Mine Closure 2011 — A.B. Fourie, M. Tibbett and A. Beersing (eds)

doi:10.36487/ACG_rep/1152_111_Mead

Faro Mine remediation project – an overview

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Abstract

Planning for remediation and closure of the Faro Mine is a major undertaking, the responsibility for which has fallen to government. Located in Canada's North, the Faro Mine provided almost 15% of the world's lead and zinc supply throughout 30 years of intermittent operations. The last operator, Anvil Range Mining Corporation, sought protection under the Companies' Creditors Arrangement Act (CCAA) and was placed into receivership in 1998. In January 2003, the federal and territorial governments acknowledged that the Faro Mine would not reopen and that a permanent, long-term remediation plan would be needed. The two governments then entered into a joint agreement with the Ross River Dena Council (RRDC) and Selkirk First Nation (SFN), committing to a collaborative approach to developing and implementing a remediation plan for the site.

Options for remediation of the Faro Mine have been considered for over 25 years. In this time, hundreds of options have been identified and reviewed by technical experts in all levels of government and the private sector. This process has led to an increasing understanding of the underlying issues associated with 30 years of mining, and in turn, allowed a better definition of the agreed upon solution. However, work must be carefully planned, as the challenges are significant. A final closure and remediation plan must address the central issues of public health and safety and environmental protection, and account for such matters as First Nations and public involvement, and managing social and economic opportunity.

This paper will provide an overview of this major remediation project, touching on many of the challenges that have been overcome to date, and highlighting those that can be expected in the next five years. Major themes will include transitioning from ten years of interim receivership to long-term government care and control, responding to an ever evolving environmental landscape, navigating a unique regulatory regime, and involving First Nations and Yukoners in the potential economic benefits of the project.

1 Introduction

The Faro Mine is located in south-central Yukon; it is 22 km north of the town of Faro, and almost 200 km northeast of the city of Whitehorse. About 65 km east of the mine complex lays the town of Ross River. Ross River is home to the Ross River Dena, a member of the Kaska First Nation. The entire complex falls within the traditional territory of the Ross River Dena Council (RRDC). Before mine development, people from Ross River utilised the area around the mine extensively for traditional activities. The Pelly River downstream of the mine site bisects the traditional territory of the Selkirk First Nation (SFN) and is integral to the life and health of its people.

The mine sites are located in the watersheds of two tributaries of the Pelly River. The Faro Mine and tailings areas are in the Rose Creek watershed, which drains to the Pelly River via Anvil Creek. The Vangorda/Grum area is in the Vangorda Creek watershed, which joins the Pelly River at the town of Faro.

1.1 Challenges due to location

Due to its location, the mine site faces the following challenges:

- Extremes of climate: average lows of -26°C in January and average highs of +21°C in July.
- Seismically active area: mine site located close to the Tintina Trench fault line.
- Mine footprint straddles a watershed divide, with two distinct pathways for water flowing off the site.

- Mine site falls within traditional territory of two Yukon First Nations, and directly upstream of a third.
- The town of Faro, created to service the mine now faces a declining population and aging infrastructure.

