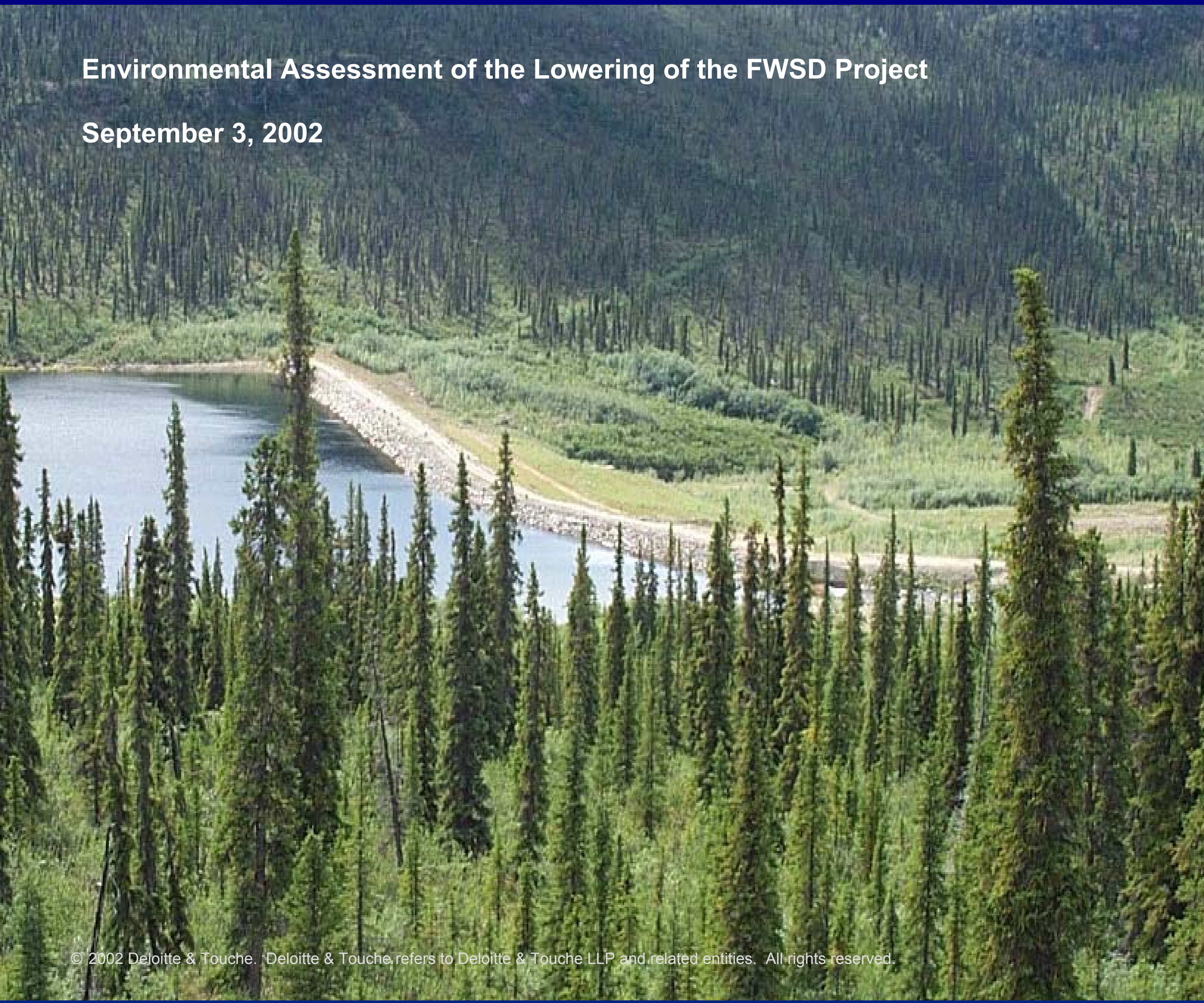
Deloitte & Touche

Anvil Range Mining Corporation
Interim Receivership



Environmental Assessment of the Lowering of the FWSD Project

September 3, 2002

Deloitte & Touche

Environmental Assessment
of the
Lowering of the Fresh Water Supply Dam Project

Submitted by Deloitte & Touche Inc.
in its capacity as Interim Receiver of

Anvil Range Mining Corporation

September 2002

Produced with the assistance of:

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and

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1. INTRODUCTION

1.1. Purpose

The mine of the Anvil Range Mining Corporation ("Anvil Range"), located in Faro, Yukon, ceased operations in January 1998 when the company filed for creditor protection under the Companies' Creditor Arrangement Act (CCAA). Deloitte & Touche Inc. (D&T) was appointed Interim Receiver ("Interim Receiver") of Anvil Range pursuant to an order of the Ontario Court (General Division) on April 21, 1998. D&T has overseen the management of the property under the terms of the water licences since that time. One of the main responsibilities of the Interim Receiver as specified under the appointment order was to “receive, preserve, protect and realize upon the Assets". Further, the court order requires D&T to "apply for any permits, licences, approvals or permissions on behalf of the Corporations as may be required by any government or regulatory authority".

D&T has worked closely with the Department of Indian and Northern Affairs Canada (“DIAND”) throughout the planning and execution of activities at the mine site.

As part of its mandate, the Interim Receiver is responsible for the ongoing care and maintenance of the property as required under the existing Water Licences (Water Licence QZ95-003 applies to the Faro Mine Site). Investigations of the Fresh Water Supply Dam (FWSD) over the past few years have indicated a considerable risk of dam failure. In order to mitigate this risk the Interim Receiver has developed the following work plan:

- Lowering the water in the Fresh Water Supply (FWS) Reservoir by 6 m (to 1090 m above sea level (ASL).
- Modifying the existing spillway to maintain the Reservoir’s normal full pool at 1090 m ASL with work to be completed in the fall of 2002. (Phase 1).
- Conducting further investigations of the low-level pipe (on-going).
- Initiating appropriate mitigation works to stabilize the low-level pipe with this work to be completed in 2003 (Phase 2).

The purpose of this document is to provide the necessary information to the Federal Department of Fisheries and Oceans (DFO) so that it may carry out a screening level review of the project as required under the Canadian Environmental Assessment Act (CEAA). The following sections include:

- A history of the Fresh Water Supply Reservoir.
- A rationale for the project including a review of alternatives and a risk assessment associated with the alternatives.
- A project description with specific details of the Phase 1 construction of the spillway.
- A description of the scope of the assessment.
- A review of existing environmental conditions.
- An assessment of environmental effects and proposed mitigation measures including a review of possible accidents and malfunctions and an assessment of cumulative effects.
- Potential options for compensation where necessary.
- A final review of the significance of any residual effects.
- An environmental monitoring and follow up program.

1.2. Mine History

The Anvil Range Mining Complex is located in the central Yukon approximately 200 km NNE of Whitehorse. Access is from the town of Faro (Figure 1.), located approximately 25 km by road to the south.

The mine complex consists of two mine sites, Faro and Vangorda Plateau. The original open pit mining and all milling and tailings deposition have taken place on the Faro mine site. Two additional open pits are located on the Vangorda Plateau mine site but no milling or tailings deposition have taken place there. The two mine sites are connected by a heavy haul road, which was used to truck ore from the Vangorda Plateau to the Faro mill. Lead and zinc concentrate and small quantities of silver and gold were the minerals of economic importance.

Fresh water is diverted around various mine facilities in four diversion channels: the Faro Creek/Faro Valley Diversion channel, the North Wall Interceptor Ditch, the North Fork diversion and the Rose Creek Diversion Canal. These channels were constructed to various design parameters. The largest channel is the Rose Creek Diversion Canal that passes Rose Creek around the tailings facility.

The Faro mine site consists of two open pits (one back-filled), rock dumps, the Rose Creek tailings facility, the FWSD and Reservoir, a number of watercourse diversions, a pumphouse, a mill, administration and maintenance buildings and water treatment facilities (Figure 2.).

The Faro Main pit was mined from 1969 to 1992. During that time, mill tailings were deposited into three surface impoundments in the Rose Creek valley: the Original, Second and Intermediate Impoundments. In total, these surface impoundments hold an estimated 54.4 million tonnes of tailings. The tailings are up to 25 metres thick and overlie native soils consisting largely of sand and gravel.

There are four water retention dams on the mine site: the FWSD that retains the FWS Reservoir in the South Fork of Rose Creek, the Intermediate Dam that retains tailings solids and non-compliant run off water, the Cross Valley Dam that retains compliant water and lime treatment sediments (polishing pond) and the Pumphouse Pond Dam that retains clean water for pump intake (historical use).

The following will focus on the FWSD and Reservoir. For details on the other components of the Faro Mine please refer to the Anvil Range Mining Corp. Project Description, Volume 1, May 2002 (Anvil Range Mining Corp. 2002a).

Figure 1. Project Location Map

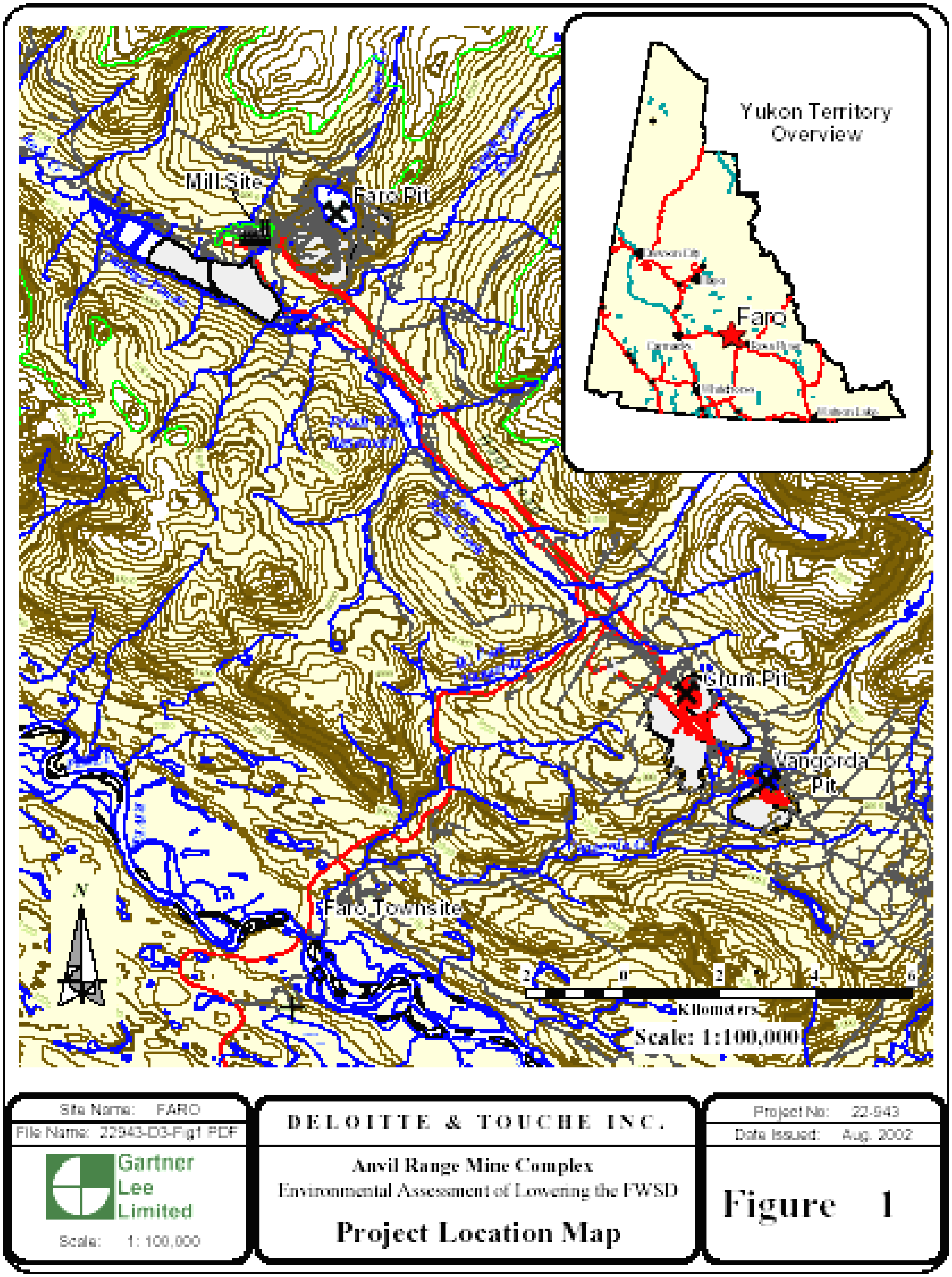
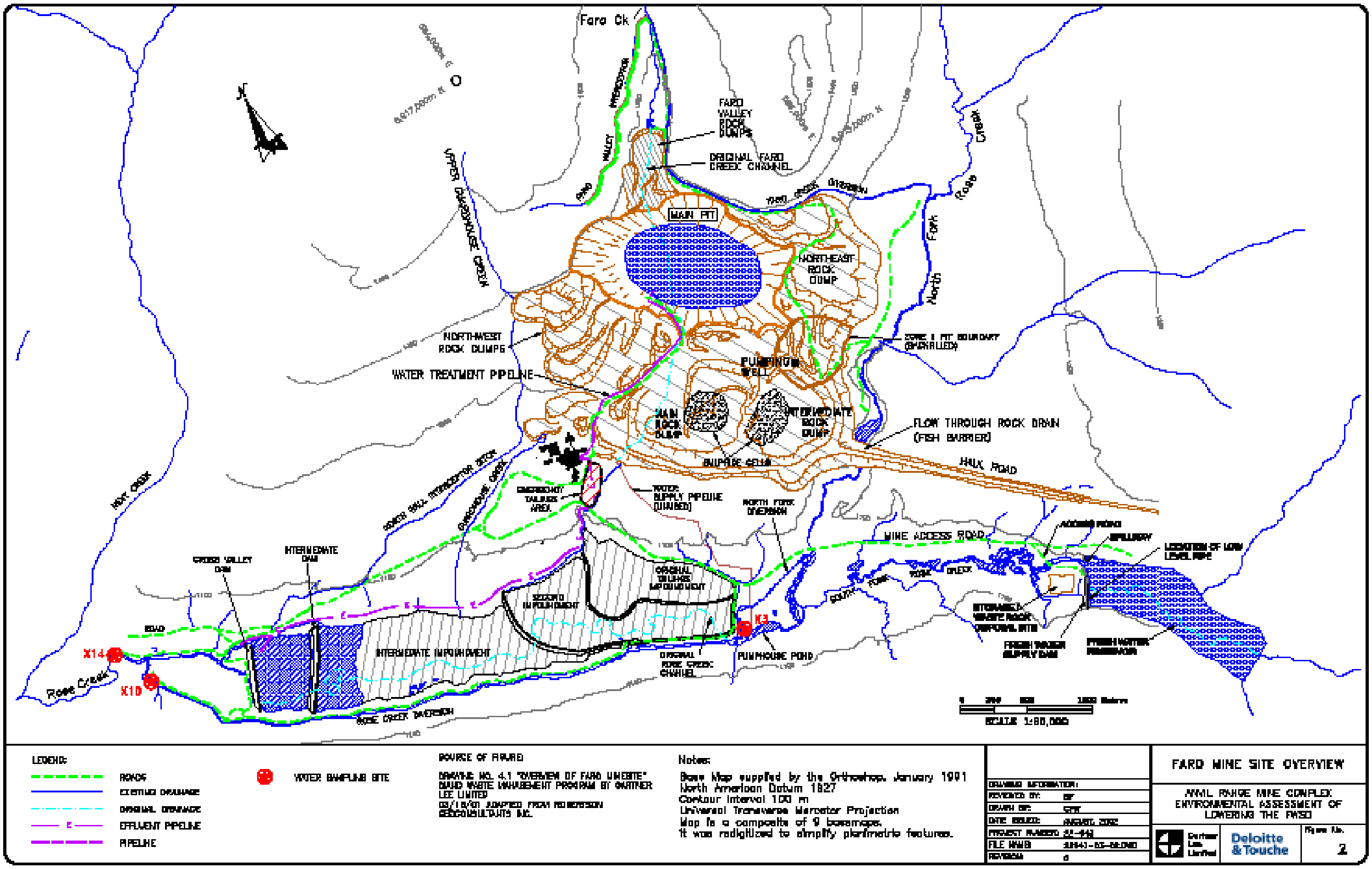


Figure 2. Faro Mine Site Overview



1.3. FWSD History - Construction and Operation

The FWSD and Reservoir are original mine structures that were required prior to 1997 to provide water for ore processing. The Reservoir was used to store fresh water for use in the milling process through the winter season. A recycle water system constructed in 1997 replaced the Reservoir as the primary supply of water to the processing plant. The Reservoir is not required for the current care and maintenance activities and would not be required for future mine operations.

The FWSD was constructed in 1969 by the prime consultant H.A. Simons International Ltd., supported by the geotechnical consulting company of Ripley, Klohn and Leonoff Ltd. Immediately after construction, a small toe berm was placed due to concerns regarding seepage and related cracking at the toe. Following a stability assessment by Golder Associates in 1989, another toe berm lift, including toe drainage measures, was placed for enhancement of the downstream face stability, and in response to concerns over the seismic stability of the dam.

The FWSD is a zoned, earthfill dam, approximately 410 m long, 20 m high at its highest point and 6 m wide at the crest. The slope of the upstream face of the dam is approximately 2.5H:1V and 2H:1V on the downstream face.

Water is released from the Reservoir by two means: an overflow spillway located on the crest of the dam near the north abutment and a low-level outlet pipe, which runs through the base of the dam near the south abutment at an elevation of approximately 1081 m ASL.

The overflow spillway is located near the north abutment of the dam and consists of a 30 metre wide concrete structure with 3.2 m high wing walls. The elevation of the crest of the dam is 1099 m ASL and the current spillway elevation is 1096.09 m ASL. The spillway discharges its water into the south fork of Rose Creek via a discharge channel excavated through rock and overburden. Discharge from the spillway then passes through two culverts situated under the access road.

The low-level outlet pipe (42-inch diameter) runs through the base of the dam near the south abutment. The system is composed of a submerged drop inlet pipe, 1066.8 mm in diameter, with outlet control valves. The valve house is located within an excavated channel along the south abutment downstream from the toe of the dam. The flow is then directed into an excavated channel , which flows into the natural Rose Creek channel. In 1984 it was determined that the pipe was capable of passing a flow of 0.91 m^3/s however, it appears that it normally discharged flows between 0.075 and 0.1 m^3/s.

The FWS Reservoir is located on the South Fork of Rose Creek. From the FWSD, Rose Creek flows approximately 21 km before entering Anvil Creek, which is another 29 km downstream to the Pelly River. The Pelly River / Anvil Creek confluence is located approximately 52 km downstream of the Town of Faro. Approximately 2.5 km downstream of the FWSD is the upper most extent of the tailings impoundment facilities, which are also situated in the Rose Creek Valley. As mentioned above, two dams in the Rose Creek Valley contain tailings and runoff water from the mill site and surrounding rock dumps: The Intermediate Dam, located approximately 5.7 km downstream of the FWSD and the Cross Valley Dam which is further 0.5 km downstream. Rose Creek has been placed in a diversion approximately 4.8 km long along the south side of the valley to pass flows around the tailings impoundment facility. No mining structures were built and no mining activity took place upstream of the FWSD.

The FWS Reservoir is approximately 1454 m long with an average width of 315 m and an average depth of 8 m. There are three tributaries, identified on the 1:50,000 NTS topographic map, which flow into the Reservoir. The largest is the main channel of the South Fork of Rose Creek. Two smaller tributaries are located near the east end of the Reservoir.

