characteristics were also assessed and described in detail. Flood signs and stream disturbance indicators (beaver dams, avulsions, elevated bars etc.) were also recorded. Basic water chemistry included in-situ measurements of pH, conductivity and temperature. Instantaneous water discharge was measured at least once in each of the study reaches. The location for a discharge estimate was a relatively uniform cross section in the lower reaches of each study reach. A propeller driven Global Flow Probe was used to measure flow. The average velocity for each measurement in the cross section was derived by moving the probe vertically from the surface to the bottom for approximately 40 seconds. Individual measurements were converted to an instantaneous discharge.

The methodology and timing of the fisheries assessment was generally consistent with all previous monitoring projects for the watershed (White Mountain Environmental Consulting 2006). Fish utilization and distribution were assessed with a variety of techniques. A Smith Route model LR24 battery powered electro-fisher was the primary method used for establishing fish presence in reaches 1 to 5 and X-14. A conductivity meter was used to measure the conductance of surface waters in each reach to assist in determining the most appropriate settings of the electro-fisher. In addition, temperature, and pH were also noted prior to each fish collection episode. The shocking time (seconds) and settings (frequency, duty cycle and voltage) used to collect fish were recorded for each sampling site. Unlike all previous surveys, only single-pass sampling techniques were used at all sampling sites in 2007. White Mountain used stop nets and the two-pass system on some of the reaches, which is typically used to calculate area related densities of fish for a section of stream. Since area related density results were not given in any of the previous reports, there was nothing to compare to. There also was no reference given to the length of stream reach, which location this was done, and where the stop nets were placed, hence replication was not feasible. As all previous studies used CPUE (catch per unit effort) statistics, these were used in this study to enable comparisons with the past surveys.

Reaches 1 to 5 and X-14 were also sampled for the presence of fish by the placement of six "Gee" type minnow traps in various habitat types within each surveyed reach. Minnow traps were all constructed of 0.63 cm mesh. The same protocols and roughly the same minnow trapping locations were used as during the freshet assessment. All traps were set for an overnight period ranging from 17.5 to 27.0 hours. A total of 36 minnow trap sets were used during the late summer assessment. Angling was additionally used at reaches 2 and 3, as well as X-14 and employed the use of flies and small spinners. The time spent angling as well as fish observed or fish captured were noted. Crew members wore polarized sunglasses at all times to assist in visual observations of fish during each visit. All observed fish locations and species were recorded. All captured fish were identified and measured for a length (± 1 mm) and weight (± 0.1 gm). Weight was determined using an Ohaus Scout II digital scale. A fork length was recorded for Arctic grayling, while total length was recorded for captured slimy sculpin and burbot. All fish were live released at site of capture.

4.0 RESULTS AND DISCUSSION

4.1 Spring Assessment

4.1.1 Evidence of Erosion

Rose Creek flows peaked on June 6th, 2007 (32.3 m³/sec), as recorded downstream at site X-14. During the spring assessment conducted June 4th to 6th, the waters of the South Fork of Rose Creek were in freshet. Flows were too swift and deep to safely wade and discharges measurements were not made at the reaches. However, mine personnel were successful in obtaining flow measurements on June 7th at the licensed sites FWSB 1 (South Fork of Rose Creek at the bridge to the Gun Club) and FWSB 5 (downstream of the limits of the 2003 construction area). Discharge was 2.505 m³/s and 3.135 m³/s respectively.

The length of the South Fork of Rose Creek within the reservoir was assessed as well as downstream of the breach into the natural wetland. To determine if and where sediment loading was occurring, samples were collected from six sites and analyzed for total suspended solids (TSS) and turbidity (Table 1).

Site Location	Total Suspended Solids (mg/L)	Turbidity (NTU)
S. Fork of Rose Cr @ Gun Club	26	6.0
Top of Reach 1	23	7.5
Top of Reach 2	26	5.5
Reach 3 u/s of North Tributary	25	5.7
Reach 3 d/s of North Tributary	117	20
Reach 4/Reach 5 boundary	78	10

TSS values are consistent in the South Fork of Rose throughout the upper half of the reservoir, with results similar to the background site near the Gun Club upstream of Reach 1. However, once the North Tributary enters the South Fork of Rose Creek, the water becomes very turbid and the TSS increases considerably. There is some reduction in TSS at the start of Reach 5, however mobilization of sediment within the breach (Reach 4) is also contributing to loading. The schematic below (Figure 2) demonstrates the concentration of TSS throughout the dewatered freshwater reservoir.

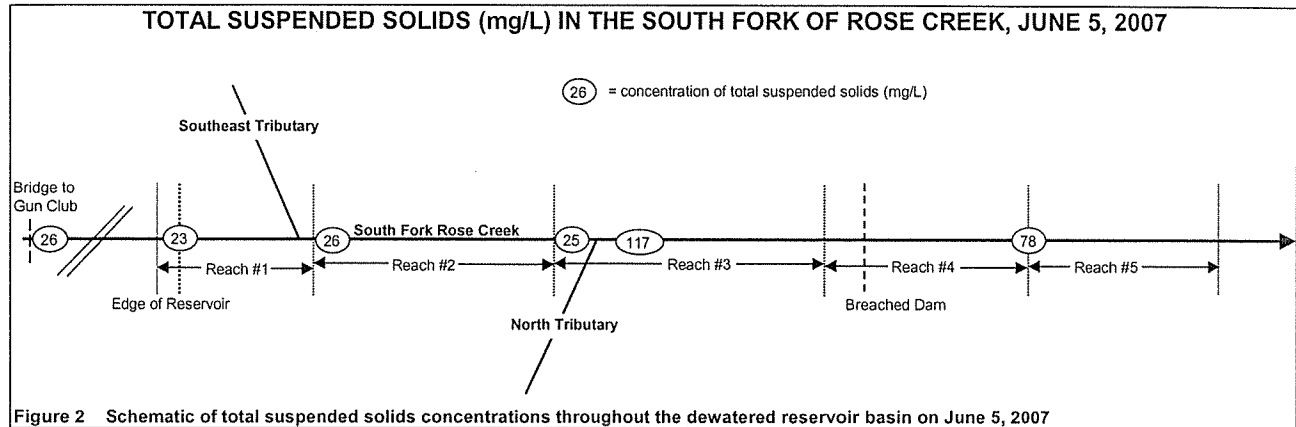


Figure 2 Schematic of total suspended solids concentrations throughout the dewatered reservoir basin on June 5, 2007

