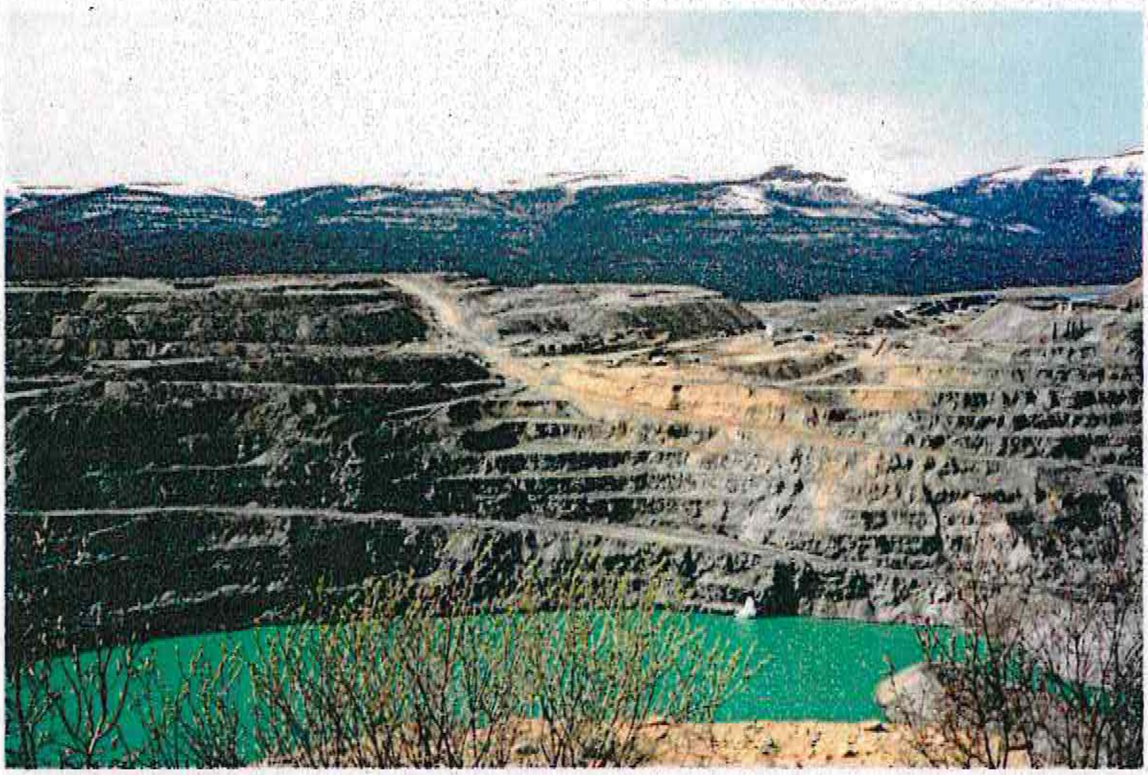
GOVERNMENT OF CANADA

NORTHERN AFFAIRS PROGRAM
WHITEHORSE, YK

CURRAGH INC.

MINE CLOSURE COSTS



EVALUATION REPORT

Report # NAP303

July 1993

GOVERNMENT OF CANADA

NORTHERN AFFAIRS PROGRAM
WHITEHORSE, YK

CURRAGH INC.

MINE CLOSURE COSTS

EVALUATION REPORT

Table of Contents

APPENDICES

CURRAGH INC.

MINE CLOSURE COSTS

SUMMARY

This report was prepared to provide a summary of estimated closure costs for the Faro operations and the Sa Dena Hes mine, and to identify possible deficiencies in the closure plans and/or the available information. The study was based on a review of the documents (listed in Appendix I) made available by the Northern Affairs Program and on brief site visits to the Faro and Sa Dena Hes mining operations.

A number of studies and reports have been prepared by Curragh Inc. on closure for the various components of the operations. The cost estimates in this review are based on work as specified by Curragh Inc in its reports, with any noted exceptions, and the work is undertaken, where possible, by contractors.