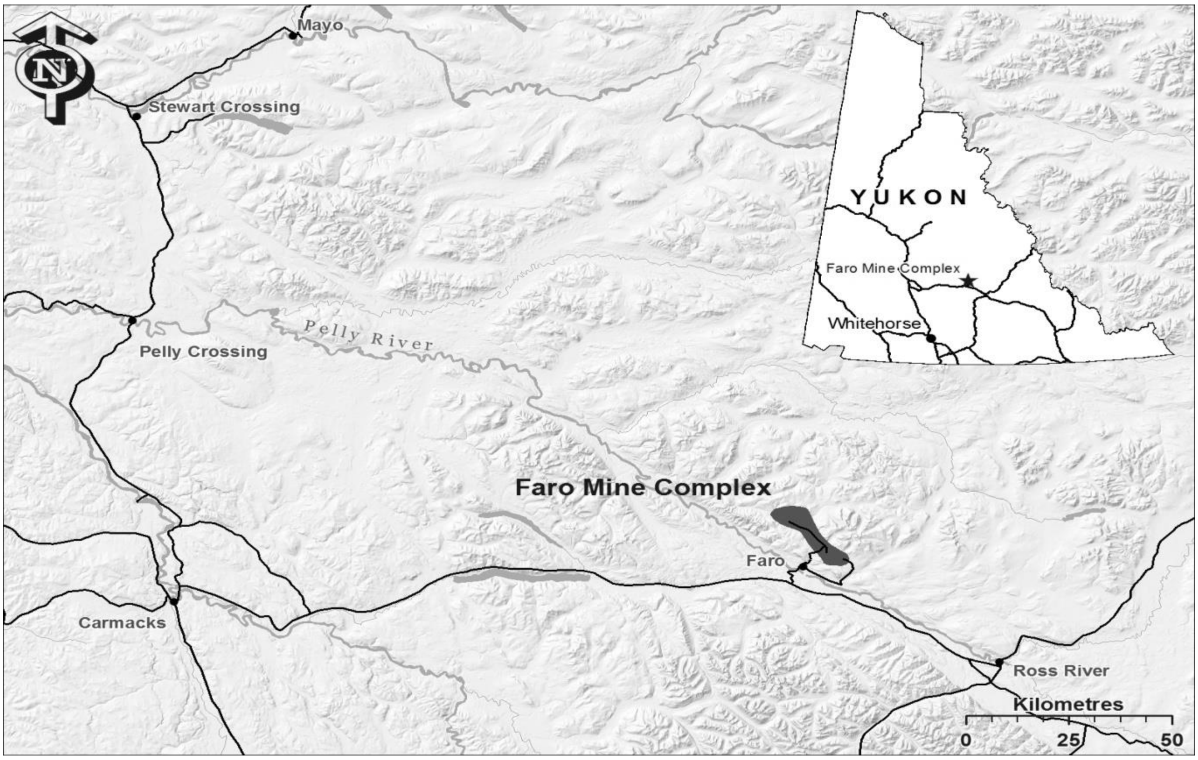

Figure 1 Location of the Faro mine site

2 Operational history

The Faro Mine opened officially in 1969, and the first owner, Cyprus Anvil, quickly became the largest private sector employer in the territory. It also represented well over a third of the economy of Yukon, and by the mid 1970s was the largest lead/zinc mine in Canada. While in production, approximately 70 million-tonnes of lead-zinc ore at an average metal content of 10% were produced.

Cyprus Anvil Mining maintained operations until 1982 when economic conditions forced the first of several shut-downs. To support tailings disposal, Cyprus Anvil developed three tailings impoundments in the Rose Creek Valley. The second one, constructed in 1974, required an initial diversion of Rose Creek. The third one, developed in the early 1980s, necessitated construction of the existing Rose Creek Diversion Channel and two dams across the Rose Creek Valley.

Operations at the Faro Mine resumed under Curragh Resources Ltd. in 1986. Curragh recognised limited remaining resources in the Faro pit and began seeking approvals and constructing infrastructure, including the 12 km Vangorda haul road, for mining at the Vangorda/Grum Mine. Mining at Vangorda commenced in 1990 and continued, concurrent with mining at Faro Mine, until mid 1992 when resources in the Faro pit were depleted. Once mining ceased in Faro pit, Curragh began depositing tailings in the Faro Pit. In late 1992, Curragh sought bankruptcy protection and ceased mining operations.

Operations resumed in 1994 under Anvil Range Mining Corporation who continued mining the Vangorda deposit and proceeded with the development of the Grum Deposit. Stripping of the Grum pit began prior to the 1993-94 shutdown, but the bulk of the Phase 1 mining occurred from 1994 to 1998. Processing of ore from the Grum deposit began in mid 1995.

Anvil Range Mining Corporation terminated mining operations in late 1996 for economic reasons and, following a financial restructuring, restarted in 1997. In 1998, all mining operations ceased for the last time when Anvil Range sought protection under the Companies' Creditors Arrangement Act, and was placed into receivership. At the time, a reclamation bond of $14 million was in place, and an expansion of the Grum pit was underway, with approximately three to six years of additional mining anticipated.

2.1 Challenges due to historic operations

After almost 30 years of historic mining activity, the Faro Mine, with a footprint of over 25 km^2, now consists of three distinct areas: the Faro Mine area (incorporating the Faro pit, disused mill, and associated buildings), the Rose Creek tailings impoundment situated in Rose Creek valley, and the Vangorda Plateau (incorporating the Grum and Vangorda Pits).