Prior to 1997, mine operations required approximately 0.4 m^3/s of fresh water to operate the concentrator plant. During the spring, summer and fall months Rose Creek contained sufficient flows to meet the demand of the concentrator and provided the flow downstream of the mine required by the Water Licence. The Faro Water Licence (QZ95-003) requires that a minimum flow of 4.5 m^3/min (0.075 m^3/s) be maintained in the Rose Creek diversion canal for fisheries and conservation purposes. However, creek flows in the winter months were not adequate to meet both obligations. The FWSD was built in 1969 in order to store sufficient water to meet the mine requirements and the fish flow requirements over the winter months. The maximum volume of water required to meet the water licence requirement for flows in the Rose Creek diversion is estimated to be 1.179 million m^3 in order to provide a flow of 0.075 m^3/s for a maximum 6 month winter period from November 1 to April 30.

Typically, the Reservoir would fill up and water would flow through the spillway from June through late fall. In 1976, steel I-beams were placed within the spillway to allow for the addition of stop logs. Stop logs were typically placed across the spillway in the fall to provide an increased water storage capacity for provision of water to the mill through the winter season. In 1999, DIAND instructed that the stop logs system be removed due to concerns that the excess water pressure caused by a higher Reservoir elevation could lead to increased seepage at the downstream toe and exacerbate cracking of the crest. No specific Reservoir elevation data was kept regarding historical normal and extreme year operating practices with respect to the Reservoir. However, it was noted that spring Reservoir levels could get very low with a drawdown of 9 to 10 m below the spillway invert on at least one occasion. The water released through the low-level pipe runs year-round and the discharge is an estimated 0.1 m^3/s during the winter months based on measurements taken during the 1999/2000 winter season.

A water recycling system was constructed in 1997 that used the mined out Faro Main pit to supply the water needs for the concentrator plant. This system went into operation in the fall of 1997 and was used until the final mine shut down in January 1998. With this system in place only a small volume of water was required from Rose Creek (less than 5% of the pre-recycling water extraction volume). Since mine closure the Reservoir has been left to fluctuate naturally with flows through the spillway for 8 to 9 months of the year and the continual release of water through the low-level outlet.

This operating history is likely to have contributed to general concerns regarding the physical condition of the dam. Significant longitudinal cracking has been documented on the upstream side of the dam crest for nearly 20 years and has been professionally investigated on two occasions. The cracking appears to be related to frost action on the upstream side and crest of the dam. Investigations by Golder Associates in 1994 traced the cracks to just less than 2 m depth while a thermistor in the crest indicates a frost penetration depth of approximately 4 m.

A recent (2001) stability assessment of the dam provided the following results, based on assumed frictional values and the measured location of the phreatic surface within the dam:

Type of Stability Analysis	Factors of Safety for the Upstream Side	Factors of Safety for the Downstream Side
Static	1.5 to 2.1	1.7 to 1.9
Pseudo-static (PGA = 0.13 g)	0.8 to 1.2	1.1 to 1.2

Based on these results, the dam appears to be stable under static conditions for the conditions and assumptions made within the assessment. However, the FWSD does not meet the minimum required Factors of Safety based on a Peak Ground Acceleration value of 0.13g, that was estimated to be the maximum design earthquake (MDE) for the structure.

1.4. FWSD Monitoring

As a condition of the Faro Water Licence for the site, annual geotechnical inspections and performance assessments of the major dams and structures in the Rose Creek Down Valley area are performed. The FWSD is instrumented with thermistors and pneumatic piezometers that are routinely monitored on a minimum twice per year basis. The monitoring results are reviewed by a qualified geotechnical engineer.

The main concerns with respect to the FWSD revolve around the following:

- The potential for piping along the low-level pipe.
- The dam is not likely adequate to resist either extreme precipitation events (e.g. Probable Maximum Flood or PMF) or seismic events (e.g. Maximum Design Earthquake or MDE).
- The presences of cracks on the crest of the dam that may extend to approximately 4 m below the crest level.

In light of the above, a number of studies were completed during 2001 in order to further assess some of the potential risks with the FWSD.

In May 2001, the engineering firm, BGC, undertook a qualitative risk assessment (termed a Failure Modes and Effects Analysis or an FMEA) of the FWSD and the other dams and structures located in the Down Valley area of Rose Creek. Within that assessment, and noting the system boundaries and the assumptions made, it was found that the FWSD did provide protection to the tailings impoundment downstream and that the highest risk identified within all the structures reviewed was the low-level pipe. In response a Dam Safety Review (DSR) compliant with the guidelines of the Canadian Dam Association (CDA), was recommended be undertaken on the FWSD, along with an inspection of the low-level pipe. The DSR fieldwork was completed in August 2002 and the final report will be issued in the fall 2002.

Diving Dynamics completed their inspection on September 18, 2001 and issued a formal report on September 25, 2001. The main concerns raised were:

- The pipe wall thickness has been significantly reduced from its original value of 9.5 mm (0.375 inch), down to values approaching 4.8 mm or a 49% reduction. Therefore, some finite life remains for the pipe.

- The presence of a five-foot bend of unknown origin in the pipe at approximately the centre of the dam over a twenty-meter section in length was noted. The bend in the pipe was measured but no concrete mechanism for its formation was determined. In addition, the entire inside of the pipe was not visually inspected due to the build-up of scaling and debris. As a result, there remains the potential risk that failure of the steel pipe and/or associated piping adjacent to it could occur.

The FWSD is located upstream of the tailings containment area described above. As a result of its location, any catastrophic release of water from the Reservoir would result in significant environmental impacts that might include sedimentation and flood disruption of aquatic habitat, as well as the breach of both the downstream Intermediate and Cross Valley dams with a resulting release of tailings solids and non-compliant water into the aquatic habitat of Rose Creek and further downstream.

With this new information and as a result of the potential risks, a defensive position was recommended to reduce the water level in the Reservoir to relieve pressure on the dam and the low-level pipe. Work began in late September 2001, utilizing siphons and later, the low level pipe to reduce the water level by approximately seven meters by January 2002. While lowering the water level in the Reservoir did relieve pressure on the dam and the low level pipe, it was recognized that the Reservoir would immediately refill to normal levels during the following spring freshet. Engineering assessments were initiated to identify various alternatives to mitigate the risk posed by the FWSD. These are described in Section 2.1.

2. PROJECT RATIONALE AND ALTERNATIVES

2.1. Alternatives for the FWSD

Various alternatives relating to reclamation of the FWSD were considered:

1. Leave low-level pipe in place and rehabilitate the dam as necessary.
2. Perform a partial breach and remediate the low-level pipe; leave a portion of the dam in place with water containment remaining upstream of the Down Valley tailings dams.
3. Perform a total breach of the dam to remove the risks associated with the dam.

Based on the engineering analyses and risk considerations described above, Alternative 2 was chosen. The rationale for not proceeding with Alternatives 1 or 3 is as follows:

- Alternative 1 - Leave the low-level pipe in its current state and rehabilitate the dam as necessary.

  Results of the qualitative assessments discussed above indicated that there is a significant risk that the FWSD will fail, and that the failure would have disastrous downstream consequences. Specifically, failure of the FWSD in its current configuration could result in overtopping and breaching of the Intermediate and Cross Valley Dams, which would in turn result in widespread contamination downstream of the mine area. That level of risk is unacceptable to the Receiver and, we believe, to other stakeholders. The more detailed risk assessments discussed below confirm the risk of downstream impacts, and show that the low level pipe is the dominant source of such risks. The Receiver believes that “stop gap” measures that do not address the low level pipe will not reduce risks to an acceptable level.

- Alternative 3 - Perform a total breach of the dam to remove the risks associated with the dam.

  The alternative of removing the dam in its entirety raises questions that can only be completely answered as part of the overall closure planning for the site. First, the presence of the FWSD (in some form) attenuates floods and can thereby play a role in the protection of the Down Valley tailings. For example, it might be possible to find a cost-effective closure scheme for the entire tailings area that relies on the presence of the dam in some form. Second, the FWSD undoubtedly provides some improvement of upstream fish habitat. Complete destruction of this habitat by removal of the dam is unlikely to be acceptable to local stakeholders, or to the DFO, in the absence of an overall site closure plan. The Receiver believes that complete removal of the FWSD deserves serious consideration as part of the Final Closure and Reclamation Plan, but that it would not be acceptable to consider this option in light of the risks identified above and the timeframe involved in making decisions around closure.

After further consideration, the geotechnical engineers advising the Receiver recommended a phased approach to Alternative 2. The phases are as follows:

- Phase I – involves the lowering of the water level in the FWS Reservoir by approximately six meters and the creation of a lowered spillway designed to handle a 1:500 flood, in the FWSD. This work phase is planned for the fall of 2002.

- Phase II – involves mitigation of the risk posed by the low-level pipe. Pending further engineering studies, it may involve the removal or the rehabilitation of the pipe. The engineering assessment will be completed in the fall / winter 2002 and the actual work will be completed in 2003.

- Phase III – involves the determination of the final configuration of the FWSD. This phase is linked to the final disposition of the tailings and the closure criteria established for the downstream structures, all of which are components of the Final Closure and Reclamation Plan, to be submitted for approval in 2006.

The project submitted for review to DFO includes both Phases I and II. It is further described in Section 3.1.

The Interim Receiver recognizes that the proposed Phase I and II would be a sunk cost if it were ultimately decided in the Final Closure and Reclamation Plan that the entire FWSD should be removed. However, the alternative of taking out the structure immediately, if this were possible both from a regulatory and technical perspective, would also be a sunk cost if it were ultimately decided that the Rose Creek Valley required flood control at its upstream end. Most importantly, the level of immediate risk requires that actions be taken as soon as possible, i.e. long before a Final Closure and Reclamation Plan can be prepared, negotiated, approved, licensed, and implemented.

2.2. Risk Assessment of Alternatives

A failure of the FWSD has the potential to mobilize tailings and other deleterious substances and wash them downstream into the lower reaches of Rose Creek and Anvil Creek, and potentially affect water quality in the Pelly River. Fish and fish habitat are found throughout these two creeks and the Pelly River. Based on mapping available for this project, there is approximately 50 km of stream length from the Faro tailings facility to the confluence of Anvil Creek and the Pelly River.

Harder & Associates (1991) provides a reach by reach summary of habitat conditions including channel width (Table 3.3 Harder & Assoc. 1991). Over the 50 km there is approximately 2 million m^2 (200 ha) of stream habitat that is known to support populations of spawning and rearing Chinook salmon and essentially providing all the habitat requirements for all life stages of Arctic Grayling, and various species of whitefish.

A risk assessment of Alternatives 1, 2 and 3 was completed to provide a more rigorous basis for selecting a preferred alternative. To more clearly show the effects of the proposed spillway lowering, only Phase 1 of Alternative 2 was considered, i.e. the subsequent remediation of the low-level pipe was not taken into consideration.

The methods, results and conclusions of the risk assessment are summarized in the following sections. Details of the assessment and the supporting calculations are provided in SRK (2002).

Risk Assessment Methods

The risk assessment considered the various failure modes associated with each of the three alternatives, estimated the probability of each failure mode occurring during the time prior to final closure of the site, and assessed the resulting downstream effects. For Alternatives 1 and 2, the primary failure modes that were considered were:

- Breaching of the dam under normal hydrologic conditions ("sunny day" conditions);
- Breaching of the dam under flood conditions; and,
- Passage of a significant flood, without breaching of the dam.

Since no dam would be present under Alternative 3, only the third failure mode was considered for that case, i.e., the passage of a significant flood.

The assessment was carried out using fault-event tree methods. The fault-event tree method allows the probability of an event to be estimated by summing the probabilities of all significant root causes. The fault-event trees for each alternative are shown in Table 1, Table 2 and Table 3. T difficult to navigate, but they do allow a tremendous amount of information to be suc portrayed. For ease of explanation, Tables 1 to 3 are colour coded.

A good starting point for an explanation of the fault-event tree method is the bright y occurring below the event tree (orange-yellow and salmon boxes) and above the fault or light green boxes). These are the major failure modes identified above. The numb portion each bright yellow box is the estimated probability that the named failure mo The probabilities are dimensionless numbers between 0 and 1, and are conditional an other words, the estimated probabilities are valid for the time period during which the conditions stay unchanged.

The area below each bright yellow box is properly termed a fault tree. In the fault tree, the probability of each failure mode (or "top fault") is estimated from consideration of various hazards or "base faults". For example, the light blue portions of Table 1 and Table 2 show how the probability of the dam breaching under "sunny day " conditions was estimated from the probabilities of various types of geotechnical failure. The light green portions show how the probability of a flood-induced breach was estimated from the probabilities of various flood events. The numbers within each box of the fault tree show the estimated or calculated probability of that event. The information used to estimate those probabilities is discussed in more detail in SRK (2002).

Briefly, the probabilities of the geotechnical failures (light blue boxes) were estimated from results of previous studies carried out by geotechnical engineers who have been associated with the project for many years:

- The probabilities of upstream and downstream slope failures were estimated from the results of slope stability calculations presented in Gartner Lee Ltd. (2001). SRK reviewed those studies and found the conclusions to be reasonable.

- The probabilities of failures associated with the low level pipe were estimated based on the experience of the SRK project team. There is no rigorous basis to calculate the probabilities associated with this type of failure, and it is common in fault tree analyses to apply expert opinion in such cases. The estimates derived by SRK were subsequently found to agree very well with those derived by the geotechnical engineers who participated in earlier qualitative risk assessments.

- As shown in the fault trees, the probability of "sunny day" failures in both the Alternative 1 and Alternative 2 cases is very similar to the probability of a failure arising from the low-level pipe. This is another way of saying the "sunny day" risks are attributable almost wholly to the low-level pipe; the slope stability risks are relatively insignificant. Furthermore, the low level pipe would be the dominant source of "sunny day" risk even if the failure probabilities derived by SRK and the earlier assessors are high by a factor of 100.

The probabilities associated with flood events (i.e. the light green and light blue boxes) were estimated from hydrologic calculations carried out using software known as DAMBRK. The DAMBRK codes were initially developed by U.S. National Weather Service, and now represent the state of the art in flood routing and dam breach models. In this case, the DAMBRK model was used only to assess the probability that the Reservoir level would exceed the crest of the dam in floods of various sizes, including the probable maximum flood or "PMF".

- The DAMBRK simulations showed that a PMF would certainly overtop the FWSD as it is currently configured, i.e. under Alternative 1, and even slightly lesser floods could overtop the dam. Those findings lead to the relatively high probability of a flood-induced breach under Alternative 1.

- In contrast, the simulations showed that the lowered spillway of the Alternative 2 dam would allow the PMF to be passed with the Reservoir level never exceeding about 4½ m below the dam crest. The only significant risk of flood-induced dam failure arises from the relatively remote possibility that the spillway would be eroded to the point where the dam could be undercut.

The portions of Table 1, Table 2 and Tab le 3 immediately above the bright yellow boxes are known as event trees. The event trees are similar to fault trees, except that they estimate the probabilities of events that derive from the top faults. The event trees are set up to follow through the answers to various questions, which are shown on the left hand side of each figure.

The first question is whether the flood wave arising from each top fault will exceed the capacity of the Rose Creek Diversion. The second question is whether the flows that escape the diversion will be sufficient to cause failure of the Intermediate Dam. The answer to both questions in all cases was determined by using the DAMBRK model. DAMBRK runs were completed to simulate breaching of the Alternative 1 dam under "sunny day" and PMF conditions.

The model estimated the amount and rate of water that would pass through the breach, and then simulated the downstream transport of that water through the wetlands, into the Rose Creek Diversion, and along the tailings area. Where the flows were sufficiently high, the model also simulated escape of the water out of the Rose Creek Diversion and into the Intermediate or Cross Valley impoundments. The key outputs of the breach and flood modeling appear as tan boxes in Table 1, Table 2 and Table 3.

- Under Alternative 1, a flood-induced breach of the FWSD will result in a very large flood wave traveling downstream. The flood wave will almost certainly exceed the capacity of the Rose Creek Diversion, and a significant flow will occur into the Intermediate Tailings Impoundment. That flow will be sufficient to inundate the impoundment and cause water levels to rise above the crest of the Intermediate Dam. The water that passes over the crest of the Intermediate Dam would likely cause down-cutting erosion that could result in a complete breach, and a significant loss of tailings downstream.

- A “sunny day” breach of the FWSD under Alternative 1 would result in a significantly lower flood wave. However, the smaller flood wave would still be difficult to contain in the Rose Creek Diversion. Water that escapes the diversion would cross the Intermediate Tailings Impoundment and pick up tailings. There would probably not be sufficient water to overtop the Intermediate Dam, but there could be an uncontrolled discharge of water, laden with dissolved zinc and suspended tailings, through the spillway and downstream.

- Under Alternative 2, a flood-induced breach would result in flows that are roughly 15% of those of the Alternative 1 flood-induced breach. The flow would be near the capacity of the Rose Creek Diversion, but would certainly not be sufficient to cause failure of the Intermediate Dam. The likely result would again be an uncontrolled discharge of water, dissolved zinc and suspended tailings through the spillway and downstream. It should be noted that the probability of a flood-induced failure is much lower under Alternative 2 than under Alternative 1, for the reasons discussed above. The probabilities shown in the flood-related orange-yellow boxes of Table 2 are correspondingly lower than those in Table 1.

- A “sunny day” breach of the Alternative 2 dam would release a flood wave that would be similar to that of the flood-induced breach, with similar consequences.

- The flows released by floods that do not breach the Alternative 1 or Alternative 2 dams are likely to be entirely contained within the Rose Creek Diversion.

If the FWSD were removed (Alternative 3), there would be no attenuation of the flood as it passes through the Reservoir area. As a result, DAMBRK predicts that flows downstream will be roughly 30% higher under Alternative 3 than under the Alternative 2. In other words, the FWSD with a lowered spillway does provide attenuation of upstream floods. Under Alternative 3, downstream flows would exceed the capacity of the Rose Creek Diversion, but probably not lead to failure of the Intermediate Dam. As was the case for the Alternative 1 “sunny day” breach and the both Alternative 2 breaches, the likely consequence would be an uncontrolled discharge of water, dissolved zinc and suspended tailings through the spillway and downstream.

Table 1. Alternative 1, FWSD as is

Table 2. Alternative 2, FWSD with Lowered Spillway

Table 3. Alternative 3, FWSD Removed

The uppermost boxes in Table 1, Table 2 and Table 3 represent the extension of the event tree to predictions of downstream impacts. Two types of impacts are considered. The upper row of orange-yellow boxes shows the probability of long-term zinc contamination due to oxidation of any tailings that are transported downstream and deposited in the flood plain. The lower row of orange-yellow boxes shows the probability of immediate toxicity to fish, caused by the release of high levels of dissolved zinc and/or suspended solids during the flood wave. The input probabilities in these cases were derived from a combination of the model outputs from Flowmaster, a 1-D network flow program (with inputs from DAMBRK), and dilution calculations. Details are provided in SRK (2002).

- The DAMBRK model outputs were reviewed to determine the likelihood that significant amounts of tailings would flow downstream. Such a flow would result only in the case of a failure of the Intermediate Dam. As discussed above, only the Alternative 1 flood-induced breach is predicted to result in a high probability that the Intermediate Tailings Dam will breach.

- In cases where the Intermediate Dam does not fail, flowrates through the Intermediate Tailings Pond were used to indicate how much tailings would be picked and carried downstream as suspended solids.

- A series of simple dilution calculations, based on average annual flows estimated in the 1996 Integrated Comprehensive Abandonment Plan (ICAP), were used to determine how far downstream the dissolved zinc and suspended solids would be above acceptable limits. A second series of similar calculations were used to estimate contaminant concentrations arising for long-term oxidation of any tailings deposited downstream.

The pale-yellow boxes in Table 1, Table 2 and Table 3 summarize the probabilities of impacts associated with each failure mode and each alternative. The percentages shown in some of the boxes indicate the percentage of the total risk contributed by each failure mode.