FARO OPERATIONS

Mining of the Faro ore deposits was initiated by Cyprus Anvil Mining Corp (CAMC) in 1969 and continued until 1982. Curragh Inc. acquired the operation in 1985. Production continued from the Faro open pits from 1986 until 1992. Development of the Vangorda and Grum ore deposits was started in 1990 as a replacement for the Faro deposits.

Faro Site

The Faro ore deposit occurred as an elongated lens of sulphides, which was 2000 m long, 800 m wide and 0 to 90 m thick. Faults split the lens into three main zones. The Zone I and III orebodies were mined in the main open pit, while Zone II was mined as a separate open pit located to the south of the main pit. The Zone II pit was subsequently filled with waste rock from the main open pit. Underground workings were developed from the southwest wall of the main Zone I/III open pit.

Aside from small remnants of ore remaining in the pit, the three zones comprising the Faro open pit and underground are mined out. Some 55,000,000 tonnes of ore and 97,000,000 m^3 of waste rock have been removed from the three zones in the deposit.

On closure of the Faro pit, it is to be filled with water. Tailings have been deposited in the Faro pit since mid 1992 and it is anticipated that tailings will be deposited in the pit until permanent closure. With the Vangorda/Grum and Down Valley tailings (Alternative 5) in the pit, there would be a 4 m water cover over the tailings.

The ore and much of the waste rock from the Faro open pits contains sulphide minerals, which have the potential to oxidize and produce an acid rock drainage (ARD).

The flows from the seeps on the exposed northwest wall are low, but the zinc concentration is high. Curragh Inc. considers that the dilution and neutralization effect of the water in Faro Lake should result in discharge water of satisfactory quality from the pit. The seeps from some of the waste dumps are acidic and contain zinc values. The flow from the southwest main dump, in particular, consistently has high zinc concentrations. While the flow varies seasonally, it averages 3.2 l/s. Zinc concentrations are of the order of 20 - 25 mg/l.

Reclamation of the Faro open pits consists primarily of controlling water flows to, and from, the pits and waste dumps as well as treatment of the ARD.

There has, reportedly, been movement detected on the southeast slope of the waste dump located adjacent to the Vangorda Haul Road causeway and immediately above the North Fork of Rose Creek. Monitors have been installed to track this movement.

It should be noted that long term stability of the waste dumps was not examined in this report. It is assumed in this report that there is no work required to ensure that the dumps are stable in the long term.

The closure cost estimates for the Faro open pits are presented in Table 2.1.1.

Mill Complex, Surface and Other Facilities

Ore from the Faro open pits as well as the Vangorda, Grum and other deposits is processed in the Faro mill to produce zinc and lead concentrates. The concentrates are transported by truck to Skagway for shipment to smelters. The mill and surface facilities will be required until permanent closure.

At closure, a site inspection would be required to prepare an inventory of site facilities, equipment, waste disposal sites and hazardous waste materials. This site inspection would serve as the basis for a detailed site reclamation plan.

The closure cost estimates for the mill and surface facilities are presented in Table 2.2.1.

Down Valley Tailings Impoundment

Tailings from the processing of ores were placed in the Down Valley Tailings Impoundment from the start of operations until mid 1992. The impoundment is located below the Faro operations in the valley of Rose Creek. The tailings consist of mineral rejects from the processing and contain sulphide minerals which can oxidize to produce ARD from the impoundment.

Five alternatives studied by Curragh Inc. for the decommissioning of the Down Valley Tailings Impoundment. The Company selected alternative No. 5. Under this alternative, most of the tailings in the Down Valley Tailings Impoundment would be pumped to the mill for reprocessing to produce a bulk zinc-lead concentrate. The tailings after reprocessing would then be pumped to the Faro open pit for permanent storage. Tailings remaining in the Down Valley Impoundment, to a maximum elevation of 1044.3 m, would be covered with water.

In addition to Alternatives 4 and 5, cost estimates were prepared for full and partial disposal of the Down Valley tailings in the Faro pit.

The closure cost estimates for the four options examined in this report are summarized in Table 2.3.15.

Vangorda Plateau Development

The Vangorda open pit, located 14 km southeast of the Faro mill, was developed during 1990 to provide ore for the Faro mill during the period between depletion of ore from the Faro pit and development of the Grum open pit. In order to mine the Vangorda deposit, it was necessary to divert Vangorda Creek around the perimeter of the ultimate pit.