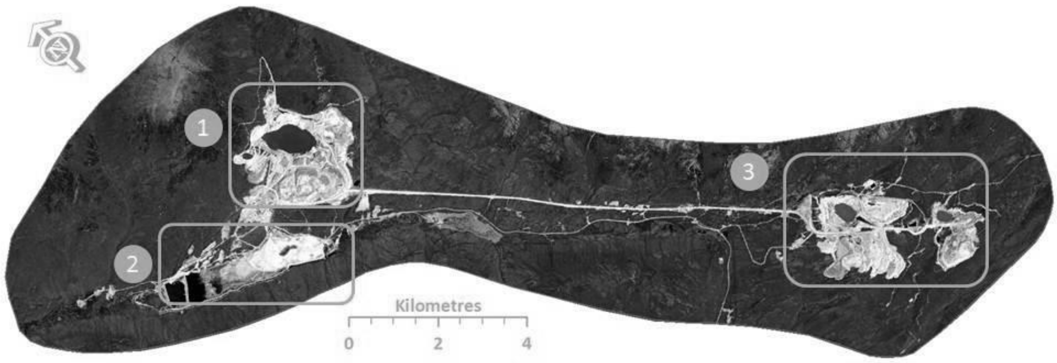

Figure 2 Faro Mine area (1), Rose Creek tailings (2), and Vangorda Plateau (3)

The Faro Mine area and the Vangorda Plateau are connected by a 13 km heavy haul road. This road was used to truck ore from the Vangorda and Grum pits to the Faro mill for processing. The lead and zinc concentrates that were produced included economic quantities of silver and gold, and were shipped to international smelters via Skagway, Alaska. Mining at the Faro Mine began along the northwest side of the Faro pit. The pit was expanded to the west and south until it reached its current size of roughly 1,700 m long and 1,000 m wide. The pit was allowed to flood in the 1990s, after the economically extractable ore was mined, and now contains a water body that is commonly referred to as the Faro pit lake. The walls of the pit contain significant pockets of mineralised rock. Above the water level, this rock continues to release contaminants into the pit lake. Much of the south and east walls of the pit are covered by waste rock that also release contaminants into the water. The northeast pit wall is physically unstable, and is gradually ravelling downwards into the pit.

Waste rock was deposited in a series of dumps that surround the pit. There is now a total of about 260 million tonnes of waste rock in the Faro dumps, and they cover roughly 335 ha of surface area. There are approximately 30 separate dumps, each with a unique history and composition.

The geochemistry of the dumps has been studied extensively. In general, there are areas of acidic and metal-leaching waste in most of the dumps, and none of the dumps can be considered completely benign.

Faro Creek initially flowed directly over the Faro pit area and joined Rose Creek near the middle of the current tailings area. The Faro Creek diversion captures the water above the northernmost dumps and routes it to the northeast of the pit where it flows into the north fork of Rose Creek. Studies have shown that it is not stable for the long term, and further movement of the northeast pit wall will breach the channel if it is left in its current alignment.

Infiltration through waste rock dumps is leading to contamination of groundwater at the Faro Mine area. This groundwater contamination is causing increasing contaminant levels in some surface waters, though these surface water changes are not ecologically significant at this time. Contamination of groundwater is expected to increase significantly in the future.

Ore processing took place in the mill complex located just southwest of the mine area. There are a number of structures in the mill area that remain in use, including the office, warehouse and the portions of the mill that have been converted to water treatment. The mill pad appears to consist of a range of rock materials, with hydrocarbon and metal contamination evident in many areas.

Throughout most of the operating periods at the Faro Mine, tailings were deposited in the three impoundments that comprise the Rose Creek tailings facility. The original impoundment was used from 1969 to 1975, has a surface area of 41.7 hectares, and holds about 6,300,000 m^3 of tailings. The secondary impoundment was used from 1975 to 1982 and again in 1986. It has a surface area of 54.5 hectares and contains about 10,400,000 m^3 of tailings. The intermediate impoundment was used from 1986 to 1992, has a surface area of 99 hectares and contains about 11,900,000 m^3 of tailings. Tailings produced from 1992 to 1998 were deposited in the Faro pit.

The impoundments were created by a series of dams and dam raises. The stability of the dams has been comprehensively investigated. Those studies concluded that the intermediate dam would be stable in the Maximum Credible Earthquake (MCE), but that weaknesses in the underlying soils mean that the secondary dam would require upgrading in two areas to ensure stability in the MCE. The geotechnical properties of the tailings have also been studied in detail, and the conclusion is that they would be subject to liquefaction and localised movement even in earthquakes that are less strong that the MCE.

A number of water management structures are also present in the tailings area. The most significant of these is the Rose Creek diversion channel, which routes the entire flow of Rose Creek around the tailings impoundments and Cross Valley pond. Recent reviews of the diversion and the local hydrology have concluded that a 1:500 year flood event could pass through the diversion, but larger floods would spill onto the surface of the intermediate impoundment.