Results

Results of the risk assessment are summarized in Table , in terms of the probabilities of deleterious impacts along various reaches of the streams below the tailings area. To avoid the use of scientific notation, all values in the table are multiplied by 1000, i.e. this represents the probability of impact per 1000.

What is most noteworthy from the table is that Alternative 1 is clearly the most risky, in terms of potential downstream impacts, while Alternative 3 is clearly the least risky. Alternative 2 is shown to be somewhere in between the others in all cases. However, it should be noted that the “Alternative 2” considered in the risk assessment is really only Phase 1. If the Phase 2 remediation of the low level pipe were taken into consideration, the risks associated with Alternative 2 would be more similar to those estimated for Alternative 3.

The primary contributors to the risks shown in Table can be discerned from the percentages in the pale-yellow boxes in Table 1, Table 2 and Table3. Under Alternative 1, the “sunny day” and flood-induced risk contribute roughly equally to the overall risk. However, under Alternative 2, the “sunny day” risks dominate. One way to interpret these results is that Alternative 2 substantially mitigates the flood risks associated with the current FWSD. The reasons are that the lowered spillway is better able to pass extreme floods, and the amount of water impounded prior to any breach is less.

By tracing downwards through the fault-event trees, it is possible to see that the "sunny day" failure risks under both Alternatives 1 and 2 are primarily due to the low level pipe. The fact that the "sunny day" risks are lower in (Phase 1 of) Alternative 2 means that lowering of the spillway also partially mitigates the low level pipe risks. There are two mechanisms involved. First, the spillway lowering reduces the head on the pipe, and thereby reduces the risk of piping failure. Second and more importantly, the lowering of the spillway reduces the amount of water that can be impounded prior to a breach, and thereby reduces the downstream impacts.

Table 4. Summary of Risk Assessment Results

	Alternative 1 FWSD as is	**Alternative 2** FWSD with lowered spillway	**Alternative 3** FWSD removed
Probability (x1000) of short term fish kill			
Rose Creek	20	0.8	0.009
Anvil Creek	15	0.3	0.003
Pelly River	8	0.1	0.0003
Pelly Crossing	3	0.02	0.00004
Probability(x1000) of long term zinc contamination			
Rose Creek	18	0.5	0.003
Anvil Creek	8	0.2	0.002
Pelly River	0.8	0.02	0.0003
Pelly Crossing	0.15	0.002	0.00003

Conclusions

Results of the risk assessment confirm the earlier inferences that lowering of the FWSD spillway would reduce the downstream risks associated with the low level pipe. The reduction in downstream risks arise from the fact that the lowered spillway will result in less hydraulic head across the low level pipe, and less water impounded behind the dam should it breach. However, there will still be significant risks associated with the low level pipe even after the spillway is lowered. The Phase 2 remediation of the low level pipe will be needed before the risks can be further reduced.

The results also show that lowering of the FWSD spillway will lead to a significant reduction in the risks associated with floods. Under the probable maximum flood, the FWSD as it is currently configured is predicted to breach, with a resulting outflow of water that will be sufficient to escape the Rose Creek Diversions and breach the Intermediate Tailings dam. The breach of the Intermediate Dam would result in a massive release of tailings to the downstream environment. In contrast, the lowered spillway will pass the probable maximum flood and mitigate the risk of a flood-induced breach of the FWSD. The downstream flood wave may still escape the Rose Creek Diversion, but almost certainly will not breach the Intermediate Tailings Dam. The downstream consequences in this case will be limited to an uncontrolled release of dissolved zinc and suspended tailings.

The risk assessment also considered the case where the FWSD is completely removed. That case leads to the lowest overall risks. However, removal of the FWSD also removes the capacity for attenuation of upstream floods by the FWSD Reservoir. With no FWSD, extreme flood waves predicted to enter the Rose Creek Diversion will be roughly 30% greater than those predicted for cases when the FWSD is in place. These findings support the earlier inference that the final configuration of the FWSD should be decided only in conjunction with the development of the Final Closure and Reclamation Plan for the entire Down Valley area.

3. PROJECT DESCRIPTION

3.1. Overall Project (Phases I and II)

As a result of the situation described above, the Interim Receiver is planning to mitigate the risks posed by the deterioration of the low-level pipe. As described above this will be accomplished in two phases.

Phase I involves the lowering the water level in the FWS Reservoir by approximately six meters and the creation of a lowered spillway in the FWSD. This work is planned for fall 2002. Phase I is an interim measure. It is required because of the mechanics of lowering the Reservoir: it provides certainty that Phase II can be completed in a single construction season. In addition, Phase I also reduces the likelihood of different failures mechanisms of the dam, in particular:

- Potential for piping along the low-level pipe: Based on a prior risk assessment, lowering of the Reservoir will reduce the average hydraulic gradient, likely the main mechanism responsible, by 33% and hence, reduce the potential for piping. This is a risk reduction in the likelihood of a piping event occurring.

- Piping within the frost- affected zone: Based on the new, lowered spillway configuration, the pond will never again be retained within this zone of the dam, unless an event approaching the PMF size is retained. This is significant risk reduction in the likelihood of occurrence.

- Ability to handle extreme precipitation events: Based on the new lowered spillway, the additive abilities of the two spillways and the extra storage capacity behind the dam, it is now possible that the FWSD could handle the inflow of PMF event without overtopping.

The purpose of Phase II – the removal or remediation of the low-level pipe – is to meet the objective of mitigating the risk presented by the current status of the low-level pipe. It is currently the intent of the Interim Receiver to proceed with Phase II in the year immediately following Phase I. However, the further engineering studies that are now underway may conclude that the risks remaining after Phase I do not require immediate removal or rehabilitation of the low-level pipe. Specifically, the studies will determine how the reduced water volume in the Reservoir has changed the impact to the down valley structures, i.e., the Intermediate and Cross Valley Dams, and the tailings impoundments. If it is determined that the reduced volume results in an acceptable impact, e.g. that a failure resulting from the low-level pipe does not cause contaminants to be discharged into Rose Creek, Phase I may be sufficient to mitigate the risk identified.

Should the engineering assessments, show otherwise, then a study will be initiated to either remediated or remove the low-level pipe. It is therefore desirable that all Phase II options be kept open until the engineering studies are completed. Once the decision is made, the details of Phase II will be submitted to DFO and DIAND for review. Therefore, we are not able to provide details of the environmental effects of the physical works that will be required to address the low level pipe, however the environmental assessment assumes that the low level pipe is repaired or removed and the possibility of the “sunny day” failure of the low level pipe is significantly reduced.

3.2. Detailed Phase 1 Work

The Phase I work consists of lowering the spillway level of the Reservoir, and hence the head of water retained behind the dam, by approximately 6 meters. This will be achieved by constructing a new spillway through the rock abutment, which currently forms the north shoulder of the dam, and on the alignment of the existing spillway. The new spillway elevation will be at Elevation 1090 m.

Design Criteria

- A design life of the Phase I project of 10 years was selected to permit this structure to span the next proposed water licence period, expected to finish on December 31, 2008. At that time, the Final Closure and Reclamation Plan will have been submitted and approved. This will include the final disposition of the FWSD.

- The design flood is the 1:500 year flood event. This design flood was selected to be compatible with the downstream water conveyance elements (e.g., Rose Creek Diversion Channel) that are also theoretically designed for the 1:500 flood event. The compatibility is important to ensure that risk reduction at the dam does not increase the potential risks to the downstream channel structures.

- The spillway width was selected such that the Probable Maximum Flood (PMF) event Reservoir level will be at or lower than the top of the dam.

Work Plan

Initially, it was intended that this work would be carried out during February and March 2002 to ensure that a lowered spillway would be constructed prior to the spring 2002 freshet. Original construction plans were postponed however, for the following reasons:

- The site characterization (drilling) indicated that overburden had been found in a supposedly bedrock channel on the downstream side. The design implication of this finding was the need for very large riprap or gabion walls. In the case of the former, the only possible source of supply in the short term would have been on the Grum side of the property. Gabion walls on the other hand are slow to construct and were not deemed appropriate for a short construction window.

- The drilling program had also identified pockets of pyrite in the spillway, indicating potentially acid generating rocks. Laboratory analyses were underway to confirm their acid generating potential, however, as a result of the short construction window, it was impossible to delay the construction until the result were available. The implication of this finding was that waste rock would have to be potentially trucked to a suitable disposal area.

- A rushed construction project, immediately prior to the spring freshet, presented risks of exceeding the licenced limit for suspended solids in the spillway because of the “newness” of the constructed surfaces and the significant amount of overburden to cut through to the deeper part of Reservoir.

- Engineers could give no assurances as to being able to complete the construction of the spillway within the required timelines.

As a result of the above and following the review of a hydro-technical study, a construction window of the fall 2002 was selected and a bid package was issued in June 2002. The Interim Receiver received two proposals for the completion of this work and selected the firm of GAIA – Golder Associates Innovative Applications. The following provides a synopsis of the expected construction.

- Lowering of the Fresh Water Reservoir

  Two siphons, a 20” and a 24” siphon are currently in place to lower the water level in the Reservoir. Since the lowering of the Reservoir is critical in ensuring that the lowered spillway be constructed, the low-level outlet pipe has recently been opened further to assist in drawing down the Reservoir water levels. All work related to lowering of the water in the Reservoir is currently being carried out by D&T under the supervision of the Site Manager, and as such is inspected on a daily basis.

- Site Clearing

  The majority of the proposed construction area lies within the existing dam structure or within the discharge channel for the existing spillway. As such all of the upstream area lies within an area that is currently underwater and devoid of vegetation. In the area of the channel some scrub brush and small trees are present, however since rock is exposed at surface over much of this portion of the site, growth is generally sparse and of limited habitat value. Since flows in the discharge channel are intermittent, and there is no direct fisheries connection to Rose Creek downstream, it is assumed that any such vegetation would not be classified as riparian vegetation. Prior to commencing with the excavation and blasting works GAIA will clear all vegetation within the work area of the proposed channel, as well as the limited staging and material storage areas they require downstream of the Dam. Much of the area has already been cleared, or will be cleared prior to stockpiling of riprap by T. Moon. Current vegetation typically comprises scrub brush and small alder.

- Overburden Removal and Blasting

  The proposed new spillway takes the form of a large trench cut through the north shoulder of the existing Dam. Excavation of the trench requires removal of the overburden soils and blasting of the rock to permit mucking out of the blasted rock. The exact sequencing of the operations will be somewhat dependent on the time of year and the frost conditions at the time the works are completed. Provided that the overburden soils are not frozen at the time of construction GAIA will strip off much of the overburden cover to the rock to provide a graded working platform for the air-tracked rock drills. Some overburden will be left in place regardless of the frost condition, since its presence will limit the potential for fly rock hence. Where the surface soils are frozen, GAIA will drill through the soils and remove the overburden in conjunction with mucking out of the blasted rock.

All blasting will be carried out under controlled conditions to limit vibrations that will propagate through the soil and rock into the dam structure, and to a lesser extent into the waters within the Reservoir. Blasting works will start at the downstream end of the spillway furthest away from the high-risk zones within the Dam, proceeding upstream. GAIA will commence with small volume blasts to permit monitoring of shear waves and hence vibration levels. As the blast design is optimized to the site conditions and it is confirmed that vibrations are within acceptable limits for both the Dam and the surrounding environment, the sizes of individual blasts will be increased to a production level.

Blasting will commence with pre-splitting of the south face of the spillway cut. Pre-splitting is considered appropriate for this side of the cut both to facilitate the proposed 60 degree slope face, and as an attempt to lower the transmission of shear waves by the bulk excavation blasts. The effectiveness of this approach will be assessed during the initial stages of excavation, and modifications made, possibly including the use of cushion blasting with buffer rows, as considered appropriate. Bulk excavation blasts will be carried out using decked charging throughout. Decked charging incorporates the use of holes which are charged at different elevations and where the charges are sufficiently delayed so as to reduce vibrations but maintain sufficient energy levels to fracture the rock to a level suitable for excavation. GAIA will provide blast monitoring throughout the operation. It is anticipated that with the water levels drawn down to the appropriate elevations that blasting will not take place within about 80 m of the water thereby limiting any effects on the aquatic environment of the Reservoir. When work commences on the upstream side of the Dam, i.e. within 140 m of the water within the Dam, monitoring will be extended to assess possible overpressures in excess of 100kPa in the water. All appropriate measures will be taken to restrict the potential for overpressures.

- Mucking out of Blast Rock and Provision of Support Bolting

Mucking out of the blast rock and any remaining overburden soils will follow closely behind the blasting operation. Truck traffic will be restricted to the area within the proposed spillway alignment and will proceed to the designated waste sites downstream of the Dam. Mucking out will be carried out using a large excavator to supply the dump trucks. Downstream of the active blasting and excavation area GAIA will construct a sediment control pond and provide associated sediment control provisions to ensure that runoff water does not enter the wetlands and Rose Creek areas downstream of the site without first passing through a system which will remove suspended solids.

GAIA's preliminary design allows for sloped side walls to the spillway trench as opposed to the original concept of a vertical sided cut. Whilst a requirement for rock slope support is not anticipated over much of the length of the spillway, each mucking out operation will be followed by a detailed inspection by a suitably qualified geotechnical engineer to assess any bolting requirements. Where bolting is required holes will be drilled using the same air-tracked rigs as used for the blasting works to drill the holes. Rock bolts will be grouted into place using epoxy cement suitable for use under winter working conditions. All bolting and grouting work will be monitored to ensure control of silt laden runoff or grout spills. The provisions provided for the general mucking out provisions will generally be suitable but will be supplemented where appropriate.

- Placement of Filter Fabric and Reno Mattresses

  Upon completion of the blasting, mucking out and excavation of overburden soils to create the spillway trench Reno mattresses will be placed in areas where soils are exposed at surface within the trench. The mattresses in conjunction with the underlying filter fabric will provide protection against future erosion, and hence limit the potential for introduction of silt or other sediments into waters flowing through the spillway and out of the Reservoir. Rockfill for the Reno mattresses is currently being produced at the mine site and will be stockpiled for use by GAIA just downstream of the Dam. At this stage it is envisioned that Reno mattresses will be pre-filled adjacent to the stockpile area and will be transported pre-assembled to their location in the spillway channel.

- Riprap Placement

  The spillway work and placement of riprap along the upstream face of the Dam are designed to elevations 1090 and 1089 m respectively. Water levels will be reduced to 1.5 to 2.0 m below the new spillway invert of 1090 m, and maintained at that elevation or lower, to ensure that riprap placement takes place in the dry. Riprap is currently being processed by T. Moon Construction from a borrow source in the vicinity of the Grum Pit, under the review of D&T, and to gradations acceptable to GAIA. Upon completion of production, GAIA will truck the riprap to a temporary stockpile area just downstream of the FWSD for use in the proposed construction works. GAIA will load the material from stockpile, truck it along the crest of the Dam, and place it in temporary stockpiles for placement using a large tracked excavator. All riprap will be placed over a layer of filter fabric placed on suitably prepared ground.

- Pouring of Concrete Spillway Structure

  A concrete spillway structure is required at the high point of the spillway channel. The timing of this work will be determined by climatic conditions, but will be completed when water levels are at least 1.0m in elevation below the proposed works. As such, all concrete work will be completed in a confined area remote from water in the Reservoir. Normal precautions will be taken in transporting and placing concrete to ensure that no spills occur in the vicinity of active watercourses.

- Site Cleanup / As-Built Survey/ Demobilization

  Stockpiling of materials sources and deposition of excavation spoil have been designated to be within a limited footprint area in close proximity of the Dam. This will limit the work area and hence the extent of any impact from construction equipment and personnel. As the various portions of the work are completed, various work areas will be restored to the extent appropriate. An as-built survey will be completed prior to removal of all plant and personnel from the site.

- Schedule

  The anticipated schedule for this work is provided in Figure 3. The lowering of the Reservoir to 1088 m is expected to be complete by the end of September. The equipment mobilization date is the third week of October and the majority of the work being performed through November. Final site clean up and demobilization is scheduled for mid-December 2002.

Figure 3. Schedule for Lowering of Freshwater Supply Dam at Faro

4. SCOPE OF STUDY

4.1. Introduction

The preceding sections have presented the project rationale, the possible alternatives, a risk assessment associated with each alternative and a detailed description of the proposed project. The purpose of this section is to define the scope of the assessment of the proposed project. Ideally the Responsible Authority(s) (RA) would carry out a screening level review on the ultimate works associated with the final closure and reclamation of the Faro Mine site, however, as explained above, there are many options and studies to be done before a final closure plan can be prepared and submitted for approval. The only project that is sufficiently developed is the remediation of the FWSD that should be carried out in the near term to minimize the risk of significant ecological consequences that would result from the failure of the FWSD. This includes both Phase 1 - the lowering of the Reservoir and Phase 2 – the remediation or removal of the low level pipe. It should also be noted that the undertaking of the dam remediation does not commit the proponent to a specific final closure plan. The very purpose of carrying out this work is to keep all closure options open, therefore this work should be considered as separate from any future projects that may be developed in association with the Final Closure and Reclamation Plan.

In order to carry out an environmental assessment it is important to define the spatial and temporal scales that will be used as well as the approach to determining if the project will result in any significant residual effects.

4.2. Temporal Scope

This assessment will focus on the time period from the completion of the proposed work on the FWSD to 2008, the anticipated year when the Final Closure and Reclamation Plan will have been prepared, negotiated, approved, and licensed. This temporal scale is chosen to avoid trying to speculate on the final closure plan and its ultimate consequences on the environment as part of assessing the FWSD remediation work. This is particularly important in the context of the cumulative effects assessment (CEA). While we know that mine closure is scheduled to begin around 2008, at this time we do not know what works will be carried out as part of closure.

4.3. Geographic Scope

The environmental assessment will review the effects likely to occur within the Rose Creek Watershed, Anvil Creek and the Pelly River. The information available for conducting the assessment decreases in detail and quality as one moves further away from the mine site. Therefore the certainty of the assessment will also decrease further downstream of the project area. In the event of any changes in the environment that result in a socio-economic impact, local and regional areas will be considered, e.g., the Town of Faro.

4.4. Assessment Approach

The approach used here will be to first identify the interaction of project activities and the environment. Where there are interactions, they will be identified as positive, negative or neutral. For each of the interactions that have a negative effect on the environment, there will be a description of the ecosystem component(s) affected and an attempt to quantify the effect.

For each negative effect, a mitigative measure will be identified and the degree to which the mitigation measure can offset the anticipated effect will be subsequently assessed. For any effects that cannot be mitigated the report will identify options for compensating for the loss. By applying the proposed mitigation and compensation measures to the project, the final impact assessment will be completed. This will identify any residual impacts.

Following the requirements of the CEAA there must be a final determination of the significance of any adverse environmental effects. While the RA is required to carry out this assessment, the report will include a summary of residual impacts and an assessment of significance following the CEAA guidelines.

The result of the assessment of residual impacts is also required for the Cumulative Effects Assessment component of the project.

Significant adverse effects will include those environmental effects that have a magnitude that is above or approaching a legal regulatory limit or exhibit any combination of the following:

- occur relatively frequently;
- are long term in duration or in permanent effects;
- will affect a large geographic area either on-site or off the mine property; and/or
- will take a long time to recover once the effect ceases.

5. EXISTING ENVIRONMENTAL CONDITIONS

5.1. Terrain/Geology

Terrain

The physical geography of the Faro area can be broadly divided into three main areas (Bond 2001):

1. The broad, linear southeast-northwest trending Tintina Trench. The Trench is the dominant structural feature of the area and is occupied by the northward flowing Pelly River. The Pelly River floodplain has an elevation of approximately 600 mASL.

2. The upland areas of the Swim Basin and the Vangorda Plateau. The bulk of the mine facilities are located on the Plateau. The Plateau generally parallels the Tintina Trench and is drained by the Vangorda Creek watershed to the south and Rose Creek to the northwest. The Plateau ranges in elevation from 1,000 to 1,400 mASL. A ridge of hills and mountains divide the Plateau from the Tintina Trench, most significant of these is Sheep Mountain to the southeast and Faro Peak to the northwest.