Based on these results, it would appear that the upper portions of the creek in the former reservoir, Reaches 1 and 2, have generally reached stability. The photographic record shows little change in this section from 2006 to 2007. Following dewatering, the South Fork of Rose Creek has generally resumed its flow within its original channel, but due to the dynamic nature of river systems, the creek will likely exhibit minor shifts in flow throughout time. There is evidence of erosion in these reaches (Photos 1 and 2 in Appendix A), however self-armouring of the channel and bends appears to have stabilized the areas.

The North Tributary flows across the mine access road into the reservoir, through an old borrow pit and over unstable soil, carving a channel for itself until it reaches the South Fork of Rose Creek (Photos 4 and 5). Judging by the presence of elevated bars in the lower section of the North Tributary and downstream in Reach 3 (Photos 6 and 7), it is apparent that a considerable amount of sediment is being mobilized.

The flow throughout Reach 3 is slower and the incidence of meandering increases. There are sections of unstable banks within this reach (Photo # 8) and the substrate is characteristically sandy.

The velocity increases in Reach 4 as the South Fork of Rose Creek flows through the constructed channel within the breach. All of the flow was not confined within the channel during freshet and some cutting into the riparian zone has occurred (Photo #9). Although additional channelling occurred in 2007, the constructed breach section is performing as designed and no remedial work is required (SRK, 2003).

The flow in Reach 5 was bank full during freshet (Photo 10) and the banks appeared stable in the upper section. There appears to be some channel shifting in Reach 5b due to sediment deposition,

possibly as a result from the construction period of the breach and subsequent erosion through the reservoir.

In previous assessments, an area of concern has been identified at the first meander in Reach 2 (Photo #3). Reach 1 generally covers a straight and swift-flowing section and there was some apprehension that significant erosion would continue where it meets this cut bank. During the 2006 field investigations, a series of stakes was placed adjacent to this site to measure erosion that may occur during future freshets (White Mountain Environmental Consulting, 2007).

Measurements at these stakes were made on June 5th, 2007 (Table 2). The stakes were initially placed one metre and three metres back from the bank edge, and each series was indicated to be five metres apart. The 2007 measurements showed some discrepancy with these measurements and they have been noted in Table 2. Assuming that each stake labelled “1” or “1.5” was originally that exact distance from the bank edge, it can then be postulated that the bank has eroded 0.13m at Series #1 (the uppermost series of stakes), 0.74m at Series #2, 1.32 m at Series #3 and 0.74m at Series #4. This represents a significant loss of material, however the TSS values measured on June 5th, 2007, would indicate that no active erosion was occurring at that time. Distances from these stakes to the bank edge should be measured again in 2008 to clarify if erosive activity is continuing.

Table 2 Distance (m) from stakes to water and edge of bank, 2007			
	Original to water as labelled on stakes	June 5 to water	June 5 to bank edge
<i>Series #1</i>			
First stake	1	0.87	0.87
Second stake	3	2.87	2.87
<i>Series #2 (5.1 m d/s from Series #1)</i>			
First stake	1	0.6	0.26
Second stake	3	2.6	2.26
<i>Series #3 (5.2 m d/s from Series #2)</i>			
First stake	1.5	0.63	0.18
Second stake	3*	2.63	2.18
<i>Series #4 (5.7 m d/s from Series #3)</i>			
First stake	1	1.2	0.26
Second stake	3**	2.87	1.93
* should actually read 3.5 m			
** should actually read 2.67 m			

4.1.2 Fish Utilization

Visibility was limited by high water turbidity throughout the mainstem reaches of the South Fork of Rose Creek during the freshest period in June. A very modest number of fish were captured during

this assessment within each sampled reach. Catch details can be found in Appendix B with the August data in Tables 4 and 5. Fish sampling was limited to minnow trapping, angling and the recording of fish that could be observed. Catch results from the traps were limited to a few juvenile burbot in reaches 3 and 4, and several adult slimy sculpin in reaches 1, 2, and X-14. Arctic grayling was the only species captured by angling but several others were observed in Reach X-14.

Generally, fish assessments during high water flow periods are less productive at discerning fish utilization. This is due to a number of factors that include limitations on the type of fish capture gear that can be used effectively during high flows, the inability to sample deeper water habitats, and the poor visibility caused by high turbidity that limits fish observation. Stream assessments in the Yukon are usually conducted in the late summer during a period when fish are theoretically maximally distributed in Yukon watersheds. During July and into the early weeks of August surface waters attain their thermal maxim and benthic invertebrate densities are at their greatest. Fish are thought to be distributed accordingly, foraging on abundant food sources in habitat that is normally inaccessible during winter low flow periods.

4.2 Summer Assessment

4.2.1 Fish Habitat Assessment

4.2.1.1 Reach 1

The channel in this reach was the steepest in gradient (2.5 %) in comparison to others that were surveyed (Appendix B, Table 3). The reach was relatively short (370 meters) and the narrow average channel width (6.0 m) and steeper gradient made stream flow swift throughout this section. Pools were mainly the result of scour as residual pool depths were very shallow offering little deep pool cover especially for adult Arctic grayling. Fish cover overall was moderate, dominated by boulders and scour pools. There was no instream vegetation. The subdominant cover types were undercut banks that have likely formed since the channel was reactivated. Other cover types included overhanging vegetation and both small and large woody debris, although few pieces of large woody debris were noted. Banks were near vertical with a texture of fines originating from a thick organic mat. Riparian vegetation consisted primarily of grasses that were interspersed with the occasional willow clump. The dominant bed materials were boulders that formed excellent armour from this higher gradient reach. There were some points where bank erosion was evident and a few sections where the stream channel had widened as a result of erosion during periods of high flow, although the heavy boulder armouring appears to be now preventing any further lateral channel migration.