The tailings contain an excess of acid generating sulphide minerals, and in fact most of the exposed tailings surface is quite acidic, with very high levels of soluble metals. The acidic conditions extend up to 6 m deep in the original impoundment. Precipitation passing through the tailings picks up some of the soluble contaminants and transports them down into the underlying tailings and soils.

Extensive groundwater investigations throughout the tailings area have identified an essentially continuous aquifer of sand and gravel outwash below the tailings. Sampling to date has identified increasing trends in concentrations of some contaminants in some areas beneath the tailings. However, this groundwater contamination is limited and is not ecologically significant at this time. One possibility is that the contaminants are being temporarily held up by reactions with the organic soils that lie between the tailings and much of the aquifer. Contamination of the groundwater below the tailings is expected to increase significantly at some time in the future.

The Vangorda Plateau includes the Vangorda pit, Vangorda waste rock, Grum pit, Grum waste rock, Grum overburden, Vangorda water treatment plant, Little Creek dam and various ancillary facilities.

The Vangorda pit is about 1150 m long and 350 m across at its widest point. The deepest point in the pit was about 150 m from the crest, but the bottom of the pit is now completely flooded. The Grum pit is roughly circular with a diameter of about 1,000 m from crest to crest. Pit wall rock and waste rock continue to release contaminants into the water that accumulates in both pits. Water quality in Vangorda pit is the worst of the three pits on the site.

There are two waste rock dumps in the Vangorda/Grum area. The Vangorda dump contains about 16 million tonnes of material and covers about 40 hectares. The Grum dump contains about 28 million tonnes of waste covering about 128 hectares. Geochemical studies of the Vangorda/Grum waste rock indicate that the Vangorda waste is generally strongly acid generating. The walls of the Vangorda pit and the in-pit dumps are also strong sources of acidity and metals. The Vangorda waste rock dump includes a seepage collection system and all water collected requires treatment before it can be released. Groundwater contamination is expected to increase in the future.

The major water management structure in the area is the Vangorda Creek diversion. However, the diversion was designed for only a 1:100 year flood event, and it has required extensive maintenance since mining ceased. Other water management structures in the area include a water treatment plant and settling pond located above the Grum pit, which are used to treat water from the Vangorda pit and waste rock.

3 Post operations management

From 1998 to 2008, ongoing site care and maintenance was carried out by the court-appointed Interim Receiver, with funding provided by the Government of Canada. These activities were required to ensure ongoing protection of human health and safety and the environment, and primarily consisted of seasonal water treatment, monitoring and maintenance of key physical structures and provision of site security.

In 2003, after seeking independent expertise about remaining mineral values in the area, the federal and territorial governments concluded that the mine did not have sufficient remaining value to support either renewed operation or the costs associated with mine closure and reclamation. At that time, the governments agreed to accept responsibility for closure planning and closure implementation at the Faro Mine.

In April 2003, the Yukon Government (YG) and the Government of Canada (Canada) concluded the Devolution Transfer Agreement (DTA), from which the YG took over the environmental responsibilities and obligations associated with lands previously under the management of the Northern Affairs Program of the Department of Indian Affairs and Northern Development (DIAND). Due to the unfunded environmental liabilities associated with historic mining activities at the Faro Mine, Canada retained the financial liabilities associated with the site.

Following conclusion of the DTA, an agreement was reached between governments, RRDC (on behalf of the Kaska Nation) and SFN to work together on the development of a remediation plan for the site. In 2004, an Oversight Committee (OSC) was established with representatives of Canada, YG, SFN and RRDC (on behalf of the Kaska Nation). This body provided strategic oversight to the project – specifically to oversee the selection of a preferred closure option to address the environmental issues at the site. It was acknowledged that once a preferred remediation option had been identified, a revised approach to governing and managing the project would be required.

In October of 2008, after a four to five year process of fully characterising site conditions and scoping, developing and evaluating possible conceptual level options for long term closure and remediation of the site, the OSC arrived at a consensus on a preferred closure plan. This essentially brought the role of the existing OSC to a close, and initiated a new series of discussions related to long term governance and management of the project. As part of this process, YG and Canada signed a bi-lateral agreement, committing both governments to play a co-proponent role through environmental assessment and permitting. Discussions between YG, Canada and Affected Yukon First Nations (AYFN as per the DTA; Ross River Dena Council, Selkirk First Nation and Liard First Nation) are ongoing in this regard.