3. The third physiographic region is the Anvil Range Mountains. The Anvil Range is located to the northeast of the Vangorda Plateau and rises to a series of peaks over 2000 mASL. The Range is characterized by steep, U-shaped alpine valleys terminating in cirques, and shattered rock and felsenmeer above 1770 m. Major summits in the Anvil Range include Mount Mye, east of the Grum and Vangorda open pits and Mount Aho, north of the Faro Main Pit.

Surficial Geology

The landforms and surficial deposits of the Vangorda Plateau have been shaped and are attributable to the last ice age which is estimated to have existed in the Yukon between 35,000 and 10,000 years ago. The southern Yukon was covered by at least four Cordilleran (i.e. mountain) ice sheets. These glaciations, from oldest to the youngest, are named the Nansen, the Kalza, the Reid and the McConnell (Bond 2001). The landforms of the Faro area are for the most part attributed to the youngest of the Yukon glaciations, the McConnell.

Significant surficial material in the study area consists of bedrock and associated colluvium, glacial till, and glaciofluvial outwash sands and gravels. Glaciolacustarine, modern alluvial and organic deposits, are found sporadically but are not discussed in detail herein. The following discussion of surficial materials is derived from the *Quaternary geology and till geochemistry of the Anvil district, central Yukon Territory* (Bond 2001):

- **Bedrock** – bedrock and/or frost-shattered bedrock (felsenmeer) is frequently found at surface in the alpine areas of the Anvil Range. Elsewhere, mountain slopes are covered in a thin veneer of colluvium (materials derived from slope movement processes) derived from the local bedrock. Glacial deposits are relatively absent above 1,500 m, although meltwater channels were identified as high as 1,700 m. Solifluction is common above the tree line.

- **Morainal Deposits (Till)** – glacial till is poorly sorted deposits of clay, silt, sand, gravel and angular boulders, which is deposited directly from glacial ice. A thick blanket of till is found covering the Vangorda Plateau. In some locations where pre-glacial valleys existed, the till deposits can be over 100 m thick (e.g. Grum valley). Generally till deposits thin to a veneer (<1 m) along the valley walls and are generally absent above 1,500 m. Till also commonly underlies glaciofluvial deposits in areas of former meltwater drainage. The area surrounding the Grum and Vangorda Deposits is characterized by a thick till blanket overlying bedrock.

- **Glaciofluvial Deposits** – during the retreat of the glaciers, melting water derived from the decaying ice transported and deposited sand and gravel in the valley bottoms and associated lateral meltwater channels. These deposits are typically stratified to crudely stratified deposits varying from sand with some silt to cobble gravels. These materials are found as significant valley fills as in the Rose Creek valley, as kame terraces at the mouth of alpine valleys or as glacial terraces and complexes associated with the Vangorda Creek valley and the Tintina Trench. Glaciofluvial deposits host the Rose Creek aquifer, which underlies the Faro Mine tailings facility. The Faro townsite is located on a major glaciofluvial (and glaciolacustarine) terrace with a well-developed stagnant ice (i.e. hummocky terrain) glacial fluvial complex to the northwest of the townsite. The valley bottom glaciofluvial deposits are frequently covered by silts, sands and gravel derived from contemporary stream.

Geology

The stratigraphy of the Anvil District consists of regionally metamorphosed sedimentary bedrock, ranging in age from late Precambrian to Permian (approximately 900 to 250 million years ago). The degree of metamorphism ranges from moderate (schist) to low (phyllite). The lower part of the sequence, Silurian aged and earlier, as represented primarily by the Mt. Mye and Vangorda Formations, is the most important with respect to the ore bodies.

During the Cretaceous Age, the meta-sediments were intruded by the Anvil Batholith, a granitic pluton that varies in composition from granite to granodiorite to quartz monzonite. A higher degree of metamorphism is generally observed near the Anvil Batholith contact. The meta-sediment rocks dip northeast and southwest, away from the Batholith.

The Mt. Mye Formation is represented by schists, with the dominant rock type being grey, non-calcareous, weakly carbonaceous phyllite with lesser interlayered black carbonaceous phyllite and schists. Mafic meta-igneous rocks, now amphibolites, are present locally but are volumetrically minor. A white, calc-silicate and marble marker horizon occurs about 500 to 700 m below the top of the Mt. Mye Formation, which has a structural thickness of at least 2,000 m (the base is not exposed).

The Vangorda Formation is represented by light to medium grey to greenish-grey calcareous phyllites. At higher metamorphic grade (amphibolite facies), the calcareous phyllite is transformed to calc-silicate rocks. Major interbanded units in the Vangorda Formation include meta-igneous greenstone, which is more common near the top of the Formation and carbonaceous pelite. The Vangorda Formation varies from 0.5 to 2 km in apparent thickness.

5.2. Climate and Hydrology

Temperature

The Anvil (Environment Canada) climate station was located at an elevation of 1158 m ASL at the mine site. The station no longer operates but temperatures were recorded from 1967 to 1980 (RGC 1996). The mean monthly temperatures are listed in the following table:

Mean Monthly Temperatures (°C) at Anvil Climate Station (1967-1980)

Parameter	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Daily Max. Temp. (°C)	-15.1	-8.3	-5.3	2.2	9.3	16.0	17.5	15.2	9.6	1.6	-7.0	-12.6	1.9
Daily Min. Temp (°C)	-24.9	-18.8	-17.3	-8.7	-1.8	3.0	5.0	3.3	-0.9	-8.1	-16.7	-22.4	-9.0
Daily Temp. (°C)	-19.8	-13.9	-11.2	-3.2	4.0	9.9	11.5	9.5	4.6	-3.1	-11.6	0	-3.4

The 1967 to 1980 temperature normals for the Anvil station show a mean annual temperature of -3.4°C. July is the warmest month, with a mean daily temperature of 11.5°C, and January is the coldest month, with a mean daily temperature of -19.8°C. Over the period of record, temperature extremes of 29.4 and -46.1°C have been measured.

Precipitation

The mean annual precipitation (MAP) at the Faro airport station is 304.7 mm, according to the 1978-2001 data (BGC, 2002). This total comprises roughly equal proportions of rainfall and snowfall as water equivalent. The mean monthly distribution of precipitation is listed in the table below. The driest and wettest months are typically April and July, respectively, over the period of record. The greatest monthly precipitation measured over the period of record was 116.2 mm in August 2000.

Monthly Mean Precipitation (mm) at Faro Airport, Yukon (1978-2001)

Month	Mean (mm)
January	14.3
February	12.1
March	10.5
April	7.2
May	24.3
June	35.8
July	58.9
August	46.8
September	38.2
October	24.9
November	17.2
December	14.6
Annual Total	**304.7**

Snowpack

The Rose Creek snow course at the site was operated by DIAND from 1975 to 1985. The snow course was located near and at a similar elevation (1080 m) as the tailings impoundment area. The accumulation of snow at the tailings impoundment typically begins in October, and the snow has generally melted by the end of April, although in 1985 it persisted into May. At maximum snowpack in March or April the density of the snowpack is about 200 kg/m^3.

Wind

Wind data from the Faro airport indicates that the prevailing wind direction is from the southeast, following the Tintina Trench. Table 4.4 (RGC 1996) show the long-term monthly mean wind speed data collected at the Faro airport. The wind data was collected from an anemometer on a 10m tower near the airport terminal. The data is measured at each hour of the day, 365 days of the year. (dates not provided).

Lake Evaporation and Evapotranspiration

Lake evaporation refers to evaporation from a free-water surface. The rate of lake evaporation was estimated from meteorological data using a computer program known as WREVAP, which was developed by the National Hydrology Research Institute (Morton, 1985). Since no trend in lake evaporation with elevation was evident, the calculated lake evaporation at the Whitehorse airport was arbitrarily selected to represent conditions at the mine site. The average lake evaporation was determined to be 490 mm per year.

Long-term Monthly Mean of Wind Speed (m/s) at the Faro Airport

Month	Mean (m/s)
January	1.4
February	1.7
March	2.2
April	2.6
May	2.7
June	2.7
July	2.6
August	2.1
September	2.1
October	2.2
November	1.7
December	1.5

Evapotranspiration refers to evaporation from a land surface including transpiration from plants, and appears to decrease with increasing elevation. The rate of evapotranspiration was also estimated from meteorological data using a computer program known as WREVAP, developed by the National Hydrology Research Institute. As the best estimate, the calculated evapotranspiration values of 190 mm per annum, or 38% of lake evaporation, at the highest elevation station, Whitehorse airport, were adopted for the mine site. Insufficient information is available, however, to extrapolate this trend to the mine site with more than a low degree of certainty.

Hydrology

The Rose Creek watershed covers an area of approximately 340 km^2 and is a significant part of the 980 km^2 Anvil Creek watershed, which drains the southeast slopes of the Anvil Range Mountains. All of the Faro Mine site facilities are within the Rose Creek watershed.

Hydrological investigations that have been undertaken throughout the mine life have generally focused on the mine sites and their immediate receiving environments. The majority of these studies were focused on determining specific needs for the mine or its design, such as the design flood for diversion channels or the minimum size of Reservoir required to provide a reliable water supply to the Faro mill.

The streamflow-monitoring network in the vicinity of the Anvil Range Mining Complex was increased around 1990 with the installation of automatic water level recorders and by expanding the number of flow measurement stations. Further updates were made in 1996.

The Anvil Range Mining Corporation Volume II (2002b) report provides a water balance for Rose Creek. From this analysis (found in Appendix 1, Table A2) the estimated average summer flow (May to October) in the south fork was 0.96 m^3/s and the average winter flow is estimated at 0.11 m^3/s. The mean annual flow is 0.5 m^3/s. The mean annual discharge in Rose Creek where it leaves the mine site (site X14) is 1.8 m^3/s. The estimated mean annual contribution from the north fork is 1.0 m^3/s. The flow from the south fork of Rose Creek makes up close to 30% of the flow in Rose Creek as it leaves the mine site.

It appears from the water balance calculations that the release from the low level pipe contributes 100% of the flow in the south fork in winter months. This is based on the 1999/2000 winter season study that reported a consistent release of 0.1 m^3/s from the low level pipe.

There have been no records kept of flows passing through the spillway, however mine personnel have visually monitored flows during the last four years.

5.3. Vegetation and Wildlife

Vegetation

The Anvil Range Mining Complex is located within the Yukon Plateau (North) Ecoregion, in the Boreal Cordillera Ecozone (Yukon Conservation Society, 1995). The region lies within the zone of discontinuous, widespread permafrost. Depressional areas consist of peat bogs, fens and local palsas. Lowlands frequently contain hummocks and sedge tussocks. Upland areas commonly include scree slopes and steep south-facing slopes with vegetation dominated by grasses. Treeline occurs at 1350 to 1500 m ASL.

Six vegetation zones were mapped within the study area, based on the field studies and mapping undertaken by Montreal Engineering in 1975. The vegetation zones include flood plain forest, upland forest, bog forest, alpine tundra, subalpine transition, and alluvial plain shrub. The FWS Reservoir is in the alluvial plain shrub zone.

The south fork of Rose Creek and its tributaries are included in the alluvial plain shrub vegetation zone. Shrub birch, shrubby cinquefoil *(Potentilla fruiticosa*), Scouler's willow and other willow species dominate the vegetation communities in the alluvial plain shrub zone. Scattered stands of white spruce and alpine fir also occur. Dwarf shrubs consist of crowberry, Labrador tea, low-bush cranberry, dwarf dogwood, dwarf blueberry (*Vaccinium caespitosum*) and arctic willow. Herbs species include arrow-leafed senecio (*Senecio triangularis*), tall Jacob's ladder (*Polemonium acutiflorum*), sweet coltsfoot (*Petasites hyperboreus*), alpine harebell, wormwood, arctic lupine, clubmoss, common horsetail (*Equisetum arvense*), grass (*Arctagrostis* sp.) and sedges. Feathermoss may form extensive mats in the alluvial plain shrub zone. Lichens, not well represented in this zone, include *Cladonia alpina* and other *Cladonia* species.

Wildlife

Wildlife studies have been completed in the project area most of which focus on big game animals. Fannin sheep reside in the Faro area with a lambing area identified in the headwaters of the south fork of Rose Creek approximately 4.5 km to the south of the FWS Reservoir. Moose are also common in the area but no specific habitat issues have been reported in the project area.

Caribou are also in the area with the Pelly drainage area identified as winter range while alpine and sub-alpine zones of the Anvil Range are known summer range. Grizzly and Black bears have been frequently observed around the mine sites. A review of background reports including the RGC (1996) and Anvil Range Mining Corp (2002b Vol. 2) do not provide any specific details on small mammals, or birds that are found in the study area.

5.4. Water Quality

Fresh Water Supply Reservoir

The FWS Reservoir develops thermal stratification and is likely a typical dymictic lake with a spring and fall turn-over period. Temperature and dissolved oxygen data collected in July and August of 2002 (site identified on Figure 4) clearly show thermal stratification occurring around 5 - 6 m. Harder (1991) reported temperature data from the Reservoir, which showed only a weak thermal cline in the lake. Surface temperatures as high as 16° C were recorded and the bottom temperatures between 5° and 11° C have been recorded (Figure 5). Dissolved oxygen profiles are also included in Figure 5 and show that the Reservoir waters are for the most part well oxygenated. The August 2002 deep water dissolved oxygen level was below 6.5 mg/L, the lower limit considered by the CCME as optimal for cold water fish.

Water quality data collected in August 2002, indicates the lake is oligotrophic. Water samples were collected at surface and at 10 m depth on August 9, 2002 (site noted on Figure 4) for analyses of physical tests, nutrients and total metals. Results are tabulated in Table . The secchi depth reading (on both August 9 and July 26, 2002) was 5 m indicating a relatively clear waterbody. Nutrient concentrations (nitrogen and phosphorus) also support the conclusion that the Reservoir is oligotrophic.

Total metals are at low levels in the Reservoir, with many below detection and only one metal, lead exceeding the corresponding CCME guideline for freshwater aquatic life. Lead was 0.0014 mg/L at surface and 0.0012 mg/L at depth; slightly exceeding the 0.001 mg/L guideline. Much of the surrounding geology contains high levels of metals. However, the drainage flowing to the Reservoir is not within a major deposit area. As there is not available data on water quality in the South Fork of Rose Creek upstream of the Reservoir, it is not known if there are metals bound to sediment that drop out in the Reservoir or if the creek generally has the same low concentration of metals as the Reservoir.

Rose Creek

Considerable water quality data is available for several locations along Rose Creek. The water flowing into the Reservoir was monitored at two stations (SMC and SRC). Prior to 1990, station SRC was located just upstream of the FWS Reservoir. The second station (SMC) was located on Small Creek, which is a tributary of the South Fork of Rose Creek. Both of these stations were sampled by mine staff in the early 1970's and in 1989 and 1990. However, there is some question about these data as there appear to be some errors in the data set, specifically, the values for the dissolved metal concentrations exceed the values for the total metal concentrations. Generally, water at these sampling stations is alkaline (~ 8 pH units). The average alkalinity was 33.9 mg/L for SRC (which drains granitic rocks) and 215 mg/L for SMC. Total sulphate and zinc concentrations were low at both sampling stations ranging from 4 to 47 mg/L and 0.002 to 0.029 mg/L, respectively.

There are also two sample stations on the Rose Creek Diversion Channel. The first, referred to as station X3, is located at the upstream end of the channel and the second, X10, is located at the downstream end of the diversion channel (Figure 2). Station X3 includes all flow from the North and South Forks of Rose Creek except for some partial North Fork flow at times when the North Fork Diversion has been in use.

Station X10 includes the influences of two tributary inflows from the south side of the Rose Creek valley and possible lateral seepage from the Second tailings impoundment.

Water pH at stations X3 and X10 are similar and have been steady over time, with average values of 7.6 and 7.9, respectively. Sulphate concentrations are also similar and have generally been less than 60 mg/L with several isolated spikes. Total zinc concentrations have generally been less than 0.10 mg/L with occasional higher spikes. The concentration of total zinc at location X10 has generally been slightly greater than location X3 since 1995. The record of total zinc concentrations for station X3 displays seasonally (winter) elevated concentrations up to 1.85 mg/L form 1987 to 1991 that is attributed to the capture in pumping wells of groundwater containing elevated zinc concentrations. The elevated zinc concentrations were not observed at downstream location X10. The practice of augmenting the winter water supply from those pumping wells adjacent to the tailings impoundment was subsequently discontinued.

Details of the water quality data from these stations can be found in Volume 2 of the Anvil Range Mining Corporation (2002b) report. The summary of water quality data from this report also indicates that arsenic, copper and cyanide were occasionally reported to be elevated in the water samples from X3 and X10.

5.5. Fish and Fish Habitat

Fish

Fish species present in the upper Pelly River watershed include chinook and chum salmon, lake trout, lake, broad, humpback and round whitefish, least cisco, inconnu, arctic grayling, northern pike, burbot, longnose sucker and slimy sculpin. Various studies regarding fish presence and habitat use have been conducted at the Anvil Range Mine Complex between 1974 and 2002. During these studies, arctic grayling (*Thymallus arcticus*), burbot (*Lota lota*), chinook salmon (*Oncorohynchus tshawytscha*), slimy sculpin (*Cottus cognatus*), longnose sucker (*Catastomas catostomus*) and round whitefish (*Prosopium cylindraceum)* have been captured in the Anvil watershed for presence, population and metal analysis purposes. Figure 6 and Table 6 indicate fish presence by stream reach. Chinook have been noted spawning within lower Anvil Creek during some years surveyed (in relatively low numbers when compared regionally) and juveniles have been noted in the lower 23 km of Anvil Creek in moderate numbers (based on regional comparisons, RGC 1996) and in the lower end of Rose Creek.

Arctic grayling are the dominant species in Rose Creek and have been captured throughout the Rose Creek mainstem, and in the North and South Forks, including headwater areas of both. Harder (1991) reported that on a regional basis the South Fork of Rose Creek supports the greatest densities of arctic grayling. Once arctic grayling reach maturity (age three to four in the study area), they spawn annually between early May and early June in the Rose Creek drainage (Weagle 1981, Harder 1988).

Fish populations have been isolated by several barriers in the watershed (Figure 6). The population in the mainstem of Rose Creek can access reaches 1 and 2 of the South Fork, up to the spillway culverts, and a portion of reach 1 of the North Fork, to a culvert above the ponds. A diversion channel on the North Fork flows intermittently but when it does it provides fish can access to the upper section of reach 1 of the North Fork.