4.2.1.2 Reach 2

The combination of greater average channel widths (8.1 m) and a much lower stream gradient (0.2%) in comparison to Reach 1 made this section of stream characteristically slow and tortuously meandering. Relatively deep residual pool depths (0.6 m) provided excellent habitat for adult Arctic Grayling which prefer mainstem pools, riffles, and runs (McPhail 2007). Overall, fish cover was moderate in this reach and was dominated by deep pools (Appendix B, Table 3). The subdominant cover type was undercut banks and other cover types included overhanging vegetation, boulders, and small and large woody debris. Large woody debris was infrequently found within the reach. Banks were generally vertical and composed of fine textured material. Riparian vegetation consisted primarily of grasses that were interspersed with young willows. The dominant bed materials were gravels in the swifter riffle sections, with others represented by glides dominated by a fine bed material. As was apparent in Reach 1, points of erosion were observed where the stream's channel had widened to accommodate an increase in stream energy during high flow periods.

4.2.1.3 Reach 3

Reach 3 had many similarities to Reach 2 that included comparable average channel widths (8.7 m), low gradient (0.1 %) and relatively deep residual pool depths (0.9 m). Sections of the South Fork of Rose Creek in this reach were tortuously meandering, and this attribute seemed to provide the underlying conditions for the development of some excellent deep corner pools. Riffles and glides were common throughout the reach. Growth of algae was apparent in the riffles above the confluence of the North Tributary. Fish cover was abundant with deep pools being the dominant cover type. Undercut banks were fairly numerous and represented the subdominant cover type (Appendix B, Table 3). Additional cover included overhanging vegetation and small woody debris. Banks throughout the reach were primarily vertical although there were numerous sloping sections. As in other reaches associated with the dewatered reservoir, banks consisted of fine textured material and the riparian vegetation consisted of grasses interspersed with willows. Unlike the upstream reaches, fines were the dominant bed material in Reach 3 with interspersed sections of gravel mainly associated with riffle locations. Fines were especially prevalent downstream of the North Tributary confluence where several disturbance indicators were apparent in the mainstem of the South Fork of Rose Creek. These included observations of elevated bars, sediment fingers, numerous eroding banks as well as recently established islands. Riparian vegetation included grasses and shrubs at an early stage of development. During the August assessment, the water was clear throughout the reach. Erosion in the North Tributary is a spring freshet phenomenon that caused the high TSS values recorded in June.

4.2.1.4 Reach 4

This relatively short reach represents the channel construction zone of the breached dam site. The walls of the former dam confine the stream channel at this location. The reach was constructed in 2003 and retains the same average channel width as the adjacent reach immediately upstream (8.7 m). The steeper gradient of this reach (1.2 %) appears to have required the construction of several stream elevation control points that act as riffles that create a steep-pool configuration rather than the more conventional riffle pool morphology apparent in the upstream reaches. Pools just upstream of the control points appear to be infilling with fines (the soft substrate could easily be moved by foot). The average residual pool depth was relatively shallow (0.4 m) limiting good quality rearing habitat for adult Arctic grayling. Fish cover abundance was moderate with the dominant cover type being boulders that are especially well suited for juvenile fish and sculpin (Appendix B, Table 3). Pool habitat was the subdominant cover type and other cover types were represented by overhanging and instream vegetation (willows), and small woody debris. Fines dominated the substrate and filled many of the interstitial spaces of the streambed. Sediment fingers extending longitudinally along the channel bed were also observed. Cobble was the subdominant substrate type and provided good armouring of the streambed in this reach. The stream channel had regular meanders and was generally confined by the former dam. Banks were generally vertical, composed of boulders and cobbles that provided some significant resistance to erosion. Riparian vegetation consisted primarily of grasses with many recently planted (2004) willow stakings. Erosion in this reach was limited to the riffle sites where flow during high water periods appeared to be making its way around elevation control points and into the riparian vegetated zones (Photo #9).

4.2.1.5 Reach 5

Reach 5 represents a section of the South Fork of Rose Creek downstream of the de-watered reservoir and below the breach construction area. A portion of the reach is formed by a channel constructed in 1968. The average channel width (4.9 m) at this location is reduced compared to upstream sites (Appendix B, Table 3). Gradient is low (0.6%) although flow remained swift in August due to the channels confined width. Further downstream is an unmodified native channel that is at some locations characterised with numerous side channels presumably in response to historic high flow events.

Pools were mainly the result of scour as residual pool depths were very shallow offering little cover for adult grayling. Fish cover overall was moderate, dominated by boulders that make excellent cover for juvenile fish. The subdominant cover types were undercut banks and overhanging

vegetation. Other cover types included instream vegetation (willow), overhanging vegetation, and both small and large woody debris, although few pieces of large woody debris were found. Banks were near vertical and consisted mainly of cobbles embedded with fines. Riparian vegetation consisted of mature stands of dense willow and alder. The dominant bed materials were cobbles with many of the interstitial spaces filled with fine grained material and organics. Quiet areas of the stream had very noticeable depositions of fine grained silt.

4.2.1.6 X-14

The reach extends from the bottom of the Rose Creek diversion canal to a water quality and flow monitoring station known as X-14. The monitoring station is located in Rose Creek downstream of the diversion canal and below all inputs from the tailings facilities of the Faro mine. This reach had the greatest average channel width (13.1 m), and a gradient that was relatively low (0.2 %) and comparable to reaches 2 and 3 (Appendix B, Table 3). The native channel below the diversion channel provides a mix of habitat types, with long glides, deep pools and shallow gravel riffles. Residual pool depth was deep (1.1 m) with some pools too deep to wade or survey. Fish cover overall was abundant and dominated by large deep pools. Subdominant cover types included clumps of small and large woody debris. Other cover types included overhanging and instream vegetation in the form of submerged willows. Banks throughout the reach were primarily vertical although there were some sloping sections just downstream of the flow monitoring station. Banks consisted of a mixture of gravel and fines. Riparian vegetation was composed largely of mature shrubs and herbs that are occasionally off-set with mature coniferous forest. The dominant bed materials were fines with riffles composed of mainly sorted gravels that formed a subdominant bed. The channel meanders were irregular with large developed side bars. The channel was occasionally confined by the valley wall.