In February 2009, the court appointed Interim Receiver of the Faro Mine discharged its responsibilities, and overall management of site operations was transferred to YG in March 2009. Following a six-month open and competitive public tender process, a three year care and maintenance contract was awarded to Denison Environmental Services. An important element of the new contract was inclusion of an AYFN and Yukoner participation strategy that set targets for maximising local socio-economic benefits.

3.1 Management challenges in the post operations era

- The Devolution Transfer Agreement does not provide a detailed template for how governments' responsibilities must be exercised in respect of the Faro Mine. New approaches are required for each major phase of the project.
- The project has a high profile within sponsoring bodies / agencies and in the politics of the host communities – Treasury Board is keenly interested; the overall degree of accountability required by Canada is commensurate with the size and complexity of the project.
- Ensuring that all objectives of the project are met whilst making clear distinctions between project governance, management and realisation of social and economic opportunities remains a challenge.
- The planning time horizons used by the Interim Receiver (short) as compared to YG resulted in significant and at times unplanned additional works during the initial years of care and maintenance transition.

- Calibrating AYFN and Yukoner participation strategies with existing capacities, expressed needs and interests related to longer term involvement, and the actual opportunities provided by the scope of the project at the pre-implementation stage is an ongoing challenge.
- The Yukon is currently a jurisdiction that is experiencing a relative boom in mineral exploration and development. Consequently, availability of both internal and external qualified resources remains an issue.
- As closure planning progresses, the need to integrate care and maintenance decision making and activities with those related to longer term remediation becomes ever more important. Weaving remediation with care and maintenance has required significant shifts in site operations planning and management.
- Complicated communication matrices will exist between functional areas, contractors, business, local government, communities, stakeholders, interest groups etc.

4 Remediation planning and the future

Options for closure and remediation of the Faro Mine have been considered for over 25 years. In this time, hundreds of options have been identified and reviewed by technical experts in all levels of government and the private sector. This process has led to an increasing understanding of the underlying issues associated with almost 30 years of mining, and in turn allowed a better definition of solutions to these issues (SRK Consulting, 2011).

Several studies related to the closure of portions of the site were completed during operations. An Integrated Closure and Abandonment Plan or “ICAP” was produced for the site operator in 1996, reviewed by regulatory agencies and other interested parties, but never approved or revised. The Interim Receiver initiated a review of the ICAP in 2002, as part of the application for a new water license. That work included review of all of the options assessed in the ICAP and the previous closure-related studies. It concluded that there were several options that could no longer be implemented and others that would not meet approval of the broader range of stakeholders that are now involved in the project.

From 2005 onwards, the Faro Project Execution Team has endeavoured to maintain transparency throughout the closure planning process and seek input from governments, communities, other stakeholders and the public. This has been accomplished through a variety of forums including workshops, information sessions and meetings, open houses, working groups, site tours, home visits and published materials. Community coordinators have played an integral role in disseminating information in communities and in gathering and interpreting community input.

A series of closure planning workshops between 2002 and 2005 helped in scoping of closure issues, identification of closure methods and scoping of study programs. Participants at these workshops varied, but at times included representatives from federal and territorial government departments, First Nations, Town of Faro, regulatory agencies and land claim resource management agencies.

In September 2006, an Independent Peer Review Panel (IPRP), made up of nine of North America’s leading experts in the scientific and engineering disciplines underlying mine closure planning, was commissioned to review a set of alternatives that had been developed from much of the work described above. The purpose of this review was to assess whether or not the proposed closure alternatives provided a full and reasonable span of possible options for consideration in the selection process, and that the individual alternatives were described in a manner that was complete, rigorous, and appropriate for comparing options in a subsequent selection process. The outcomes of the initial IPRP review, coupled with results from both additional technical studies and community/stakeholder feedback allowed further refinement of initial alternatives into a final short list of five closure options.

In early 2008, the IPRP was reconvened to review the short-listed options for technical feasibility and completeness. The Panel confirmed at the time that the remaining remediation options were all technically feasible and equally capable of achieving the same level of water quality in the downstream receiving environment.

Community members, technical consultants and governments spent over a year evaluating the risks and uncertainties associated with the performance of the short list of closure options against the overall project objectives. The findings of the assessment and evaluation process were presented to the OSC, who reviewed the findings and were able to agree on a preferred option that will form the basis of the overall closure and remediation plan for the Faro Mine. This essentially brought the role of the existing OSC to a close, and initiated a new series of discussions related to long-term governance and management of the project.