Figure 4. Freshwater Supply Reservoir Water Sampling Locations and Habitat Mapping

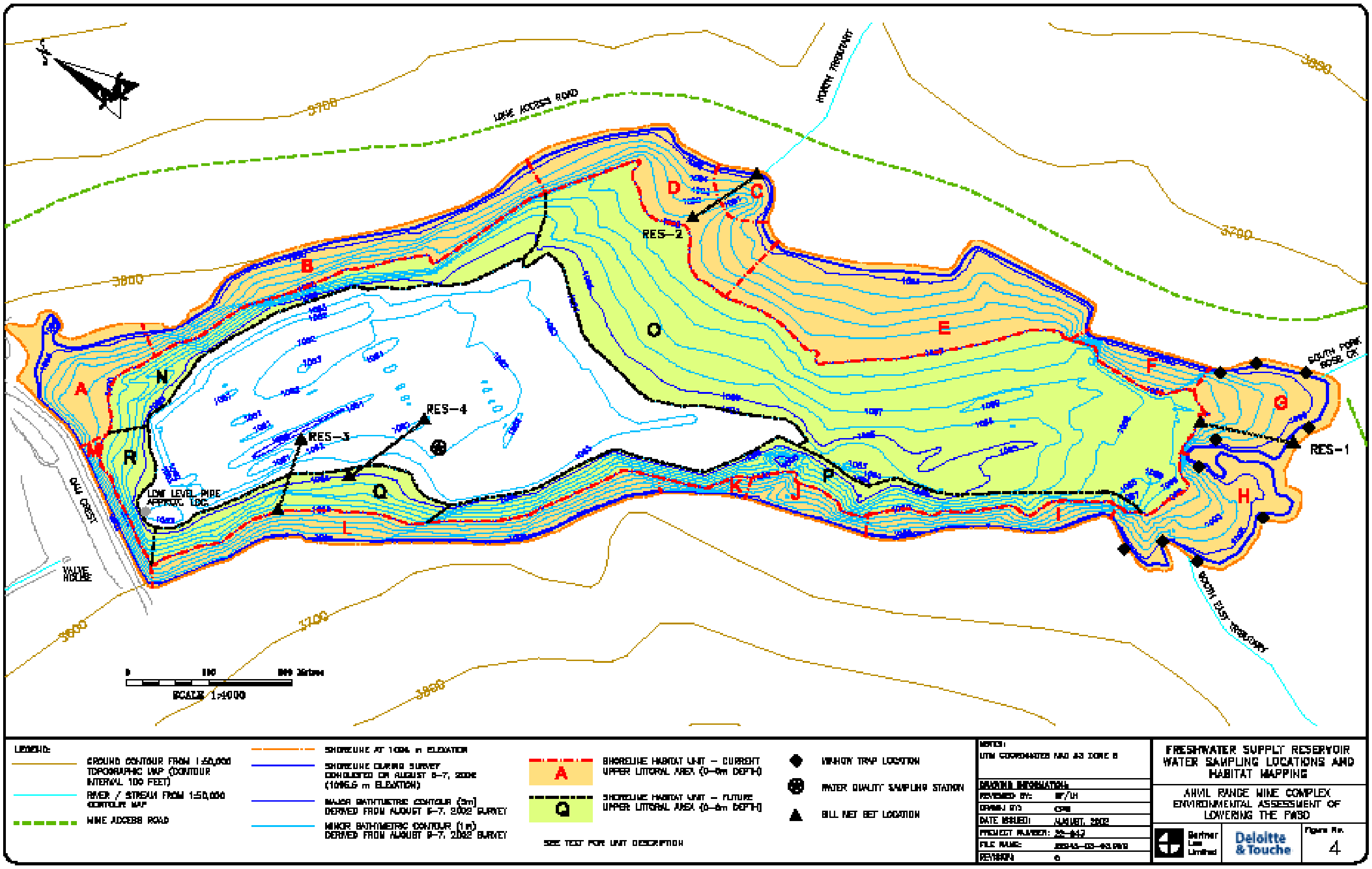
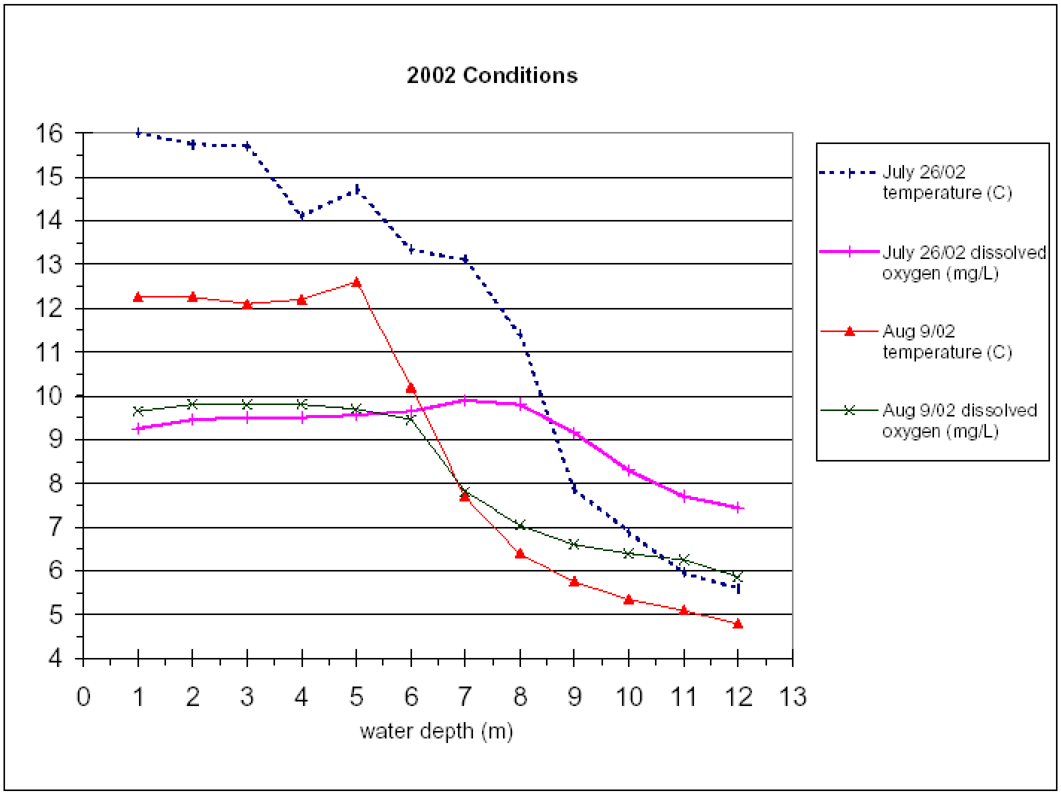


Figure 5. Temperature and Dissolved Oxygen Profiles of the FWS Reservoir



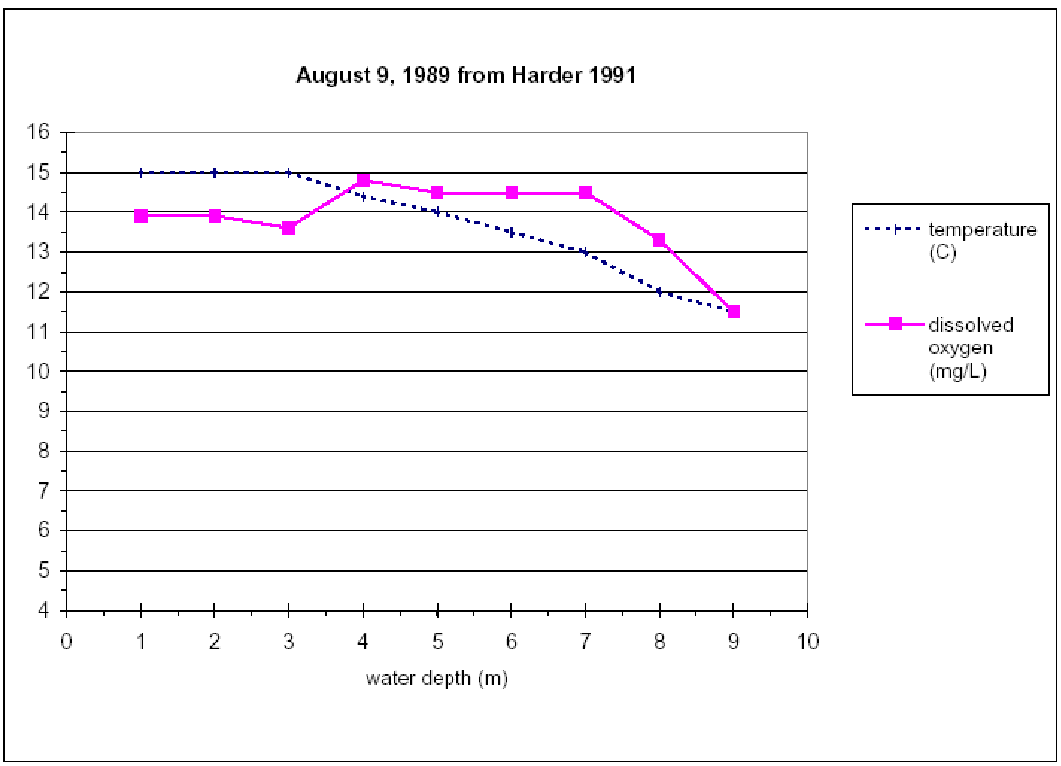


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Table 5. Water Chemistry of the Faro minesite Freshwater Supply Reservoir

Sample ID	Detection	CCME	Surface	@ 10 m
Date Sampled	**Limit**	**Guideline**	8/9/02	8/9/02
Physical Tests				
secchi depth	field		5 m	
conductivity	field		80 uS	91 uS
temperature	field		12.3 C	5.1 C
dissolved oxygen	field	>9.5 early life stages, >6.5 others	9.7	6.2
Hardness (CaCO3)	0.6		48.9	59.1
pH	0.01	6.5 - 9.0	7.69	7.34
turbidity	field		1 NTU	1 NTU
Total Suspended Solids	3		<3	<3
Nutrients				
Nitrate Nitrogen	0.005		<0.005	<0.005
Nitrite Nitrogen	0.001	0.06	<0.001	0.002
Total Dissolved Phosphate	0.002		0.002	0.003
Total Phosphate	0.002		0.003	0.002
Total Metals				
Aluminum	0.005	0.1[a]	0.047	0.073
Antimony	0.0005		<0.0005	<0.0005
Arsenic	0.0005	0.005	<0.0005	<0.0005
Barium	0.02		0.02	0.03
Beryllium	0.001		<0.001	<0.001
Boron	0.1		<0.1	<0.1
Cadmium	0.00005	0.0011[a]	<0.00005	<0.00005
Calcium	0.05		15.1	17.8
Chromium	0.001		<0.001	0.001
Cobalt	0.0003		<0.0003	<0.0003
Copper	0.001	0.002[a]	0.001	0.001
Iron	0.03	0.3	0.07	0.11
Lead	0.0005	0.001[a]	**0.0014**	**0.0012**
Lithium	0.005		<0.005	<0.005
Magnesium	0.1		2.7	3.6
Manganese	0.0003		0.0077	0.0118
Mercury	0.00005		<0.00005	<0.00005
Molybdenum	0.001	0.073	<0.001	<0.001
Nickel	0.001	0.025[a]	<0.001	<0.001
Potassium	2		<2	<2
Selenium	0.001	0.001	<0.001	<0.001
Silver	0.00002	0.0001	<0.00002	<0.00002
Sodium	2		<2	<2
Thallium	0.0002	0.0008	<0.0002	<0.0002
Tin	0.0005		<0.0005	<0.0005
Titanium	0.01		<0.01	<0.01
Uranium	0.0002		0.0006	0.0008
Vanadium	0.03		<0.03	<0.03
Zinc	0.005	0.03	<0.005	<0.005

notes:
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
a = criteria has been calculated based on hardness and pH of samples
shaded values indicated exceedenceds of the CCME guidelines for freshwater aquatic life

Another population exists in the FWS Reservoir that can access the reaches immediately upstream of the Reservoir of two small tributaries as well as reach 4 of the South Fork of Rose Creek. Culverts at the mine access road, approximately 4.5 km upstream of the Reservoir are the first of several barriers in this area of Rose Creek. A separate population exists at the haul road rock drain, which extends to the headwaters and Dixon Lake. Similarly the section of the North Fork above the haul road rock drain barrier supports a population of grayling that also extends up to a series of ponds in the headwaters of this fork.

Several studies of fish in the FWS Reservoir have been conducted between 1981 and 2002 for presence, population and metals analysis purposes. Arctic grayling, slimy sculpin and burbot have been documented in the Reservoir and the South Fork of Rose Creek upstream. The arctic grayling caught in the Reservoir have ranged in size from 15 to 31 cm. Catch results of gill net sampling conducted in 2002 were directly compared to gill net sampling conducted in 1981 and 1989, as adequate data was available from these historical studies to derive an estimate of the number of fish caught per unit of effort. The 1981 studies (Weagle 1981) indicate a catch ranging from 2 to 10 fish or 0.02 to 0.11 arctic grayling per 100 m^2 net area per hour for three 48 hour sets during July, August and October. The August 1989 study (Harder 1991) captured 24 fish or 8.33 arctic grayling per 100 m^2 net area per hour during a day set. During the 2002 study, sinking and floating nets set during the day resulted in a catch of only 3 grayling (0.27 arctic grayling per 100 m^2 net area per hour), while an overnight set resulted in a catch of 61 fish (3.26 arctic grayling per 100 m^2 net area per hour). These results do not indicate a particular long-term trend in fish populations in the Reservoir. Of the three sampling events, catch per unit effort was lowest in 1981 and highest in 1989.

The general conclusion of studies between 1981 and 2002 indicate that the arctic grayling population in the Reservoir and in reach 4 of the South Fork of Rose Creek area are in good biological condition and sufficient habitat exists to support all life phases of arctic grayling.

Stream Habitat

The Faro Mine is wholly within the Rose Creek watershed and as such there have been several alterations to the creek associated with the Anvil Range Mine Complex. These alterations include diverting Faro Creek around the Faro pit to enter the North Fork, rather than flowing directly into the mainstem of Rose Creek. The Faro pit and associated dumps are located north of the mainstem, just west of the North Fork. In addition to the diversion of Faro Creek, additional alterations to the Rose Creek watershed include:

- Diversion of the mainstem around the tailings impoundment facilities.
- Creation of the pumphouse pond on the mainstem at the upstream end of the Rose Creek diversion.
- Diversion of the lower 500 m of the North Fork.
- Construction of the FWSD converting approximately 1500 m of stream habitat into lake habitat.
- Construction of the haul road over the North Fork, all tributaries to the east and the upper south fork.

A classification of fish habitat in the Anvil watershed was conducted in 1989 and 1990 (Harder & Associates 1991) and other reports summarized in RGC (1996). These reports provide details of fish habitat in Anvil Creek. The most notable feature of Anvil Creek is the availability and use of Chinook spawning habitat primarily in the lower reaches of Anvil Creek.

The following details of fish habitat in Rose Creek are based on Harder's reports (Harder 1988, 1992) and field work by Gartner Lee in July and August of 2002. A habitat summary of Rose Creek, by stream reach, is outlined in Table 6 and the reach breaks and main habitat features are shown on Figure 6. Habitat descriptions focus on arctic grayling. Lower Rose Creek (reaches 1 and 2 on Figure 6) contain high quality habitat for spawning and rearing arctic grayling and moderate habitat for adults during both summer and winter. Rose Creek meanders through this section and contains diverse habitat including gravels for spawning as well as deep pools and side channels. Based on Harder (1988), arctic grayling spawn in this reach. Flow is expected here in the winter. Next Creek flows into

Rose Creek from the north at the upstream end of reach 2. This creek is narrow with little flow over a relatively steep gradient (>10%) of step-pools resulting in low value for all life stages of arctic grayling.

The diversion channel around the tailings (reach 3) is considered to have low rearing habitat and moderate value for spawning, winter and summer habitat. The upper 2/3 of the diversion is a wide (20 m) channel with predominantly gravel and cobble substrate. The lower 1/3 contains steps of boulders and pools. Velocities in the lower section may make it difficult for juvenile grayling passage. Based on Harder (1988), arctic grayling spawn in this reach. Flow is expected here in the winter and is augmented with release from the Reservoir.

Reach 1 of the South Fork of Rose Creek includes the pumphouse pond and a natural channel that is predominantly riffle over cobble. Due to this combination and augmented winter flows, the habitat value is moderate for spawning and high for rearing, winter and summer habitat. Reach 2 is a meandering section with side channels created by beaver dams. The deep water and augmented slow flow over a substrate of fines result in high value habitat for rearing, winter and summer habitat but low value for spawning. Reach 3 is the Reservoir (described in detail in the previous section), which provides high value habitat for rearing, winter and summer habitat but low value for spawning arctic grayling. There are two culverts under an access road that cross the lower end of the FWSD Spillway and form an impassable barrier for fish movement from Rose Creek into the FWS Reservoir.

The unnamed tributary that flows into the Reservoir from the north is a relatively steep gradient from the current Reservoir shore to the mine access road 40 m upstream with cobble substrate (Photo 1). This channel section provides moderate rearing and summer habitat and low spawning and winter habitat. The unnamed tributary that flows to the Reservoir from the southeast is an unconfined low-flow channel through the willow-sedge-spruce valley with a substrate of fines (Photo 2). The channel at the mouth is defined with boulder substrate. This channel offers moderate rearing and low value spawning, winter and summer habitat. Reach 4 of the South Fork, is predominantly riffle channel over boulder and cobble (Photo 3) with some beaver dams in the upper end. Habitat is considered moderate for all grayling life stages. Reach 5 contains three barriers at the lower end: a culvert under the mine access road, the rock drain under the haul road and a steep gradient section (>20%). Fish cannot move in either direction across this section. There is moderate summer habitat and low habitat for all other life stages. Reach 6 is predominantly riffle over boulders at a 5% slope, with habitat considered moderate for spawning (grayling have been observed spawning at the upper end) and low for all other life stages. Dixon Lake is a shallow basin in reach 7, which offers low spawning habitat but high value habitat for rearing, and moderate value summer and winter habitat.