4.2.2 Fish Utilization

Summaries of the fish observations and captures within each reach by each fish collection method for 2007 are presented in Tables 4 to 6 in Appendix B. A listing of the individual lengths, weights or life history stage by location of capture is contained in Appendix C. Arctic grayling, burbot, and slimy sculpin were captured in all surveyed reaches of Rose Creek in varied numbers and life history stages. The following is a brief description of the life histories of each species captured and the life history stages where they were found in each of the surveyed reaches.

4.2.2.1 Arctic Grayling

Arctic grayling often display migrations between spawning sites, feeding sites, and over-wintering areas. Not only do they shift habitat seasonally, their preferred habitat types also change as they

grow. The annual movement between over-wintering sites and summer feeding sites is a characteristic part of grayling life history (West et al. 1992). Arctic grayling spawn in the spring usually shortly after the ice leaves the streams and surface waters begin to warm. Grayling are known to spawn on riffles over a wide range of substrate types (Tack 1973). Fry can be found along the quiet margins of streams or in slow side channels of large rivers. Juvenile and sub-adult habitat preferences are less well known. Grayling sexual maturation is usually reached in five years at a size of about 250 mm (McPhail 2007).

The occurrence of numerous grayling adults, juveniles, and fry in Reach 3 is indicative of the presence of spawning, rearing, and nursery habitat for this species in this reach. The deeper pools, particularly in reaches 2, 3, and X-14, appear to provide excellent cover for adult grayling especially during August. Some of the adults observed and one that was captured were quite large reaching well over 300 mm (Photo #11). Captured juveniles ranging in size from 34 to 88 mm were also collected in varying densities by electro-fishing in all reaches, although catches were greatest in reaches 3 to 5. With the exception of Reach 1, where grayling continue to be in low abundance, their presence in other reaches suggest little change in distribution or abundance from previous electro-fishing assessments (Appendix B, Table 7).

4.2.2.2 Burbot

Burbot are known to aggregate for spawning in late winter or early spring from December to early March. Riverine populations are normally migratory often associated with spawning. In rivers, burbot spawn in low velocity areas of main channels and in side-channels behind deposition bars (McPhail 2007). The preferred substrate is usually fine gravel, sand, or even silt. Burbot grow rapidly in their first year depending on food resources and can reach 100 – 200 mm by fall (McPhail 2007). Movements of juveniles appear to be shorter in distance than adults for riverine populations (Evenson 2000).

Burbot juveniles were represented in modest catch numbers throughout each surveyed reach. The size range of juveniles was very consistent in reaches 1 to 5 ranging from 183 to 240 mm. A single burbot fry was captured at X-14 in August and had a length of 55 mm. The lack of mature adults and fry in the catch over several survey years suggests spawning habitat downstream of the assessment area. If this is the case then juveniles likely migrate upstream from downstream spawning sites to rear in the upper reaches of Rose Creek that would include the assessment area. Their wide distribution and low catch numbers, as was the case in previous assessments, suggest continued stability in use as rearing habitat of juvenile populations in the assessment area (Appendix B, Tables 7 and 8).

4.2.2.3 Slimy Sculpin

Slimy sculpin are widely distributed throughout the Yukon. Slimy sculpin spawn in the early spring after water temperatures rise above 4° C (McPhail 2007). Nest cavities are excavated under rocks by adult males who also guard the nest. Eggs are adhesive and stick to the underside of rocks. Upon hatching fry can be found along stream edges in quiet water. Slimy sculpin are carnivorous and feed on a wide variety of aquatic organisms. Little is known of their movements although they are thought to be mostly non-migratory.

Slimy sculpin fry were captured or observed in reaches 1, 3, 4, and X-14 indicating some spawning success. The highest densities were found in Reach 2 where 32 were captured ranging in size from 29 – 96 mm. Adults were captured in all study reaches. The lowest capture rates were in reaches 4, 5, and X-14. It was noted that in Reach 3 very few were captured below the confluence with the North Tributary. The high sediment input from the North Tributary may have had an impact on the relative abundance of slimy sculpin in those immediate reaches downstream. However, their continued wide distribution throughout the reaches and similar catch statistics compared to previous assessments suggest some stability of slimy sculpin populations in the assessment area (Appendix B, Tables 7 and 8).