4.1 Summary of the remediation plan for the Faro Mine

The current design for remediation of the Faro Mine includes the following major elements:

4.1.1 Faro Mine area

- Retain Faro pit as a contaminated water storage reservoir and utilise it for storage of water treatment sludge.
- Reconstruct the Faro Creek diversion to improve physical stability and flood handling capability.
- Breach the north fork rock drain and construct a lined channel for north fork Rose Creek to avoid contamination by groundwater.
- Consolidate highly sulphidic waste rock.
- Cover all waste rock with engineered covers designed to meet specific needs of each waste rock component (cover design varies depending on types of rock being covered).
- Relocate tailings in emergency tailings area to tailings pond.
- Collect contaminated ground and surface water for storage in Faro pit and provide seasonal treatment using lime precipitation in a high density sludge treatment plant.

4.1.2 Rose Creek tailings area

- Reconstruct upper Rose Creek diversion channel to pass the probable maximum flood (PMF) and provide fuse plug to divert peak flows.
- Repair lower Rose Creek diversion channel to pass 1:500 year flood event.
- Construct a new spillway on the intermediate dam, capable of passing the PMF flow from Rose Creek.
- Raise the intermediate dam to provide flood routing capacity for the PMF.
- Construct water conveyance and erosion control facilities on the tailings cover.
- Upgrade the secondary dam to withstand the maximum credible earthquake (MCE).
- Breach the Cross Valley dam.
- Cover tailings surface with engineered cover.
- Collect contaminated ground and surface water for storage in Faro pit, and seasonal water treatment.

4.1.3 Vangorda Plateau

- Retain Vangorda pit as a contaminated water storage reservoir and storage location for treatment sludge.
- Retain Grum pit as a pit lake.
- Build a new Vangorda Creek diversion to improve physical stability and flood handling capacity.
- Cover waste rock with engineered covers.

- Collect contaminated ground and surface water for storage in Vangorda pit and seasonal water treatment.
- Breach watercourse crossings on the haul road.

A preliminary project schedule for the execution of the remediation plan has been developed. Although social, environmental and cultural factors have not been fully considered to-date, the preliminary execution schedule allows for an assessment of the potential social and economic effects of the remediation plan itself.

Construction is planned to take place over a 14 year period. Following this, a 25 year transition period is expected, where a more hands-on adaptive management approach will be adopted before site care and maintenance settles down to long-term equilibrium. Site management and water treatment will be required in perpetuity.

Under the current execution schedule, an average of 80 tradespersons and professionals would be employed yearly during the 14 year implementation phase, with peak employment of approximately 115 workers. There will be a heavy civil construction fleet, a heavy mining fleet and a specialised trades team. All these trades will have approximately 14 years of work. Throughout the implementation and the longer-term phase, there will be a care and maintenance and water treatment team, and an overall monitoring team. The majority of workers are expected to come from Faro and Ross River. Post implementation, it is expect the project will require ten permanent workers, five seasonal workers and five workers related to technical and First Nation traditional environmental monitoring, land stewardship, and research in the post-construction phase.

The current estimate for construction costs associated with the Faro Remediation Plan is $577 million. This estimate includes provisions for the major execution activities, engineering, and post-construction care and maintenance.

4.2 Remediation planning challenges

The mine site encounters the following remediation challenges:

- Overall project delivery strategies and adopting best practice standards from industry are sometimes challenging to implement within a government procurement context.
- Significant specialist expertise and resources are required to manage over sustained periods of time; specialist technical resources are limited within Canada – as the world resource development industry expands, the availability of these resources decreases.
- Uncertainties due to relatively new regulatory regime in Yukon, with few examples of projects of this size and nature (remediation, not development).
- Emerging environmental issues and rate of geochemical change challenge the planning and regulatory timelines.
- Extremely long project timeline (100+ years) challenges overall approach to project management and increases the risk of significant resource turnover.
- Climatic variations limit implementation scheduling.

The immediate next steps in remediation planning involve developing the selected remediation plan to a stage where it is suitable for assessment under the Yukon Environmental and Socio-economic Assessment Act (YESAA). This includes advanced design engineering, social and economic effect assessments, initial implementation scheduling and planning, and consideration of Traditional Knowledge held by local First Nations. Once the regulatory and permitting stage is complete, the project will move through the construction and adaptation phases into long-term care and maintenance.

References

SRK Consulting (2011) Project Description Draft 4A excerpted from Project Proposal Draft, pp. 1–3.