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Table 6. Rose Creek Watershed Fish Habitat by Stream Reach

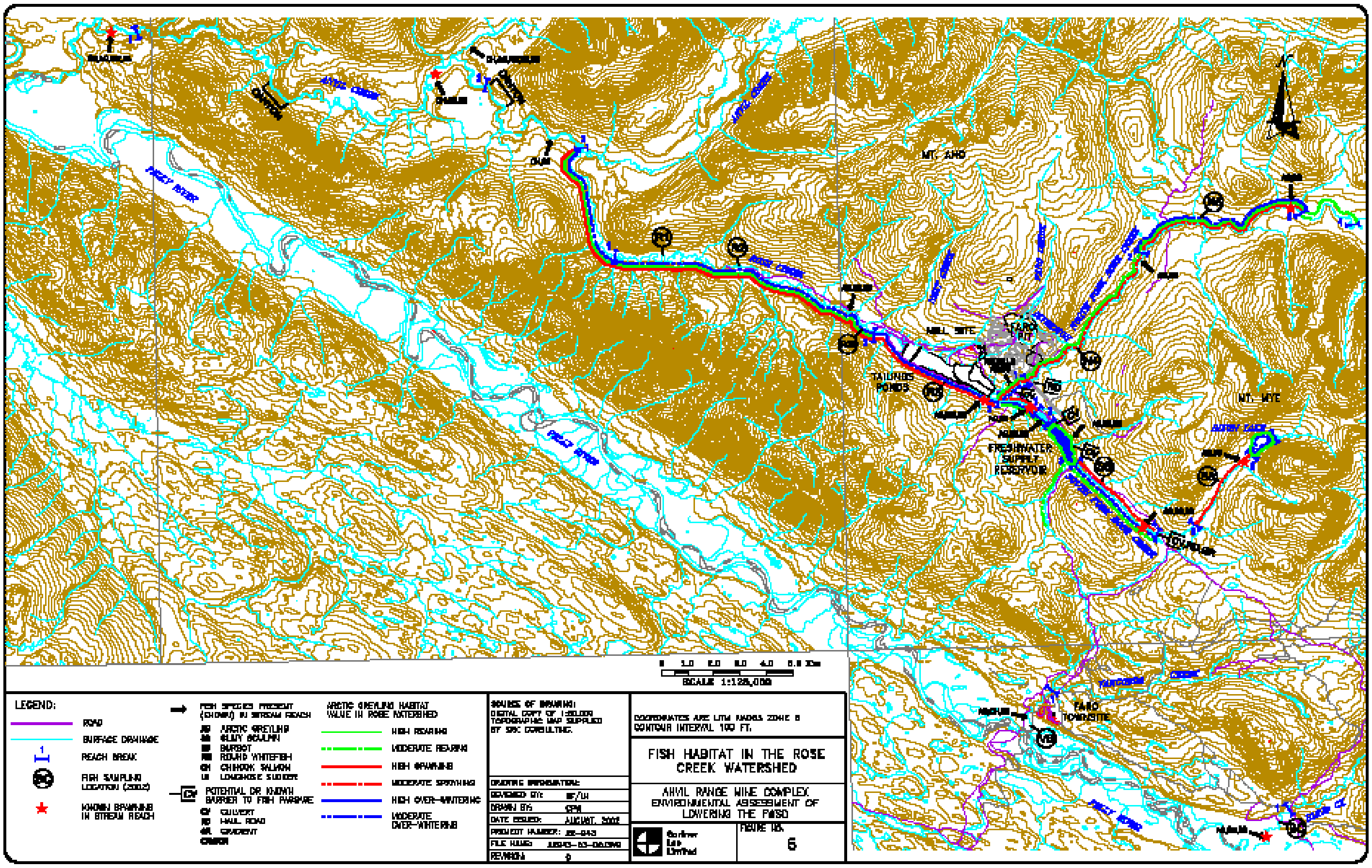
Watercourse	Reach	Arctic Grayling Habitat Rating				Channel Width	Gradient (%)	Channel Type	Bed Material[a]	Cover	Barriers	Other
		Spawning	Rearing	Summer	Winter							
Rose Cr.	1	high	high	moderate	moderate	25	1.5	riffle (pool, run)	gravel (cobble, fine)			side channels, flows in winter
Rose Cr.	2	high	high	moderate	moderate	13	1	run (riffle, pool)	cobble, gravel (boulder, fines)	20% - pools, cutbanks, boulder, little wood debris		side channels, flows in winter
Rose Cr.	3	moderate	low	moderate	moderate	20	1.5	run (riffle, step-pool sections)	gravel, cobble (boulders in steps)	5% - boulders	step sections a potential juvenile barrier	flows in winter
Rose South Fork	1	moderate	high	high	high	10	1.2	riffle (pool, run) and pond	cobble (boulder, gravel)			pumphouse pond
Rose South Fork	2	low	high	high	high	6	0.5	pool (run)	fines			beaver dams, multiple channels
reservoir	3	low	high	high	high						spillway culverts	
North tributary	1	low	moderate	moderate	low	3.5	10	riffle (step, pool)	boulder (cobble)	boulder	mine road culvert	
Southeast tributary	1	low	moderate	low	low	2	4	glide	fines (boulder at mouth)	vegetation	low flow	
Rose South Fork	4	moderate	moderate	moderate	moderate	7	2.2	riffle (pool, run)	boulder (cobble, gravel)	20% - boulder, pools, vegetation, cutbanks		
Rose South Fork	5	low	low	moderate	low	7	4.3	riffle (pool, run)	boulder		mine road culvert, haul road and steep section	
Rose South Fork	6	moderate	low	low	low	5	5	riffle (run, step, pool)	boulder, cobble	20% - boulder, vegetation, cutbank		
Rose South Fork	7	low	high	moderate	moderate			Dixon Lake	fines			Dixon Lake
Rose North Fork	1	moderate	moderate	moderate	moderate	7	1.4	pool (riffle, run)	boulder (cobble, gravel, fine)	ponds, pools	mine road culvert (on one of the two lower channel options)	two options for water flow below mine road - through boulder channel or series of ponds
Rose North Fork	2	moderate	moderate	moderate	low	10	2	riffle (pool, run)	cobble (gravel, fines)	20% - pools, cutbanks, boulder	haul road	side channels
Rose North Fork	3	moderate	high	moderate	moderate	9	2	run (riffle, pool)	cobble (fines, gravel)			side channels, ponds
Rose North Fork	4	low	low	low	low			ponds	fines			ponds and small lake but very low pH (3) noted

Notes:

a. fines = <2mm, gravel = 2-64mm, cobble = 64-256mm, boulder = 256-4,000mm; sub-dominant substrate in brackets

See Figure 6 for reach location

Figure 6. Fish Habitat in the Rose Creek Watershed



Within the South Fork, arctic grayling populations both upstream and downstream of the FWSD appear to have sufficient habitat exists to support all life phases.

Reach 1 of the North Fork of Rose Creek (below the mine access road) contains two channel options in the lower end. The native channel has been converted to a series of ponds that flow to the pumphouse pond and a boulder diversion channel directed downstream of the pumphouse pond. To minimize sediment entering the pumps, prior to about 1996, flows were directed through the ponds during most of the year and through the diversion channel during freshet when the greatest sediment loads would be present. Since this time, flows are directed through the ponds with excess through the diversion channel when required during freshet. The culvert directing flows to the ponds is a barrier to upstream fish passage. The ponds and native channel above it provide moderate habitat to all life stages of grayling.

The haul road crosses the North Fork at the downstream end of reach 2, and a rock drain was used to pass the creek under the haul road. This rock drain is an impassable barrier to fish passage in either direction. This diverse section provides low winter habitat and moderate spawning, rearing and summer habitat. Faro Creek has been diverted around the Faro Pit and now flows into the North Fork in reach 1. Faro Creek carries low flows and is a step-pool channel greater than 10% slope at the North Fork. The entire creek is considered low habitat for arctic grayling. Reach 3 contains diverse habitat with beaver ponds and riffle sections resulting in high rearing and moderate spawning, summer and winter habitat. Grayling are known to spawn in the upper section of this reach (Harder 1988). A series of ponds are located in reach 4, however, these have been considered acidic with low dissolved oxygen, providing low habitat for all life stages.

Within the study area, the best spawning habitat for arctic grayling is found at the upper end of the Rose Creek diversion channel and within the South Fork just downstream of the Reservoir. Patches of spawning habitat are also present in the North Fork and in the south fork upstream of the Reservoir.

The best quality summer habitat for fry, juvenile fish and adults is located within the pumphouse pond, the South Fork just downstream of the Reservoir, and possibly within the Reservoir itself. Arctic grayling fry normally spend at least their first summer in stream habitat however, Harder (1988) only captured grayling young-of-the-year in the FWS Reservoir. Summer habitat also exists in pools within the South Fork upstream of the Reservoir and the North Fork.

A large area for over-wintering has been created by the Reservoir. Fish located downstream of the dam likely over-winter in the pumphouse pond or other deep areas of Rose Creek, where water flows continue below the ice.

Reservoir Habitat

Data to update the bathymetric map of the Reservoir was collected on August 6 and 7, 2002. Laberge Environmental Services collected the data. Fifteen transects were established and geo-referenced using a Garmin 12XL GPS unit. A Raytheon Survey Fathometer was used to collect the depth data. The elevation of the water surface at the time of the survey was determined relative to established survey points on the dam crest and was established to be 1095.5 m geodetic. The transect locations and depth data were entered into Auto CAD and a contour map generated and provided in **Figure** 7.

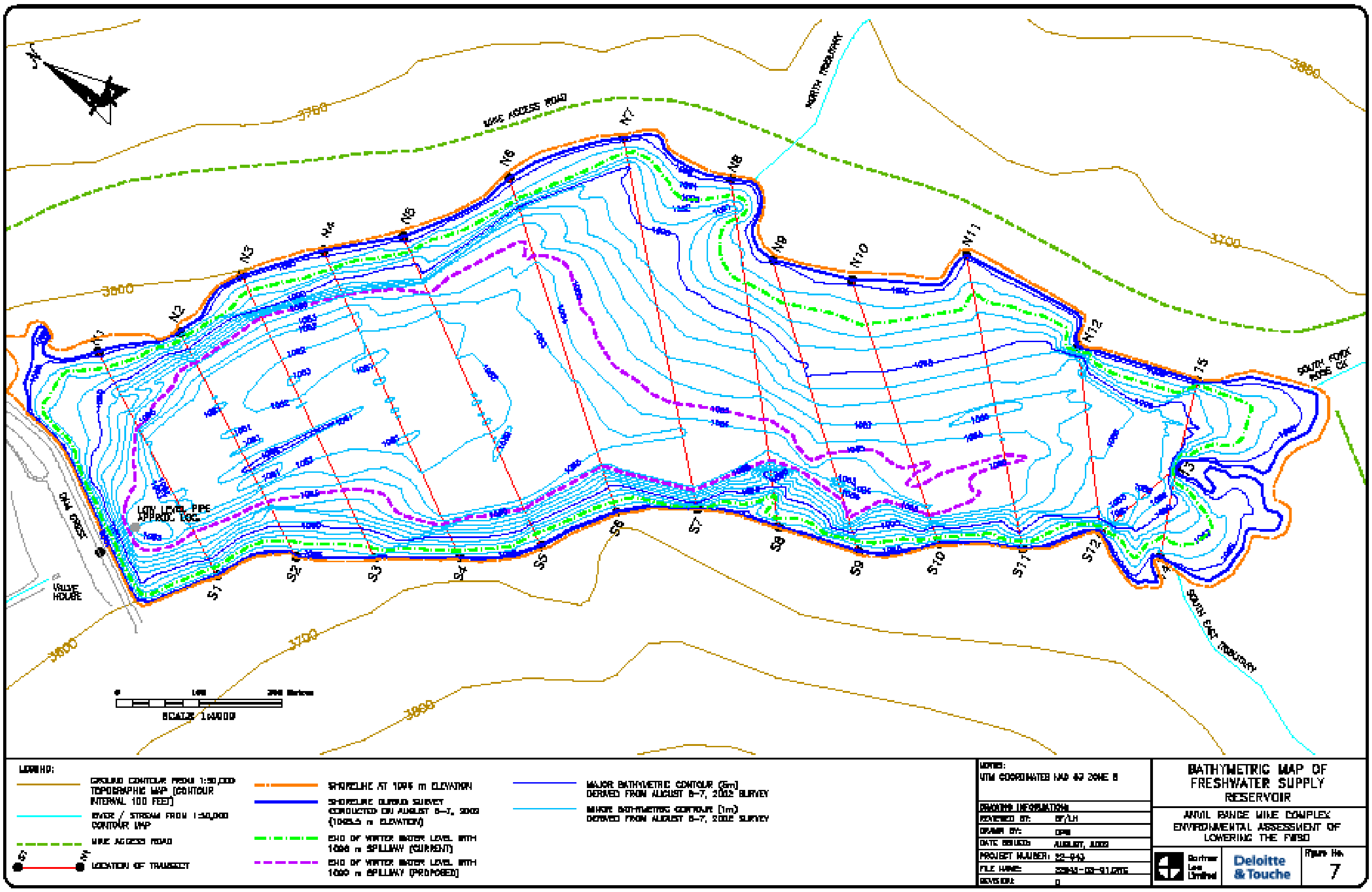
Habitat data in the form of substrate composition in the littoral area of the Reservoir was also collected in August 2002. This information was overlaid on the bathymetric map to determine the areas of different habitat types.

Based on the water elevation at the time of the survey (1095.5 m), the maximum depth of the Reservoir was 16.1 m and the average depth was 7.5 m. The surface area of the Reservoir is approximately 486,600 m^2 and the total volume was 3,683,700 m^3. The previous survey completed in 1989 provided an estimate of the volume at 5.8 million m^3. However, according Harder (1991) the survey was conducted at a surface water elevation of approximately 1096 m, 0.5 m higher than during this survey. 1096 m is the normal full pool elevation for the Reservoir, therefore adjustments were made to the 2002 data to estimate the surface area and Reservoir volume at the 1096 m elevation. At the current full pool elevation the surface area is 514,960 m^2 and the Reservoir has a total volume of 4,065,500 m^3.

Habitat data in the form of substrate composition in the littoral area of the Reservoir was also collected in July 2002. Using an Aquaview underwater camera substrate type was identified substrate size was measured along the shore as well as underwater, using the camera and a metre stick for reference. This information was overlaid on the bathymetric map (Figure 4) to determine the habitat polygons from 0 to 6 metres depth to characterize fish habitat under current full pool conditions of the Reservoir and 6 to 12 metres depth to characterize habitat once the Reservoir is lowered 6 m.

As a general rule the near shore area of a lake to a depth of 6 m is defined as the littoral zone (RIC 1999) and is the most productive area of the lake as light penetrates to the bottom sediments and aquatic plants can grow. Descriptions of each habitat polygon are outlined in Table 7 and include slope, substrate and aquatic vegetation. In addition, shoreline substrate exposed by wave action and vegetation was noted for the shoreline perimeter polygons. In general, the north side of the Reservoir is more gradually sloped than the south side and has a greater abundance of aquatic vegetation. At the east side, two shallow bays are present. Aquatic vegetation identified within the Reservoir includes milfoil (*Myriophyllum sibiricum*), bur-reed (*Sparganium angustifolium*), pondweed (*Potamogeton alpinus*) and mare's tail (*Hippuris vulgaris*). The near shore substrate is predominantly fines with boulders, with cobble and gravel visible in some areas. Angular material is located along the south side of the Reservoir at the shale bedrock bluffs. Boulders are visible lining the upstream end (to 4 m depth) of the flooded South Fork Rose Creek channel (polygon G). Branches from flooded vegetation (willow) are located throughout the Reservoir, generally denser at the 6 to 12m water depth. In addition, stumps from cut trees (white spruce) are present throughout the Reservoir. Photo documentation of the Reservoir is provided in Photos 4 to 8.

Figure 7. Bathymetric Map of the Freshwater Supply Reservoir



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5.6. Resource Use

Other than mining, resource use in the Rose Creek watershed appears to be somewhat limited. Arctic grayling are the third most popular sport fish in the Yukon and sport fishing is known to occur in the accessible areas of Rose Creek, in particular the lower end of the South Fork and within the Reservoir (Harder 1991). While there are no specific records, big game hunting and fur trapping are also resource uses in the area. Caribou, moose and mountain sheep are all known to frequent the Rose Creek watershed.

First Nations traditionally used the Rose and Anvil Creek areas for hunting and trapping and they fished Chinook salmon near the mouth of Anvil Creek. Since the establishment of the Faro Mine, the hunting and trapping activities in the area have been discontinued (Anvil Range 2002b).

5.7. Summary

The review of the environmental baseline information available for the Faro Mine site and the specifically the FWSD and Reservoir indicates the most important environmental feature is the fish population and fish habitat associated with Rose Creek and the Reservoir. The arctic grayling in this area support a sport fishery and previous studies have indicated the creation of the lake has likely increased the productivity of the fish habitat in this area of the Rose Creek watershed. The background information on the terrestrial environment for the mine site is somewhat limited. This is likely, in part, due to the effect mine development has had on the area both by degrading habitats and by creating disturbances that wildlife tend to avoid. No notable wildlife habitat, vegetation or vegetation communities or other terrestrial features have been identified in the area that require special attention. Therefore, the primary ecosystem component that the following section will focus on will be the fish and fish habitat within Rose Creek.

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Table 7. Fresh Water Supply Reservoir Fish Habitat

Polygon	Current Water Depth (m)	Slope[a]	Substrate[b]	Aquatic Vegetation	Shore Substrate (exposed by wave action)	Shoreline Vegetation
A	0 - 6	low	fines over cobble and gravel, a few round boulders, willow branches		fines (sand), cobble, few boulders	grass, sedge, willow
B	0 - 6	low	fines, a few round boulders, willow branches, few stumps	milfoil	gravel, cobble	grass, sedge, willow, spruce
C	0 - 6	low	fines, some gravel	pondweed, bur-reed	round boulder, cobble, sand	willow, spruce
D	0 - 6	low	fines (over gravel and cobble), few round boulders, willow branches	milfoil	fines (sand), gravel	grass, sedge, willow, few spruce
E	0 - 6	low	fines over cobble and gravel, a few round boulders, willow branches, stumps	abundant pondweed, milfoil	fines (sand), gravel	grass, willow, few spruce
F	0 - 6	low and moderate	fines (possibly over cobble)	milfoil, pondweed	cobble, gravel, boulder	grass, willow, few spruce
G	0 - 6	low	fines (mud and sand) with round boulders from Rose inlet to 4 m depth	milfoil, pondweed, mare's tail	fines (sand)	grass, sedge, willow
H	0 - 6	low	fines	milfoil, pondweed, mare's tail	gravel, cobble, fines	grass, sedge, willow
I	0 - 6	moderate	fines, willow branches	little pondweed	fines	grass, willow, spruce
J	0 - 6	moderate	fines over angular cobble and boulder, willow branches	little pondweed	bedrock (shale)	willow, spruce
K	0 - 6	high	angular cobble and gravel with cover of fines, willow branches	little pondweed	bendrock cliff, boulder (shale)	willow
L	0 - 6	moderate	angular cobble and gravel with cover of fines, willow branches	little pondweed, bur-reed	cobble and gravel (shale)	grass, willow, spruce
M	0 - 6	high	angular cobble and gravel with cover of fines	little pondweed, bur-reed	dyke	
N	6 - 12	moderate	fines, few round boulders, abundant willow branches, few stumps	none observed		
O	6 - 12	low	fines, willow branches	none observed		
P	6 - 12	moderate and high	fines, a few round boulders, willow branches	none observed		
Q	6 - 12	low and moderate	fines, few boulders, few willow branches	none observed		
R	6 - 12	low to high	angular cobble and gravel with cover of fines	little pondweed, bur-reed	dyke	

Notes:
a. gentle slope = 0-15%, moderate slope = 15-30%, steep slope = >30%
b. fines = <2mm, gravel = 2-64mm, cobble = 64-256mm, boulder = 256-4,000mm

milfoil = *Myriophyllum sibiricum*
bur-reed = *Sparganium angustifolium*
pondweed = *Potamogeton alpinus* (also less abund
mare's tail = *Hippuris vulgaris*

6. ENVIRONMENTAL EFFECTS AND MITIGATION

6.1. Site Preparation

The construction site and associated storage area requirements and quarrying are all within areas of the mine site that are currently clear of vegetation or only sparsely vegetated. The riprap required for the project is being quarried from an existing borrow source in the vicinity of the Grum Pit. The Grum pit area is in the Vangorda Creek watershed and is well upstream (over 6 km) of fish bearing waters. The blasting and sorting activities in the borrow area are well displaced from any fish populations and will not have an impact on fish or fish habitat. We have no, site specific, information for terrestrial use of the site but being within the vicinity of the Grum Pit suggests that there are limited habitat values that would be affected by the quarrying.

There is only limited clearing required for the work on the FWSD as the work area lies within the existing dam structure and spillway discharge channel. Also the access road is already in place. The spillway flows are intermittent and flow for 6 to 7 months of the year therefore there is some vegetation growth within the spillway channel however it is sparsely distributed with limited habitat value. Removal of vegetation and overburden activities will take place once the Reservoir is drawn down to the project elevation of 1088 m and appropriate erosion control measures are put in place to contain and manage runoff from the newly exposed areas to ensure sediment is not deposited into the Reservoir or Rose Creek.

Overall the site clearing and quarrying will have limited environmental consequences as the Faro Mine has already affected the areas. Standard erosion control practices will be used to minimize and contain any potential for erosion. The project is scheduled to take place between late October and mid December so there is no risk of impact to nesting birds. The impact to terrestrial animals will also be negligible as the affected areas are within the footprint of the mine. No new areas outside the mine property are required for this project.

6.2. Reservoir Lowering and Operation

The long term effect of this project will be to lower the normal full pool level by 6 m from elevation 1096 to 1090 m. Other operational aspects of the Reservoir, in particular the water release from the Reservoir to meet the existing water licence requirements of 4.5 m^3/minute flow in the Rose Creek diversion will be maintained. Regardless of the course of action taken to eliminate the risk of dam failure because of the low level pipe, the Reservoir will continue to be operated so that the flow releases prescribed by the current water licence will be met. Therefore if the low level pipe is removed or filled in then siphons or some mechanism would be used to pass water over the dam and into the channel that the low level pipe currently discharges into.

The shift to a normal full pool level of 1090 m will cause changes in various limnological parameters, which are summarized below. This comparison also includes the estimated change Reservoir conditions at the end of winter after a release of 1.179 million m^3 of water over the 6 month winter period required to meet the 0.075 m^3/s flow requirements in the Rose Creek diversion.