5.0 SUMMARY

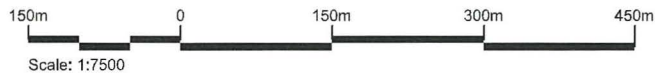
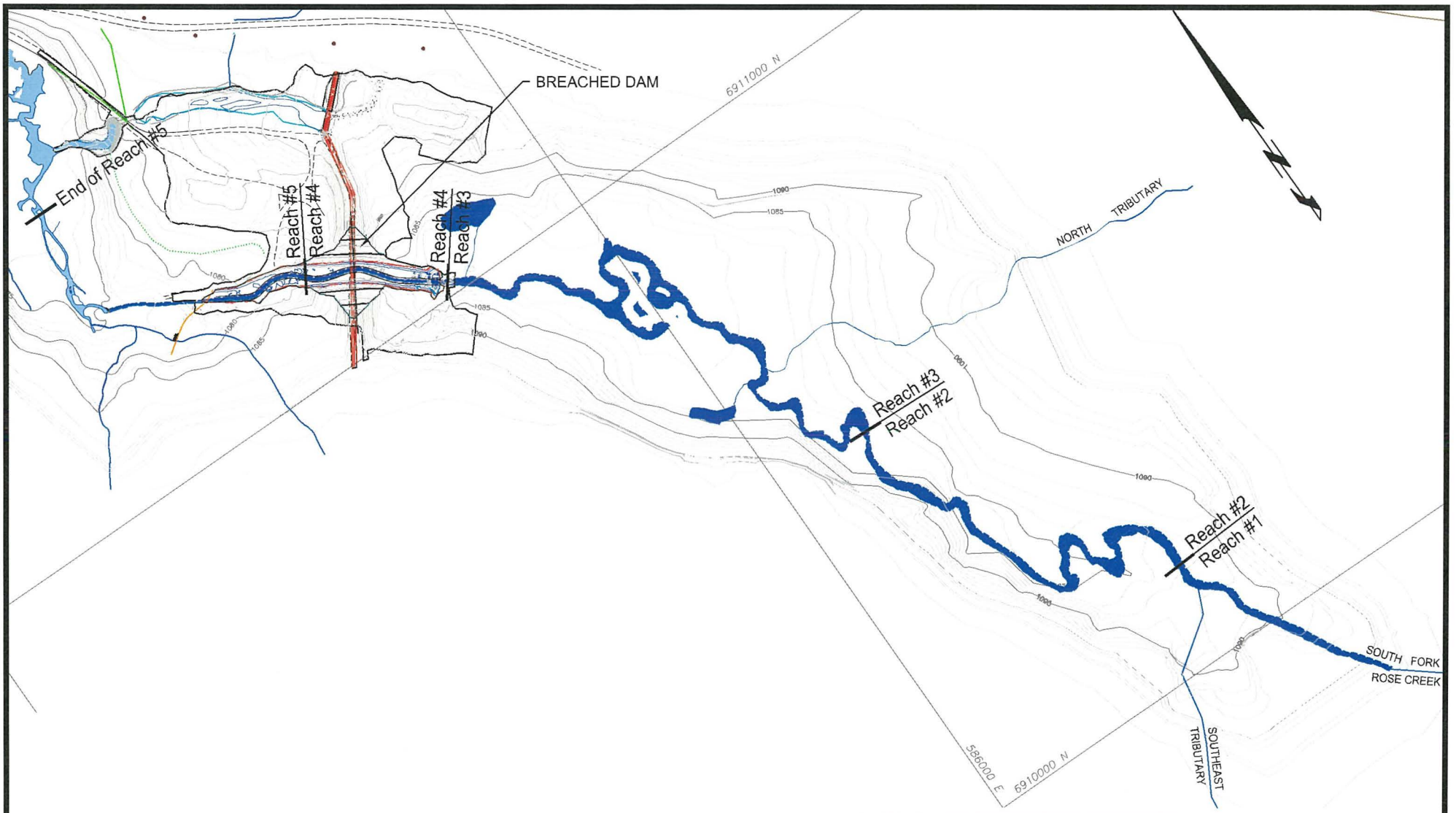
Overall, good quality fish habitat can be located in all the surveyed reaches. No barriers to the movement of fish were found in the reaches studied. Some of the best pool habitat was in Reach 3 where numerous Arctic grayling adults, juveniles and fry were observed. Considering Reaches 1 to 4 have only recently been established, the utilization of habitat in each by at least three fish species indicates excellent colonization. Further, the capture of fry in some of these reaches suggests habitat use for spawning by both Arctic grayling and slimy sculpin. While fish densities have remained relatively low based on fish capture results over several years of fish monitoring at these sites, there has been little change in the distribution of species or assemblage between reaches.

Catch and effort statistics for the various reaches in 2007 were comparable to previous survey results with differences likely attributable to year to year fluctuations in abundance and catch rather than habitat specific variables (Appendix B, Tables 7 and 8). None-the-less, products of erosion such as those originating from retrogressive erosion of the North Tributary and observed fine sediment deposition in the lower sections of Reach 3 and throughout reaches 4 and 5 is likely hindering the process of colonization by fish. Fine sediment can impact the porosity and permeability of the substrate, impede algae and periphyton growth, and cause a decline in both the abundance and diversity of benthic organisms that are the primary food source for grayling and slimy sculpin (McPhail 2007).

Arctic grayling, slimy sculpin and burbot have historically been documented in the freshwater reservoir prior to dewatering and in the South Fork of Rose Creek (Gartner Lee Ltd, 2003). The presence of these three species since dewatering indicates success in the re-establishment of the channel and habitat in the South Fork of Rose Creek.

6.0 REFERENCES

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<i>Laberge</i> ENVIRONMENTAL SERVICES		
Assessed Reaches of the South Fork of Rose Creek in the Dewatered Freshwater Reservoir		
January 19, 2008		Figure 1

APPENDIX A
SITE PHOTOGRAPHS, 2007



Photo #1: An area of bank erosion in Reach #1, July 25, 2006.



Photo #2: A year later shows little, if any, lateral channel movement in this area, August 15, 2007.



Photo # 3: Angling in large pool in upper reach of Reach #2. Evidence of past erosive activity just upstream of the pool. June 6, 2007.



Photo #4: Retrogressive erosion of the North Tributary over and through loose soils and silt of the valley floor. June 5, 2007.



Photo #5: The North Tributary carving a channel through the reservoir to the South Fork of Rose Creek, June 5/07.



Photo # 6: Formation of an elevated bar in the lower reach of the North Tributary, June 5, 2007.



Photo #7: Sediment deposition (fingers) in Reach #3 just downstream of the confluence with the North Tributary, June 5/07.



Photo # 8: Bank instability in Reach #3, June 5, 2007.



Photo #9 : The freshet flows have flooded into areas of the riparian zone creating new channels at constructed riffle sites in Reach #4, June 6, 2007.



Photo # 10 : Bank to bank flow in Reach #5. Looking upstream to Reach #4. June 4, 2007.



Photo #11 : An adult Arctic grayling caught in Reach #2, August 15, 2007.



Photo # 12 : A total of 26 slimy sculpin and one Arctic grayling fry were captured by electro-fishing in Reach #2, August 15, 2007.