The waste rock from the Vangorda open pit has been placed on the dump located to the southwest of the open pit. From tests conducted by Curragh Inc., most of the waste from the Vangorda open pit has the potential to generate acid. To minimize the quantity of acid generation, Curragh Inc. segregated the high sulphide waste and altered phyllite waste into two separate cells. The cells would be surrounded by glacial till berms and then covered with till when mining of the pit was complete.

The Grum open pit, which is significantly larger than the Vangorda pit, will be mined in three stages to provide a balance between ore and waste mining. Overburden stripping has commenced on the deposit. Most of the waste in the Grum pit does not have the potential to generate acid. In addition, sulphide waste will not be left exposed in the final pit walls.

Reclamation of the Vangorda and Grum open pits consists primarily of controlling water flows to, and from, the pits and waste dumps as well as treatment of the ARD. The closure cost estimates for the Vangorda Plateau Development are presented in Tables 2.4.1 to 2.4.7.

Summary of Faro Operations Cost Estimates

The closure cost estimates for the Faro Operations outlined in Section 2.0 of this report represent, for the most part, a liability which has already been incurred and which must be met before, or on, permanent closure. One exception is the Grum Waste Dump where sulphide waste has not as yet been removed from the pit.

The estimated closure costs are summarized in Tables 5.1.1 to 5.1.4, depending on the option selected for the Down Tailings Impoundment.

Table 5.1.1 **Summary of Closure Costs based on Curragh Inc.'s Alternative 5.**

Table 5.1.2 **Summary of Closure Costs based on Curragh Inc.'s Alternative 4.**

Table 5.1.3 **Summary of Closure Costs based on disposal of the tailings in the Faro pit.**

Table 5.1.4 **Summary of Closure Costs based on partial disposal of the tailings in the Faro pit.**

Monitoring and maintenance fund requirements are shown in Table 5.1.5.

SA DENA HES OPERATIONS

The Sa Dena Hes mine is located 50 km north of the town of Watson Lake in southeastern Yukon. Access to the mine is by a 25 km road off the Robert Campbell Highway, 50 km north of Watson Lake.

Open Pit and Underground Mines

Mining was started with small open pits on the Main and Jewelbox zones. Underground mining on the Jewelbox zone provided the ore for the mill after these open pits. Following mining of the Jewelbox zone, Curragh Inc. expects to mine the Gribbler, Burnick and Attila zones. Underground exploration and development has been undertaken on the Attila and Burnick zones.

The reclamation for each ore zone can be undertaken after completion of mining of that zone. For the open pits, a spillway should be constructed at the low point in the pit crest to allow for a controlled outflow of water, if it is expected that the pit fills with water. Bulkheads would be constructed over each underground opening to seal the mine.

In the reclamation plan, it was proposed that the waste dumps be constructed with a 2H:1V slope. The waste rock dump for the Jewelbox underground mine is a side hill dump with the rock at the natural angle of repose. This dump, at least, should be reworked before permanent closure.

The closure cost estimates for the open pit and underground mines are presented in Table 3.1.1.

Mill, Surface and Other Facilities

At closure, a site inspection would be required to prepare an inventory of site facilities, equipment, waste disposal sites and hazardous waste materials. This site inspection would serve as the basis for a detailed site reclamation plan.

The closure cost estimates for the mill, surface and other facilities are presented in Table 3.2.1.

Tailings Impoundment

Tailings from the processing of ores mined from the mines are placed in the Tailings Impoundment. The tailings consist of mineral rejects from the processing and contain little of the sulphide minerals which can oxidize to produce

ARD from the impoundment.

The impoundment is located below the mill site on a small saddle between two hills. Dams were constructed on the north and south ends of the impoundment area to retain the tailings. A diversion ditch was constructed to divert a small tributary of False Canyon Creek away from the tailings pond. Interceptor ditches were excavated along the east and west sides of the impoundment to minimize the amount of surface runoff flowing into the impoundment area.