Parameter	Existing 1096 Spillway	Proposed 1090 Spillway	Percent Change
Normal full pool conditions:			
Surface Area	514,957 m^2	328,097 m^2	- 36%
Perimeter	4040 m	3378 m	- 16%
Maximum depth	16.6 m	10.6 m	
Mean depth	8.0 m	4.9 m	
Total Volume	4,065,500 m^3	1,602,700 m^3	- 61%
Littoral Area	186,921 m^2	189,105 m^2	+ 1%
End of winter conditions			
Water surface elevation	1093 m	1085 m	
Surface area	405,480 m^2	166,070 m2	- 59%
Perimeter	3666 m	2740 m	- 25%
Maximum depth	13.6 m	5.6 m	
Mean depth	6.5 m	2.5 m	
Volume	2,886,156 m^3	423,313 m^3	- 85%
Littoral area	178,003 m^2	166,070 m^2	- 7%

A reduction in the normal full pool elevation by 6 m will decrease the surface area by 187,860 m^2 and there will be a reduction of 2,462,800 m^3 in lake volume. This represents a significant reduction in total lake habitat. However, the reduction to a 1090 elevation will likely create a more productive Reservoir as the proportion of lake area in the littoral zone goes from being 30% of total lake area to 58% as well as there being an absolute increase of 2,184 m^2 of littoral habitat.

The consequences of physical changes to the Reservoir includes a reduction in the total area available for rearing and foraging, increased shoreline erosion at the new elevations and the ability of the lake to provide overwinter habitat. However, the littoral area, normally considered the most productive area of a lake will be slightly increased. Without further limnological studies it is unclear if the lowering of the Reservoir would result in a significant reduction in productivity.

The August 2002 habitat survey of the Reservoir indicates little difference in the substrate conditions at current Reservoir levels and those found at lower depths. Also, the historic operating range of the Reservoir does include some of the shore area that will be exposed when the Reservoir is operated at 1090 m. Also, about one half of the time that the Reservoir is operating at ranges where shorelines have not been exposed to erosion by waves takes place overwinter when ice covers the lake. The rate of infilling and time it takes the Reservoir to reach the 1090 full pool condition will have an effect on the potential for sediment to be mobilized. While this could impact water quality from time to time, it is likely confined to periods of wind as the Reservoir is refilling in the spring and is likely a short term impact and may not be any different than current conditions given the similarity in substrate conditions throughout the Reservoir (Table 7).

Of particular concern would be the overwinter dissolved oxygen levels. A possible consequence of the reduced volume of water is that the total available dissolved oxygen over the winter (under ice) will not be sufficient to support the biological and chemical oxygen of the water, the sediments, and the fish. This Reservoir has been drawn down to low levels in the past and as far as we know, there have been no reports of early spring fish kills, suggesting that oxygen levels have remained adequate to support the fish populations in the Reservoir in late winter, under ice conditions. However, the increased productivity associated with the increased proportion of littoral habitat could result in there being a greater oxygen demand in the lake over the winter months when ice cover and low flows limit the opportunity for oxygen levels to be replenished.

The potential effect of decreased oxygen levels can be mitigated through the implementation of a lake aeration program. It is unlikely that the increased productivity and associated increase in oxygen consumption will be immediate, therefore overwinter dissolved oxygen conditions can be monitored and if decreasing trends are reported a lake aeration system could be set up for the next winter. In the context of this environmental assessment, this aeration program would only be temporary until the final closure plan for the FWSD is decided. The final closure plan would have to take into account the existing condition of the FWS Reservoir and integrate any on going fish habitat requirements into the plan.

The lowering of the Reservoir and associated loss of lake habitat will be offset to a small degree by an increase in stream habitat. There will be a 155 m increase in reach 4 of the south fork of Rose Creek, 60 m on the tributary on the south east end of the Reservoir and 146 m for the tributary on the north side of the Reservoir. If an average channel width of 4 m is assumed for these creeks (Table 6), the total increase in stream habitat is approximately 1400 m^2. Also, there is no indication that there are any barriers to fish movement in these sections of the streams that are currently under water. While the different habitats in the lake and streams are difficult to compare directly, at a very basic level the reduction of 186,860 m^2 in lake area will be offset by a total of 3584 m^2 made up of a combination of littoral and stream habitat.

There are no specific, practical mitigation measures such as re-design or relocation of the project that can be applied to offset the reduced areas and volumes in the Reservoir as a result of developing the 1090 spillway. Such changes to the project to reduce habitat loss would compromise the benefits the proposed project would provide to alleviate the consequences of failure of the FWSD. This project does significantly offset the potential risks to fish and fish habitat resources downstream of the Reservoir. As presented in the Alternatives Assessment Table 2, lowering the Reservoir level to 1090 and repairing the low level pipe significantly reduces the potential for a failure of the FWSD of a magnitude that would cause the destruction of the dams downstream in the tailings facilities and the subsequent mobilization of tailings and other contaminants downstream of the mine into lower Rose Creek and Anvil Creek.

In the short term the Reservoir will be lowered to between 1088 - 1089 m for the construction phase to ensure that all the work can be completed in the dry, which includes placing riprap around the new spillway to a point one meter below the base of the spillway. The impact of the short term Reservoir lowering to 1088 is within the range of the current fluctuation of the Reservoir and will not have a noticeable effect on fish or fish production. This low level will be attained in October and held at that level during the construction phase. Fish activity also drops during this time of year. Arctic grayling spawn in the spring so all fish age classes present in the Reservoir will be mobile and able to avoid any stranding as the water level drops.

However, it is unusual that the Reservoir would be at such a low elevation at the start of the winter period. The Reservoir can be drawn down to 1081 - 1080 m, the elevation of the low level pipe. Between 1088 and 1081 m the volume of water available is 1,150,900 m^3. This is sufficient water to maintain a release of 0.075 m^3/s for 177 days or just under the 180 days between November 1 and April 30th - the winter period when flow augmentation is required in Rose Creek. A 6-month period of no inflow to the Reservoir or flow inputs to other areas of Rose Creek is considered an extreme case and under normal circumstances a 180 day supply of water is not required. As can be seen from the climate data in section 5.2, snowmelt occurs in April so that inflow to the Reservoir would normally begin in April, well before April 30th. Therefore, the construction phase of the project has a very low probability of affecting Rose Creek downstream of the FWSD by not being able to supply the required flow of water.

6.3. Spillway Construction

The spillway construction consists of removing portions of the existing spillway and dam to achieve the desired spillway invert elevation of 1090 m. This will be achieved through excavating and blasting. The amount of blasting will depend to some extent on the degree to which surface materials are frozen. The work on the dam and spillway is expected to take approximately 58 days between late October and mid December with most of the blasting, mucking and riprap placement taking place through November. Throughout the construction period water will be released from the low level pipe as it normally is in November and on through the winter so flows in Rose Creek will not be affected.

The work is scheduled to commence once the Reservoir is lowered to 1088 m which is one meter below the elevation rip rap has to be placed. This will allow all the work on the dam and the spillway to take place in the dry and provide a level of safety if an unexpected inflow of water (i.e. rain event) were to occur. However, based on the climate data provided in Section 5.3, the temperatures at the mine site in November are typically below freezing which means that most if not all of the precipitation will be in the form of snow. Inflows to the Reservoir at this time will be minimal providing favourable conditions for controlling Reservoir water levels.

As described in Section 3.2, the blasting will be controlled to maintain the integrity of the dam as well as to meet the DFO guidelines for blasting around fish bearing waters. The blasting is not expected to occur any closer than 80 m from the Reservoir and the contractor is confident that blasts can be contained to maintain overpressures below 100 kPa. All of the blasted material will be removed from the spillway and the rock that is left behind that may be covered by residue from the blast will be covered by a Reno Mattress and a layer of clean riprap. The blasting during this project is not expected to harm fish or fish habitat (through degraded water quality). Overpressures in the Reservoir next to the dam face will be monitored to ensure the DFO guidelines are met.

The removal of overburden and blast rock has the potential to introduce sediments into the Reservoir and downstream water courses. The contractor is committed to constructing a sediment control pond and to provide sediment control provisions to ensure that sediment laden runoff from the construction site is diverted into the pond where the sediment can settle out before the water is discharged into Rose Creek. Given the time of year, the probability of a high rain event that causes significant erosion is unlikely. Therefore the probability of a significant event resulting in the discharge of sediment laden waters, exceeding CCME guidelines, into Rose Creek is low.

Concrete will be used to finish the high point of the spillway channel. The concrete will be poured when water elevations are at least one meter below the new spillway crest to ensure that the work is done in the dry. Water will not flow through the spillway until the concrete has properly cured. General good practices of concrete usage will be followed including cleaning of trucks in a designated area away from any watercourses and the Reservoir. The potential for concrete or concrete wash water to impact the water quality in Rose Creek or the FWS Reservoir is low.

Once the new spillway is completed there is the potential for sediment laden waters to be flushed into Rose Creek during initial flows through the spillway over the work areas. This may occur and cause a short term increase in turbidity levels in Rose Creek.

However, this may also be mitigated by weather conditions between the time the spillway work is completed and the first flow through the spillway in the spring. Snow melt and rain events prior to flows passing down the spillway would tend to wash fine particles like rock flour into the interstices of the riprap placed in the new spillway and dam face. The flushing effect of snowmelt water and/or rain would reduce the amount of material on the surface that would be mobilized by the first flush of water through the spillway. Therefore the potential to affect water quality is considered low and if it does occur the duration would be short.

6.4. Accidents and Malfunctions

The possibility of accidents and malfunctions during construction of the project generally relate to the potential for deleterious substances to enter the environment and impact fish and fish habitat. There is also the potential for an accident during blasting that results in the killing of fish. For the most part these have been addressed in the spillway construction section. The environmental management plan will provide details on the standard operating procedures and environmental monitoring program that will be implemented during the construction phase to ensure early identification of any accident or malfunction and to minimize the consequences.

A potential consequence of accidents and malfunctions beyond the mitigation measures already proposed, is a delay in the completion of the project. From an environmental point-of-view a delay in project completion will not be a problem unless the delay results in the completion date moving into April. A delay that leaves work to be completed in early spring is at risk of being flooded by rising water levels in the Reservoir. However, it is likely that the contractor would be able to locate and deliver to the site, replacement equipment in a timely manner thus preventing a 3-month delay in completion.

6.5. Effects of the Environment on the Project

One of the reasons for this project is to mitigate impacts of the environment on the FWSD. The risk assessment has determined the 6 m lowering of the Reservoir will mitigate the risk of downstream impacts in the event of a dam failure related to a peak mean flood events. Section 6.3 concludes that weather conditions during the construction phase are unlikely to impact the project. However there is a low probability that a significant rain event could occur during the early stages of the construction – one that generates inflows that exceed the capacity of the low level outlet and siphons. If a large rain event occurred after construction began there is the risk that the Reservoir could fill to the spillway elevation. Starting construction once the Reservoir is lowered to 1088 m mitigates the risk of a rain event impacting the construction phase. The construction will begin at the downstream end of the spillway and work up towards the dam. Therefore, water levels would have to rise to 1096 m for the work area to be affected by such an event. This is unlikely as 3.2 million m^3 of water is required to refill the Reservoir and this would require an inflow rate of 3.7 m^3/s over a 10 day period which is approximately 4 times the mean flow in the south fork of Rose Creek during the summer months and this assumes there is no flow out of the Reservoir. Once the work advances to the spillway section on the dam the work will be into late November when the probably of significant inflows is low.

6.6. Cumulative Effects

The Anvil Range Mining operation located in the Rose Creek watershed is the only significant project in the area and at this time the only known associated activities in the area are related to care and maintenance of the Anvil Range Mine site. While this project to modify the FWS Reservoir is being presented as a distinct project, it is difficult to totally separate it from the past activities as the buildings, diversion channels and open pits, etc have all been created for the single purpose of extracting commercially viable ore deposits of lead, zinc, silver and gold from the area.

The timeline applied to this cumulative effects assessment will be up to and including the year 2008. This timeline has been chosen because that is the date by which the closure plan will have been prepared, approved and closure work initiated. As mentioned earlier the Reservoir lowering is being proposed to eliminate or significantly reduce the risk of a failure of the FWSD and consequences to downstream fish habitat and facilities. By 2008 a detailed plan of the final disposition of the FWSD and Reservoir will have been completed.

The past and current impacts within the Rose Creek watershed are all related to the Anvil Range Mine and can be categorized as impacts to water quality, water quantity and physical changes to habitat. The anticipated negative effects of the spillway lowering project are related to fish and fish habitat. Lowering the Reservoir is not likely to have any significant effects on the terrestrial resources, therefore this assessment will focus on the cumulative effects on fish and fish habitat.

The development of the mine has resulted in various alterations of fish habitat. These have included putting Rose Creek into a 4.8 km diversion channel to pass the creek around the tailings impoundment facilities, developing a pond on Rose Creek upstream of the diversion channel from which to pump water for the mill operations, creating barriers on the North and South Forks of Rose Creek when the main haul road was constructed and damming the South Fork of Rose Creek to create a 51.5 ha FWS Reservoir which displaced 1.7 km of stream habitat. Also, an uncontrolled release of tailings occurred from the original tailings impoundment in 1974. The following is a brief description of the effect of these facilities and activities:

- Shifting 6 m of Rose Creek into a diversion channel resulted in a 1.3 m reduction in the stream length and an associated loss of fish habitat.
- The creation of the pond for the pumping freshwater to the mill created a pond approximately 12,500 m^2 in Rose Creek changing 250 m of creek habitat into slow moving pond habitat. This pond has sufficient depth to provide overwintering habitat for fish
- The haul road created a barrier 575 m up the North Fork of Rose Creek and blocking access for arctic grayling to move upstream. The blockage on the upper end of the South Fork is also associated with the haul road
- A review of the water quality data provided in the baseline report (Anvil Range Mining Corp 2002b) indicates that between 1985 and 2001 there have been water samples taken from Rose Creek that contained concentrations of arsenic, copper, zinc and cyanide that exceeded the maximum concentrations provided in the current water licence. (Note - This study has not conducted an assessment of the source of these elevated levels).
- A subjective review of benthic data comparing total abundance and number of species suggests that the benthic community in Rose Creek has shown some impact from mining activities.
- The Anvil Range Mining Corp 2002 Baseline report concluded that mining activities may have had an impact on the arctic grayling and sculpin populations in lower Rose Creek.
- Harder (1991) concluded that the creation of the FWS Reservoir had a beneficial impact on the productivity of the South Fork of Rose Creek.

Therefore the incremental impact of the lowering of the FWS Reservoir is considered here in the context of the original mine development. Relative to pre mine conditions this project will result in returning the aquatic ecosystem back to a condition closer to what is was i.e. all stream habitat.

However, since the mine was developed, the operation has resulted in impacts to the aquatic environment which have resulted in decreased fish and benthic production in lower Rose Creek while construction of the FWSD has resulted in an increase in the productivity of fish habitats in the south fork of Rose Creek. However, it is not known if the increased production has been sufficient to offset the reduction in production that has been reported in Rose Creek below the mine site. This lowering may result in some reduction of productivity of the habitat however, it is not possible to quantify this reduction, nor to determine if it would change the assessment of the net impact the mine has had on Rose Creek.

The risk assessment predicted a probability of the effect that a dam failure associated with a peak mean flood would have on the Pelly River at Pelly Crossing 150 km downstream. The probability is higher for the do nothing and remove the dam completely scenarios as compared to the Reservoir lowering project. The cumulative effect of discharging zinc contamination throughout the Pelly River down to Pelly Crossing has not been assessed here.

6.7. Summary

Construction impacts

The construction activities of constructing the 1090 m elevation spillway is scheduled to take place once Reservoir levels are reduced to 1088 m elevation so that all aspects of the work will take place in the dry. The 1088 elevation provides a 1 m buffer to ensure that work areas remain dry during the construction phase. The contractor intends to employ appropriate erosion and sediment control measures to ensure that sediment and other deleterious substances from the work site do not enter the Reservoir or Rose Creek. Standard operating procedures will be employed during the installation of the concrete spillway and blasting to ensure that water quality and fish are not affected. Blasting will be monitored and if overpressures exceed criteria, adjustments will be made to stay within DFO guidelines. Generally, the construction practices required to complete this project are commonly used. Standard operating procedures and environmental monitoring should be adequate to ensure that the construction phase has no significant impact on the aquatic environment in the Reservoir or downstream in Rose Creek.

Operational impacts

The project clearly provides the potential to significantly benefit downstream fisheries resources. A failure of the FWSD leading to subsequent failures of the downstream dams in the tailings area will transport tailings downstream into the lower Rose and Anvil Creek areas. The flood of water will mobilize metals and other deleterious substances and contaminated water will likely reach the Pelly River. Previous tailings spills have been identified as having a negative impact on the benthic and fish communities in Rose Creek downstream of the mine. The risk assessment by SRK summarized in section 2 has predicted that zinc contaminated water and a fish kill would occur as far downstream as Pelly Crossing, 150 km downstream of Anvil Creek. Pelly River supports an important population of Chinook salmon. Anvil Creek supports a variety of fish species including arctic grayling and Chinook salmon, which support a fishery and would be impacted by a failure of the FWSD. The habitat at risk in Anvil and Rose Creeks is estimated to be 2 million m^2 of stream habitat plus the habitat and fish stocks in the Pelly River, while the net habitat loss is estimated to be 183,276 m^2 in reduced lake area minus the estimated increase in tributary stream habitat.

From a habitat balance perspective the lowering of the Reservoir will reduce the lake area by 36% (183,276 m^2) and total volume by 60% but the littoral area will actually increase slightly. While the reduced area or volume in the lake reduces the physical area for fish to live, the maintenance of the littoral area means that the area that supports plant growth, highest benthic production, fish foraging and refuge habitat (amongst aquatic vegetation) in the Reservoir could sustain a similar level of productivity after the Reservoir is lowered. At this time we do not know if near shore or off-shore habitats are more important to the production of fish in the Reservoir. The do nothing option might result in a significant impact to 2 million m^2 of stream habitat plus the loss of the entire lake habitat (514,957 m^2) in the Reservoir. In this context, the incremental loss of the 183,276 m^2 of lake habitat by lowering the Reservoir 6 m is a minor impact to the Anvil Creek watershed.

One aspect of the smaller lake size that can be mitigated is the lake's ability to support fish over winter. Lake aeration is a proven method of reducing or eliminating the winter kill of fish due to low oxygen levels during late winter periods. However, this will only offset one aspect of the reduced productivity of the FWS Reservoir due to its smaller size. Leaving the reduced area/volume of the Reservoir as an effect that could require compensation.

7. COMPENSATION OPTIONS

The need to develop a compensation plan for this project will be determined by the final judgment of the project benefits in terms of the known loss of 183,276 m^2 of lake habitat and the slight increase in littoral habitat balanced against the possible impact to 2 million m^2 of stream habitat. The selection of appropriate compensation is challenging due to the nature of the project area. The mine site including the FWSD and Reservoir will be subject to a Final Closure and Reclamation Plan that will be developed and approved over the next 5 to 6 years.

Compensation works are ideally built to function in perpetuity but DFO also prefers compensation that replaces like for like and in a location as close as possible to the area of loss. Since the FWSD will be subject to an, as yet undefined, closure plan, actions to augment lake production or establish lake-like habitat within the mine site should be considered carefully as the closure plan may render the compensation work useless. The final closure plan could include the complete removal of the FWSD or alterations to downstream flow conditions that may render compensation works in those areas redundant in 6 to 10 years from now. The upstream areas of the North and South Forks of Rose Creek are relatively pristine areas where man-made compensation has the risk of decreasing not increasing current productivity. Also, many of these areas have no access for machinery.