Photo # 13 : Electro-fishing downstream of the diversion canal near X14, August 14, 2007.



Photo #14: A minnow trap set in Reach #1, June 5, 2007.

APPENDIX B
TABLES 3 TO 8

Table 3 Channel, cover and morphology characteristics from stream reaches of Rose Creek associated with the former reservoir, dam breach section and downstream from the breach construction area, August 2007.

Parameter		Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	X-14
Site	Survey Date (dd/mm/yr)	14/08/2007	15/08/2007	15/08/2007	15/08/2007	15/08/2007	15/08/2007
	Reach Length (m)	370	690	950	265	335	360
	Survey Location (UTM)	08V 05 86 359 E 69 10 168 N	08V 05 86 190 E 69 104 00 N	08V 05 85 908 E 69 110 90 N	08V 05 85 523 E 69 113 22 N	08V 05 85 300 E 69 114 22 N	08V 05 79 349 E 69 150 78 N
Channel	Ave. Channel Width (m)	6.0	8.1	8.7	8.7	4.9	13.1
	Ave. Wetted Width (m)	4.7	7.2	6.3	6.9	4.2	10.9
	Ave. Residual Pool Depth (m)	0.3	0.6	0.9	0.4	0.4	1.1
	Bankfull Channel Depth (m)	0.3	0.3	0.8	0.5	0.6	0.3
	Discharge (m ³ /sec)	0.432	0.664	--	0.613	0.554	2.039
	Gradient (%)	2.5	0.2	0.1	1.2	0.6	0.2
Cover	Cover Abundance (%)	moderate (~15)	moderate (~15)	abundant (~25)	moderate (~15)	moderate (~15)	abundant (~20)
	Dominant Cover Type	boulders and scour pools	deep pools	deep pools	Boulders	boulders	deep pools
	Subdominant Cover Type	undercut banks	undercut banks	undercut banks	deep pools	undercut banks and overhanging vegetation	large and small woody debris
	Other Cover Types Present	overhanging vegetation, small and large woody debris	boulders, overhanging vegetation, small and large woody debris	overhanging and instream vegetation, and small woody debris	Overhanging and instream vegetation, and small woody debris	instream vegetation, small woody debris, and scour pools	overhanging and instream vegetation
	LWD Frequency	Few	Few	none	None	none	few
	% Crown Closure	0	0	0	0	0	0

Table 4 Minnow trapping survey results from stream reaches of Rose Creek associated with the former reservoir, dam breach section, and downstream from the breach construction area, June and August 2007.

Site	Reach	Lift Date (dd/mm/yr)	Number of traps used	Average Soak Time (hr)	Catch		
					Arctic grayling	burbot	slimy sculpin
Former reservoir	Reach 1	06/06/07	6	24.3	0	0	2
		15/08/07	6	24.5	1	1	1
	Reach 2	06/06/07	6	23.4	0	0	3
		15/08/07	6	27.0	0	2	3
	Reach 3	06/06/07	6	21.9	0	1	0
		16/08/07	6	22.3	0	0	1
Dam breach section	Reach 4	05/06/07	6	23.5	0	1	0
		14/08/07	6	19.5	0	1	2
Downstream of breach construction area	Reach 5	15/08/07	6	23.5	2	1	0
	X-14	05/06/07	6	23.5	0	0	1
		14/08/07	6	18.3	0	0	0

Table 5 Angled and observed fish catch results from stream reaches of Rose Creek associated with the former reservoir, dam breach section, and downstream from the breach construction area, June, July (observations during the revegetation assessment) and August 2007.

Site	Reach	Date (dd/mm/yr)	Angled or Observed	
			Arctic grayling	slimy sculpin
Former reservoir	Reach 1	15/08/07	-	2 adults and fry
	Reach 2	24/07/07	Several adults	-
		15/08/07	7 adults and 2 juveniles	3 adults
	Reach 3	24/07/07	Several fry	-
		15/08/07	8 adults and numerous fry	-
		16/08/07	10 adults and numerous fry	-
Dam breach section	Reach 4	14/08/07	-	3 adults and fry
Downstream of breach construction area	X-14	04/06/07	1 adult and 2 sub-adults	-
		05/06/07	1 adult and 12 sub-adults	-
		14/08/07	2 adults	3 adults

Table 6 Electro-fishing survey results from stream reaches of Rose Creek associated with the former reservoir, dam breach section, and downstream from the breach construction area, August 2007.

Site	Reach	Date (dd/mm/yr)	Shock time (sec)	Catch		
				Arctic grayling	burbot	slimy sculpin
Former reservoir	Reach 1	15/08/07	716	1	0	7
	Reach 2	15/08/07	725	1	0	26
	Reach 3	16/08/07	745	10	0	17
Dam breach section	Reach 4	14/08/07	791	6	1	3
Downstream of breach construction area	Reach 5	16/08/07	717	8	0	5
	X-14	14/08/07	728	6	1	2

Table 7 Comparison of electro-fishing results from August sampling of stream reaches of Rose Creek associated with the former reservoir, dam breach section, and downstream from the breach construction area, 2004 to 2007.

Site	Reach	Species	Total Catch (capture/100 sec)			
			2004 ¹	2005 ¹	2006 ¹	2007 ²
Former reservoir	1	Arctic grayling	1.00	1.84	0.30	0.14
		burbot	0.36	0.12	0.10	0
		slimy sculpin	0.68	0.86	0.64	0.98
	2	Arctic grayling	0.23	0.24	0	0.14
		burbot	0	0	0	0
		slimy sculpin	4.28	3.30	7.11	3.59
	3	Arctic grayling	0.26	0.07	0	1.34
		burbot	0.58	0.21	0.03	0
		slimy sculpin	2.02	5.50	4.22	2.28
Dam breach section	4	Arctic grayling	1.28	0.28	0.06	0.75
		burbot	0.37	0.14	0.06	0.13
		slimy sculpin	0.64	0.14	0.49	0.40
Downstream of breach construction area	5 ²	Arctic grayling	2.96	5.13	2.00	1.12
		burbot	0.23	0	0	0
		slimy sculpin	0.56	1.84	3.41	0.70
		round whitefish	0	0.17	0.41	0

¹ based on 2 pass block net electrofishing technique

² based on 1 pass electro-fishing technique

Table 8 Comparison of minnow trapping results from combined June and August sampling of stream reaches of Rose Creek associated with the former reservoir, dam breach section, and downstream from the breach construction area, 2004 to 2007.