On permanent closure, the tailings impoundment and the retaining dams would be recontoured to permit free drainage from the area. A 150 mm cap of topsoil would be placed on the surface to reduce precipitation infiltration and eliminate dust. A permanent spillway would be constructed to accommodate a 200 year flood event. The decant tower would be filled with soil and the overflow pipe plugged with concrete. The interceptor ditches would be removed to restore natural flows. The dam on the reclaim water pond would be breached to re-establish the original flow channel. Any accumulation of tailings in the reclaim pond should be returned to the tailings impoundment.

The closure cost estimates for the tailings impoundment are presented in Table 3.3.1.

Summary of Sa Dena Hes Closure Cost Estimates

In the case of the Sa Dena Hes operations, only some of the closure cost estimates outlined in Section 3.0 of this report represent a liability which has already been incurred and which must be met before, or on, permanent closure. In addition, the reclamation of each ore zone can be undertaken after completion of mining of that zone.

A summary of the estimated closure costs is shown in Table 5.2.

CURRAGH INC.

MINE CLOSURE COSTS

SECTION 1.0

INTRODUCTION

CURRAGH INC.

MINE CLOSURE COSTS

1.0 INTRODUCTION

Robert J. Rodger, P. Eng. was retained by the Department of Indian and Northern Affairs (DIAND) Northern Affairs Program - Whitehorse to provide a review of the status of closure plans and an estimate of closure costs for the Curragh Inc. mining operations in the Yukon.

The objectives of the study were to provide a summary of closure costs for the Faro operations and the Sa Dena Hes mine, and to identify possible deficiencies in the closure plans and/or the available information.

The terms of reference for this review as presented in the Statement of Work of May 9, 1993 are as follows:

1. "Review existing abandonment plans, their costs and previous consultants reports for both the Faro Mine site and the Sa Dena Hes Mine site,

2. Based on the information available and discussions with government officials and site visits, identify deficiencies in abandonment plans that have been put forward and identify abandonment components that have not been previously identified or costed out,

3. Where abandonment plans have not been approved by government, identify the alternatives which have been put forward during Water Board hearings, including placing all the Down Valley tailings in the Faro Pit, recycling of tailings and Option IV and any costs which have been developed for these alternatives,

4. Identify any site conditions that may lead to a variation in the cost of abandonment,

5. Summarize abandonment costs in current dollars including costs for the various options for which there is some information and cost estimates or ranges for components which have been identified but not included in previous abandonment plans."

The study was based on a review of the documents (listed in Appendix I) made available by the Northern Affairs Program and on brief site visits to the Faro and Sa Dena Hes mining operations.

Verification of pit wall, dam and dump stability or other geotechnical aspects of the closure plans is not part of the terms of reference of this report, and geotechnical analysis has not been conducted on any aspect of this review.

The tailings and some of the waste dumps have the potential to generate acid. Assessment of water quality was not part of the terms of reference of this report, and no assessment was undertaken of the impact on water quality.

1.1 BASIS FOR COST ESTIMATE REVIEW

In this review, the cost estimates are based on the following assumptions:

The work, where possible, is to be undertaken by contractors; and,

The work is as specified by Curragh Inc in its submissions, with any noted exceptions.

In addition to assuming that the work is undertaken by contractors, it is assumed that the major components, such as the tailings covers, are let under single contracts. The unit prices should be lower for relatively larger contracts.

Unit costs estimates were reviewed on the basis of in-house data, and compared to rates charged by contractors in Northern B. C. and Yukon as well as the rates contained in the DIAND report entitled "Mine Reclamation in the Northwest Territories and Yukon".

Given the short time frame allotted for the study and the relatively limited information base for estimating many of the costs, relatively more effort was devoted to the major cost items.

A contingency has been applied to the cost estimate. The amount of contingency, applied to the total estimated cost, depends on the level of engineering which has been undertaken on a project. For the most part, the design is considered to be conceptual, reflecting a low level of engineering design. In addition, there are sufficient uncertainties regarding dam stability, effectiveness of the proposed covers and other factors that the minimum contingency which should be applied is 20 %.

Engineering, procurement and construction management (EPCM) for this type of project would commonly cost 7 to 12 % of the project cost after contingency. These are the percentages used in this review.