Ideally compensation for this project would be in the form of lake like habitat to offset the reduced size and possible reduction in productive capacity of the Reservoir. In 1992 Harder & Associates prepared a report for the owners of the mine at that time that identified habitat options for Rose Creek. This report discounted enhancement options below the tailings facility as the potential for degraded water quality to affect the option was deemed to be too great to warrant development in that area. Harder focused some of his attention to the area of Rose Creek as studies indicated that the FWS Reservoir had a significant influence on the production capabilities of the lower reaches of the South Fork down to the North Fork with the single most limiting factor in the area being the lack of access upstream into the Reservoir and habitat in Rose Creek above the Reservoir. Harder's report (1992) suggested that a channel be built that fish could use to pass around the current culvert barriers and access the Reservoir (Figure). This would open up additional lake habitat, particularly for overwintering for the grayling population in reaches 1 and 2 of the south fork of Rose Creek. Harder suggested an 8 m wide channel 450 m long would be required. Not only would it provide access to the Reservoir but it would also provide 3,600 m^2 of new stream habitat.

The report also recommended the construction of off-channel pond habitats in the lower reaches of the North and South Forks of Rose Creek (Figure 8). These ponds would provide summer rearing and over-wintering habitat. Further assessment would be required to determine the extent of groundwater infiltration to the ponds as this source of water would ensure the productivity of the habitat. Development of these ponds would be restricted to areas where the valley is relatively wide and the gradients low. Connecting channels would be required to provide access. Also, being at the upstream end of the mine site means that closure plans are not likely to affect the habitat. Additional ground studies would be required to determine the optimal pond size and locations before an estimate can be made about the amount of habitat that could be created.

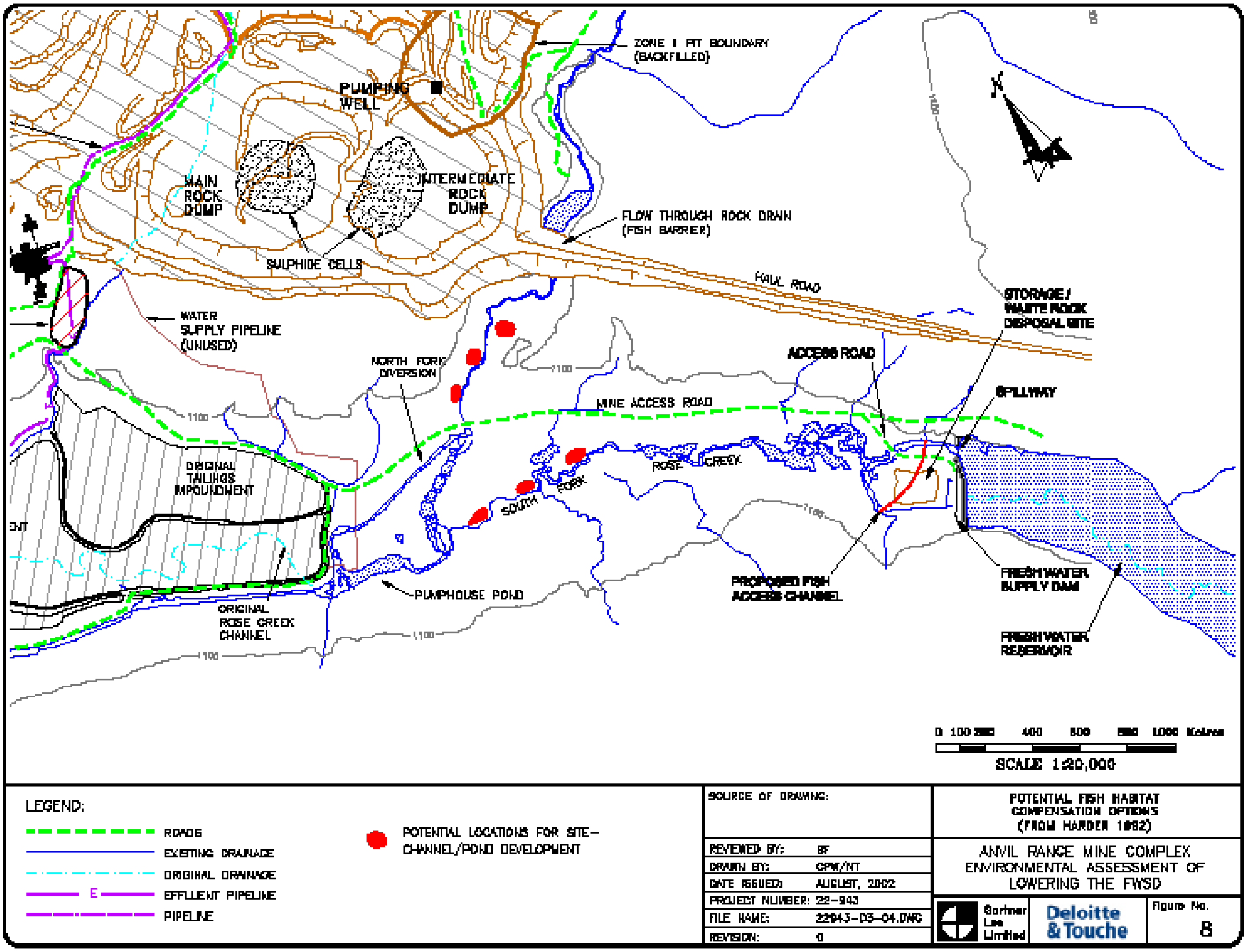
8. SIGNIFICANCE OF RESIDUAL EFFECTS

The primary effect of the project is the loss of approximately 186,860 m^2 of lake habitat. This is partially offset by the creation of 3584 m^2 of stream habitat. The project's effect on the productivity of the Reservoir could be mitigated by the fact that the littoral area of the Reservoir will remain unchanged. However, the effect of maintaining a similar area of littoral habitat once the Reservoir level is lowered is uncertain and would require further study to evaluate the effect. The other offset is the reduced risk of a failure of the FWSD and a significant reduction in the consequences of a failure on downstream tailings impoundments and fish and fish habitat in Rose and Anvil Creeks and the Pelly River. The impact to the Reservoir can also be offset to some degree by adding aeration to the Reservoir if dissolved oxygen levels decrease during the winter months. If it is determined that the entire 183,276 m2 of lake area requires compensation, the opportunity to offset this reduction reduced in lake area is unlikely to be fully met by the proposed compensation measures. If sites suitable for the construction of 50 m by 50 m off-channel ponds were identified, 74 ponds would have to be built to achieve the same total area.

A specific quantification of lost lake habitat (total area lost minus mitigation, minus compensation) cannot be provided at this time. However, the loss will be permanent as it is unlikely that the 1096 spillway/Reservoir elevation will be re-established at closure. The effect will be local to the fish populations that utilize the Reservoir and the lower, accessible reaches of the streams tributary to the Reservoir. However, because the littoral area is largely unaffected there may not be a significant adverse effect of the project on the productivity of the habitat that supports population of arctic grayling that in turn supports a sport fishery. Also, the project will provide a significant benefit to the downstream fish populations including Chinook salmon and arctic grayling if the FWSD were to fail sometime in the next 4 – 6 years.

The potential impacts associated with other aspects of the project including quarrying, site preparation and construction will be mitigated using standard environmentally sensitive construction practices and will not create any significant adverse effects.

Figure 8. Fish Habitat Compensation Options



9. ENVIRONMENTAL MONITORING AND FOLLOW UP PROGRAM

A detailed environmental management plan (EMP) will be developed while the DFO review is conducted. The plan will include details of the monitoring required during the construction phase. The follow up program will include monitoring to ensure that if unforeseen impacts arise they are identified, and plans are developed to address them. Finally, it will include details of a monitoring program to assess the success of any reclamation works that are specified.

The construction aspect of the EMP will address the mitigation measures identified in this report and provide details on aspects such as sediment control measures, preliminary calculations for blasting to demonstrate that the proposed blasting program will not impact fish. Details for sediment control will include specifications for settling ponds that are suitably sized for the precipitation events that could take place during the construction phase. The plan will include the appropriate components of the contractor's standard operating procedures. In general these will include details of a spill contingency plan for containment and clean up of spills of hazardous chemicals and fuels. A detailed list of the materials to be included in spill containment kits will be provided including kits carried on all vehicles and larger more comprehensive kits on site where refuelling will take place. Standard procedures for refuelling such as no refuelling within 30 m of Rose Creek or the Reservoir will be included.

A detailed monitoring program will be developed that identifies what will be monitored and when and what requires inspection. One of the roles of the monitor will be to provide advice and training to workers on site regarding any sensitive environmental issues. The monitor will dialogue with the contractor to identify any potential problems before they arise and prepare contingency plans to minimize any environmental consequences. The monitor will have the authority to stop any work activities that contravene the EMP or are causing an unacceptable impact to the environment. Monitoring should be proactive working with the contractor and regulatory agencies to ensure the project proceeds with minimal delay and minimal impact to the environment.

10. PUBLIC CONSULTATION

To date, numerous stakeholders have been solicited to obtain feedback on this project. The following provides a description of the consultation initiated to date with the key parties affected by this project.

- DIAND – Representatives from DIAND Water Resources in Whitehorse, namely, Dave Sherstone and Bud McAlpine, have been involved with this project since its inception in September 2001. Bill Slater became formally involved in July 2002. Representatives from DIAND Ottawa, Robert Lauer, Joanna Ankersmit and Rick Myers have also been apprised of this project as it has progressed from September 2001 until today.

- DFO, Whitehorse – A letter was sent to DFO in January 2002 apprising them of D&T's intention to proceed with the FWSD project. In June 2002, the report entitled "Phase I Reservoir Lowering Project FWS Dam, Faro Mine, YT – Summary Report and Technical Specifications" was sent to Sandra Orban. Regular meetings and discussions have been held between DFO and the Interim Receiver to communicate the intention and rationale for this project.

- YTG, Dept. of Environment – Phone conversations were held with Jon Bower, Manager, Environmental Assessment related to this project. As well at Jon's suggestion, a brief meeting was held with Don Toews, Chief, Fisheries on Aug. 21, 2002.

- Technical Advisory Committee (TAC) - The TAC members represent various constituents including Government, Non Governmental Organizations, and First Nations. The table below lists the TAC members and their affiliation.

Organization	***Name of Representative***
Anvil Range Mining Corp.	Dana Haggar
Deloitte & Touche Inc.	Valerie Chort, Wes Treleaven
Dept. of Fisheries and Oceans	Sandra Orban
DIAND, Environment	Ian Church
DIAND, Mineral Resources	Robert Holmes
DIAND, Mineral Resources	Fred Privett
DIAND, Mineral Resources	Judy Tousignant
DIAND, Mining Land Use	Allan Carlick
DIAND, Water Resources	Dave Sherstone
Environment Canada	Eric Soprovich
Gartner Lee	Eric Denholm
Ross River Dena Council	Chief Jack Caesar
Selkirk First Nation	Chief Lucy McGinty
Town of Faro	Mayor Mel Smith
Yukon Conservation Society:	Bob Van Dijken
Yukon Salmon Committee	Marg Hansen
Yukon Salmon Committee	Lorelei Smith
YTG, Economic Development	Rod Hill
YTG, Faro MLA	Jim McLachlan
YTG, Renewable Resources	Chuck Hubert

The FWSD project was described to the TAC through the following correspondence / meetings:

- TAC Memo dated March 12, 2002. Specifically, page 3 described the Interim Receiver's intention with respect to the FWSD:

  " The freshwater dam was constructed approximately 35 years ago. Since then, modifications were made to the original structure to strengthen the dam. Historically, concerns have been expressed that the dam does not meet current standards/guidelines relating to earthquakes and cracking at the crest of the dam. During 2001, three studies were undertaken to characterize the dam from a geotechnical perspective. These included:

- *A Failures Mode and Effects Analysis and a Physical Stability Assessment, both conducted by BCG Engineering. The first indicated that the structure provides some flood protection for the downstream tailings impoundment system and the second indicated that the dam was more stable than was originally understood and that there were minimal risks of a dam failure at this time with the exception of the low level pipe noted below.*

- *The low level pipe in the dam, used historically to lower the water level in the freshwater Reservoir, was then inspected in September by a dive team. Key findings were that the pipe wall thickness had deteriorated in several locations and the thickness had reduced up to 45% at these locations. In addition, it was determined there was a 5 foot bend in the pipe at approximately the centre of the dam. A geotechnical inspection followed the dive inspection and indicated that there was no sign of cracking, settlement or turbid seepage. The pipe according to the as-built drawings has been installed on bedrock and the reason for the bend in the pipe has not been determined.*

With this new information, a program to reduce the water level behind the dam was initiated in late September utilizing siphons to relieve pressure on the dam and the low-level pipe. As well, engineering assessments and investigations relating to the requirements for a full breach were initiated to determine any requirements for a residual structure or gate control system upstream from the tailings impoundment infrastructure.

The plan is to proceed in two steps:

- *First lower the spillway up to 8 meters to allow the spring freshet to flow through the lowered spillway system. This would ensure that the level of the freshwater Reservoir would be significantly below its current design level. This work is planned for the fall of 2002. During the winter, a drilling program and required survey work was completed as part of the spillway design requirements.*

- *Over the next 12 - 24 months, the dam breach and residual structure will be designed and constructed, and the low level pipe issue will be corrected in such a way as to minimize the risk to the down stream tailings infrastructure. "*

- The Environmental matters section of the May 17, 2002 court report was sent to the TAC members in preparation for the July 17 2002 Annual Meeting. Paragraphs 19 to 23 described the background, rationale and plans related to the FWSD and the low-level pipe. Of particular relevance was paragraph 23:

    - *"Lowering the spillway is considered the first phase of the dam reclamation. Following the lowering of the spillway, the next phase will address the issue of the low-level pipe. The Interim Receiver intends to mitigate the risk by either removing the pipe or remediating the pipe in place during the 2003 operating year. This work cannot be deferred beyond next year. The final disposition of the tailings in a Closure Plan is still to be determined. This will impact what residual structure, if any, is to be maintained upstream at the current freshwater dam location. Once a determination is made then the final phase of the reclamation program can be planned and implemented."*

- At the July 17, 2002 TAC meeting, plans for the FWSD were discussed. The minutes issued to TAC members summarized the issue as follows:

  "The Fresh Water Supply Dam (FWSD) was identified in the Comprehensive Risk Assessment Matrix as the highest risk element at the site. With this knowledge, the Interim Receiver initiated investigations to fully understand the issues relating to the dam and began a program of risk mitigation and dam remediation to respond to the issues that engineers have highlighted.

  In 2001, the Interim Receiver engaged professional divers to complete a comprehensive inspection of the low level pipe1 using both ultrasound and visual inspections. The results showed the pipe had deteriorated by 50%, and a 1.5 m slump was identified along a 20 m section of the pipe in the centre of the dam. The water level in the Fresh Water Reservoir was immediately lowered following these findings to reduce the overall pressure on the dam and on the pipe. Additionally, a sediment monitoring program was established at the low-level pipe outfall to identify changes in seeps occurring at the dam face. Such changes should they occur may indicate a loss of integrity of the pipe.

  Phases of Risk Mitigation

  A risk mitigation plan was developed, with Phase I and Phase II for immediate implementation. The objective of these two phases is the mitigation of the risk presented by the deterioration of the low level pipe. For clarity, the definitions for each of the three phases are listed below:

  - *Phase I – involves the lowering of the water level in the Fresh Water Reservoir by approximately six meters and the creation of a lowered spillway in the Fresh Water Supply Dam (FWSD). This work phase is planned for Fall 2002.*

  - *Phase II – involves mitigation of the risk posed by the low-level pipe. Pending further engineering studies and risk comparisons, it may involve the removal or the rehabilitation of the pipe. The engineering assessment will be completed in Fall 2002 and any work that is shown to be necessary to mitigate risks will be completed in 2003.*

  - *Phase III – involves the determination of the final configuration of the FWSD. This phase is linked to the final disposition of the tailings and the closure criteria established for the downstream structures, all of which are components of the Final Closure and Reclamation Plan, to be submitted for approval in 2006.*

Rationale for a Phased Approach

  The rationale for a phased approach is that the purpose of Phase I – the lowering of the spillway – is required because of the mechanics involved in lowering the Reservoir. It provides certainty that Phase II can be completed in a single construction season. In addition, Phase I also reduces the likelihood of different failures mechanisms of the dam, in particular:

  - *Potential for piping along the low-level pipe: Based on a prior risk assessment, lowering of the Reservoir will reduce the average hydraulic gradient, likely the main mechanism responsible, by 33% and hence, reduce the potential for piping. This is a risk reduction in the likelihood of a piping event occurring.*

o *Piping within the frost-affected zone: Based on the new, lowered spillway configuration, the pond will never again be retained within this zone of the dam, unless an event approaching the PMF size is retained.*

o *Ability to handle extreme precipitation events: Based on the new lowered spillway, the additive abilities of the two spillways and the extra storage capacity behind the dam, it is now possible that the FWS Dam could handle the inflow of PMF event without overtopping.*

The purpose of Phase II – the removal or remediation of the low level pipe – is to meet the objective of mitigating the risk presented by the current status of the low level pipe. It is currently the intent of the Interim Receiver to proceed with Phase II in the year immediately following Phase I. However, further engineering studies that are now underway may conclude that the risks remaining after Phase I do not require immediate removal or rehabilitation of the low level pipe. It is therefore desirable that all Phase II options be kept open until the engineering studies are completed. The decisions relating to the final use of this structure are separate from the decisions for the design of Phases I & II. As mentioned above, the final use of the structure will ultimately be decided as part of the Final Closure and Reclamation Plan, to be developed during 2003-2008, as proposed in the Project Description recently submitted to DIAND Environment."

- Yukon Fish and Wildlife Management Board - An email requesting a contact and a meeting was sent on August 12, 2002. No response was received. A copy of this final report will be couriered to the Board for their review.

- Yukon Fish and Game Association - A meeting was held between D&T and Adam Skrutkowski, Director, Yukon Fish & Game Association on August 22, 2002. A copy of this final report will be couriered to the Association for review.

- Town of Faro - An Open House was held in Faro on Aug. 22, 2002. Flyers notifying council and the Town of Faro of the meeting were posted in various locations in the town. No persons from the town attended the meeting. In addition, on August 23, an open house related to the CEAA application for the renewal of the water licences was also held in Faro. The information presented included a description of the plans for the FWSD project. No inquiries were made regarding the impact of this project. A copy of this report will be sent to the Town of Faro.

- Ross River Dena Council
  As members of TAC, Ross River received copies of the correspondence items listed above. Representatives from Ross River attended the July 17 TAC meeting in Faro, namely: Chief Jack Caesar, Jason Acklack, Jenny Caesar, Dorsi Dryer, Mike Gergel. A letter was sent to Chief Jack Caesar advising him of the Open House being held in Faro with respect to the FWSD. As well, offers have been extended to meet with him and council. A copy of this report will be sent to the Ross River Dena Council. DFO will also initiate consultation with Ross River and other First Nations as appropriate.

Stakeholder consultation will continue during the approval process.

11. REFERENCES

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Photographs

Deloitte & Touche

- PHOTOGRAPHS -

PHOTOGRAPH 1

Tributary entering FWS Reservoir from north during high flow conditions (Aug 29 /00)

PHOTOGRAPH 2

Tributary entering FWS Reservoir from southeast during high flow conditions (Aug 29 /00)

Deloitte & Touche

- PHOTOGRAPHS -

PHOTOGRAPH 3

Lower section of Reach 4 South Fork Rose Creek

PHOTOGRAPH 4

FWS Reservoir with Faro mine site in background

Deloitte & Touche

- PHOTOGRAPHS -

PHOTOGRAPH 5

Shoreline at Polygon F

PHOTOGRAPH 6

South Fork Rose Creek Inlet (July 26 / 02)

- PHOTOGRAPHS -

PHOTOGRAPH 7

Exposed Substrate at Polygon G (July 26 / 02)

PHOTOGRAPH 8

Susbstrate at Polygon M - dam ((July 26 / 02)