Site	Reach	Species	Total Catch (capture/trap/24 hr)			
			2004	2005	2006	2007
Former reservoir	1	Arctic grayling	0	0.62	0	0.08
		burbot	0.12	0.07	0.09	0.08
		slimy sculpin	0.12	0.21	0	0.25
	2	Arctic grayling	0.12	0.08	0	0
		burbot	0.06	0.17	0.42	0.18
		slimy sculpin	0	0.08	0	0.53
	3	Arctic grayling	0	0.19	0	0
		burbot	0	0.09	0	0.08
		slimy sculpin	0.06	0	0	0.08
Dam breach section	4	Arctic grayling	1.04	0.65	0	0
		burbot	0	0.20	0	0.15
		slimy sculpin	0	0	0.10	0.15
Downstream of breach construction area	5	Arctic grayling	0.15	0.17	0	0.33
		burbot	0.14	0.17	0.20	0.16
		slimy sculpin	0	0	0	0
	X-14	Arctic grayling	0	0.08	0	0
		burbot	0.14	0	0	0
		slimy sculpin	0.14	0	0	0.07

APPENDIX C
FISH DATA, 2007

Capture Location	Date	Capture Method	Species	Length (mm)	Weight (mm)
Reach 1	15-Aug-07	Electro-fishing	Arctic Grayling	88	6.1
Reach 1	15-Aug-07	Minnow trapping	Arctic Grayling	115	14.0
Reach 1	15-Aug-07	Minnow trapping	Burbot	222	49.6
Reach 1	15-Aug-07	Electro-fishing	Slimy Sculpin	35	0.7
Reach 1	15-Aug-07	Electro-fishing	Slimy Sculpin	36	0.6
Reach 1	15-Aug-07	Electro-fishing	Slimy Sculpin	38	0.9
Reach 1	15-Aug-07	Electro-fishing	Slimy Sculpin	51	1.4
Reach 1	15-Aug-07	Electro-fishing	Slimy Sculpin	54	1.3
Reach 1	15-Aug-07	Minnow trapping	Slimy Sculpin	55	1.3
Reach 1	06-Jun-07	Minnow trapping	Slimy Sculpin	56	1.8
Reach 1	15-Aug-07	Electro-fishing	Slimy Sculpin	56	1.9
Reach 1	06-Jun-07	Minnow trapping	Slimy Sculpin	58	1.8
Reach 1	15-Aug-07	Electro-fishing	Slimy Sculpin	60	2.2
Reach 1	15-Aug-07	Electro-fishing	Slimy Sculpin	64	2.7
Reach 1	15-Aug-07	Electro-fishing	Slimy Sculpin	65	2.5
Reach 1	15-Aug-07	Electro-fishing	Slimy Sculpin	66	3.8
Reach 1	15-Aug-07	Electro-fishing	Slimy Sculpin	66	2.7
Reach 1	15-Aug-07	Electro-fishing	Slimy Sculpin	67	2.5
Reach 1	15-Aug-07	Electro-fishing	Slimy Sculpin	75	4.2
Reach 1	15-Aug-07	Observation	Slimy Sculpin (2 adults and fry)		
Reach 2	15-Aug-07	Electro-fishing	Arctic Grayling	44	0.9

Capture Location	Date	Capture Method	Species	Length (mm)	Weight (mm)
Reach 2	15-Aug-07	Angling	Arctic Grayling	350	-
Reach 2	15-Aug-07	Observation	Arctic Grayling (6 adults and 2 juveniles)		
Reach 2	24-Jul-07	Observation	Arctic Grayling (several adults)		
Reach 2	15-Aug-07	Minnow trapping	Burbot	209	36.2
Reach 2	15-Aug-07	Minnow trapping	Burbot	225	56.4
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	29	0.3
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	32	0.3
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	34	0.5
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	35	1.2
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	35	0.4
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	35	0.3
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	36	0.6
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	36	0.3
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	36	0.4
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	37	0.6
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	37	0.4
Reach 2	06-Jun-07	Minnow trapping	Slimy Sculpin	38	0.5
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	39	0.6
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	39	0.6
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	39	0.5
Reach 2	06-Jun-07	Minnow trapping	Slimy Sculpin	45	1.2

Capture Location	Date	Capture Method	Species	Length (mm)	Weight (mm)
Reach 2	06-Jun-07	Minnow trapping	Slimy Sculpin	55	1.5
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	56	2.2
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	59	2.1
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	59	1.9
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	59	2.0
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	60	2.7
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	63	2.4
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	65	2.8
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	65	2.6
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	66	3.2
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	66	2.8
Reach 2	15-Aug-07	Minnow trapping	Slimy Sculpin	74	4.0
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	78	4.0
Reach 2	15-Aug-07	Electro-fishing	Slimy Sculpin	86	7.3
Reach 2	15-Aug-07	Minnow trapping	Slimy Sculpin	90	8.1
Reach 2	15-Aug-07	Minnow trapping	Slimy Sculpin	96	8.3
Reach 2	15-Aug-07	Observation	Slimy Sculpin (3 adults)		
Reach 3	16-Aug-07	Electro-fishing	Arctic Grayling	37	0.7
Reach 3	16-Aug-07	Electro-fishing	Arctic Grayling	44	0.5
Reach 3	16-Aug-07	Electro-fishing	Arctic Grayling	45	0.5
Reach 3	16-Aug-07	Electro-fishing	Arctic Grayling	46	1.0

Capture Location	Date	Capture Method	Species	Length (mm)	Weight (mm)
Reach 3	16-Aug-07	Electro-fishing	Arctic Grayling	47	0.3
Reach 3	16-Aug-07	Electro-fishing	Arctic Grayling	47	1.1
Reach 3	16-Aug-07	Electro-fishing	Arctic Grayling	50	1.3
Reach 3	16-Aug-07	Electro-fishing	Arctic Grayling	52	1.6
Reach 3	16-Aug-07	Electro-fishing	Arctic Grayling	53	1.3
Reach 3	16-Aug-07	Electro-fishing	Arctic Grayling	55	1.3
Reach 3	16-Aug-07	Observation	Arctic Grayling (10 adults and schools of fry)		
Reach 3	16-Aug-07	Observation	Arctic Grayling (7 adults, 2 juveniles)		
Reach 3	15-Aug-07	Observation	Arctic Grayling (8 adults and 2 schools of fry)		
Reach 3	24-Jul-07	Observation	Arctic Grayling (fry)		
Reach 3	06-Jun-07	Minnow trapping	Burbot	220	50.0
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	15	0.2
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	33	0.5
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	35	0.4
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	36	0.9
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	36	0.8
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	37	0.8
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	39	0.8
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	40	0.8
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	40	0.8
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	40	0.8

Capture Location	Date	Capture Method	Species	Length (mm)	Weight (mm)
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	41	0.4
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	41	0.9
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	43	0.9
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	45	0.8
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	61	2.7
Reach 3	16-Aug-07	Minnow trapping	Slimy Sculpin	70	4.0
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	70	3.3
Reach 3	16-Aug-07	Electro-fishing	Slimy Sculpin	74	3.7
Reach 3	16-Aug-07	Observation	Slimy Sculpin (4 adults)		
Reach 4	14-Aug-07	Electro-fishing	Arctic Grayling	34	0.4
Reach 4	14-Aug-07	Electro-fishing	Arctic Grayling	41	0.7
Reach 4	14-Aug-07	Electro-fishing	Arctic Grayling	43	1.0
Reach 4	14-Aug-07	Electro-fishing	Arctic Grayling	43	0.8
Reach 4	14-Aug-07	Electro-fishing	Arctic Grayling	44	1.0
Reach 4	14-Aug-07	Electro-fishing	Arctic Grayling	65	2.6
Reach 4	14-Aug-07	Minnow trapping	Burbot	183	28.5
Reach 4	05-Jun-07	Minnow trapping	Burbot	210	34.8
Reach 4	14-Aug-07	Electro-fishing	Burbot	240	62.1
Reach 4	14-Aug-07	Minnow trapping	Slimy Sculpin	58	1.9
Reach 4	14-Aug-07	Minnow trapping	Slimy Sculpin	65	2.9
Reach 4	14-Aug-07	Electro-fishing	Slimy Sculpin	74	3.9

Capture Location	Date	Capture Method	Species	Length (mm)	Weight (mm)
Reach 4	14-Aug-07	Electro-fishing	Slimy Sculpin	83	6.7
Reach 4	14-Aug-07	Electro-fishing	Slimy Sculpin	111	15.1
Reach 4	14-Aug-07	Observation	Slimy Sculpin (3 adults or juveniles and fry)		
Reach 5	16-Aug-07	Electro-fishing	Arctic Grayling	52	1.4
Reach 5	16-Aug-07	Electro-fishing	Arctic Grayling	54	2.1
Reach 5	16-Aug-07	Electro-fishing	Arctic Grayling	56	1.9
Reach 5	16-Aug-07	Electro-fishing	Arctic Grayling	57	1.7
Reach 5	16-Aug-07	Electro-fishing	Arctic Grayling	60	2.2
Reach 5	15-Aug-07	Minnow trapping	Arctic Grayling	62	1.9
Reach 5	15-Aug-07	Minnow trapping	Arctic Grayling	62	1.9
Reach 5	16-Aug-07	Electro-fishing	Arctic Grayling	62	2.5
Reach 5	16-Aug-07	Electro-fishing	Arctic Grayling	107	14.0
Reach 5	16-Aug-07	Electro-fishing	Arctic Grayling	230	162.0
Reach 5	15-Aug-07	Minnow trapping	Burbot	215	48.9
Reach 5	16-Aug-07	Electro-fishing	Slimy Sculpin	47	1.2
Reach 5	16-Aug-07	Electro-fishing	Slimy Sculpin	66	3.3
Reach 5	16-Aug-07	Electro-fishing	Slimy Sculpin	66	2.7
Reach 5	16-Aug-07	Electro-fishing	Slimy Sculpin	83	6.4
Reach 5	16-Aug-07	Electro-fishing	Slimy Sculpin	89	6.8
X-14	14-Aug-07	Electro-fishing	Arctic Grayling	56	1.7
X-14	14-Aug-07	Electro-fishing	Arctic Grayling	120	9.4

Capture Location	Date	Capture Method	Species	Length (mm)	Weight (mm)
X-14	05-Jun-07	Angling	Arctic Grayling	125	17.5
X-14	05-Jun-07	Observation	Arctic Grayling (1 adult and 12 sub adults)		
X-14	04-Jun-07	Observation	Arctic Grayling (1 adult and 2 sub adults)		
X-14	14-Aug-07	Observation	Arctic Grayling (2 adults)		
X-14	14-Aug-07	Electro-fishing	Burbot	55	1.6
X-14	05-Jun-07	Minnow trapping	Slimy Sculpin	11	0.2
X-14	14-Aug-07	Electro-fishing	Slimy Sculpin	29	0.4
X-14	14-Aug-07	Electro-fishing	Slimy Sculpin	48	1.2
X-14	14-Aug-07	Electro-fishing	Slimy Sculpin	50	1.5
X-14	14-Aug-07	Electro-fishing	Slimy Sculpin	65	2.9
X-14	14-Aug-07	Electro-fishing	Slimy Sculpin	66	3.3
X-14	14-Aug-07	Electro-fishing	Slimy Sculpin	74	3.3