The estimates are in constant 1993 dollars.

CURRAGH INC.

MINE CLOSURE COSTS

SECTION 2.0

FARO DECOMMISSIONING PLAN COSTS

2.0 FARO DECOMMISSIONING PLAN COSTS

The Faro mining operation was established by Cyprus Anvil Mining Corp (CAMC) in 1969 and continued until 1982. Curragh Inc. acquired the operation in 1985 and the mine has been in production since 1986.

Decommissioning of the Faro operations is covered by a number of studies prepared by Curragh Inc. and its consultants (Appendix I).

The elevations used in this report for the Faro site are based on the most recent mean sea level datum, as outlined in the Curragh Inc. "Overview of the Environmental Plans" Appendix "F".

2.1 FARO OPEN PIT AND UNDERGROUND MINES

Aside from small remnants of ore remaining in the pit, estimated at 300,000 tonnes, the three zones comprising the Faro open pit and underground are mined out. Some 55,000,000 tonnes of ore and 97,000,000 m^3 of waste rock have been removed from the three zones in the deposit.

This section of the report examines the closure aspects of the Faro pit as a mining operation. The closure aspects of the use of the Faro pit as a tailings disposal area are covered in Section 2.3.6.

Assessment of closure of the mining operation requires examination of the impact on water quality. Curragh Inc. and its consultants have conducted a number of studies on water quality (Appendix I). The Faro ore body was located in the Faro Creek valley. To undertake mining of the deposit, Faro Creek was diverted to the east into the North Fork of Rose Creek. Both Faro Creek and North Fork flow southwest into Rose Creek, located in the valley below the Faro operations.

2.1.1 Open Pit and Underground Mines

The Faro ore deposit occurred as an elongated lens of sulphides, which was 2000 m long, 800 m wide and 0 to 90 m thick. The strike of the lens was northwest - southeast and it dipped at 20^0 to the southwest. Faults split the lens into three main zones. The Zone I and III orebodies were mined in the main open pit, while Zone II was mined as a separate open pit located to the south of the main pit. The Zone II pit has since been filled with waste rock from the main open pit. The underground workings were developed from the southwest wall of the main Zone I/III open pit.

Tailings have been deposited in the Faro pit since mid 1992. It is anticipated that tailings will continue to be deposited in the pit until permanent closure. Depending on the alternative selected, tailings from the Down Valley Tailings Impoundment may also be placed in the Faro pit. Based on its estimates, Kilborn concluded that there was sufficient space in the Faro pit to accommodate the Vangorda/Grum and Down Valley tailings (Alternative 5).

With closure of the Faro pit, it will be allowed to fill with water, to a final elevation of 1173.5 m. With the Vangorda/Grum and Down Valley tailings (Alternative 5) in the pit, there would be a 4 m water cover over the tailings.

Sulphide waste rock remains on the walls of the pit, particularly on the northwest (in the area designated as MPA 3 & 4 in the seep surveys) and southern walls (MPA 9). These areas will remain exposed after the pit has been filled with water.

From the seep surveys conducted during 1987 - 88, the flows from the seeps on the exposed northwest wall are low. Although the zinc concentration is high, Curragh Inc. considers that the dilution and neutralization effect of the water in Faro Lake should result in discharge water of satisfactory quality from the pit.

2.1.2 Waste Rock Dumps

The waste rock from the open pits has been placed on dumps located around the open pit. During mining of the Faro pit by Curragh Inc., waste rock containing sulphide minerals was segregated into sulphide cells in specific areas of the waste dumps. These cells have been covered with a layer of phyllite rock. During the CAMC era, there was no segregation of sulphide waste rock. As a result, the drainage from some of the waste dumps established during that period is acidic.

The water from the waste dump located over the Zone II open pit contains high zinc values. At present, this water is pumped from a well in Zone II to the main pit.

From the seep surveys conducted during 1987 - 88, the flow from the southwest main dump consistently has high zinc concentrations. While the flow varies seasonally, it averages 3.2 l/s. Zinc concentrations are of the order of 20 - 25 mg/l.

Drainage ditches have been constructed around the toe of the northeast and south dumps as well as the southeast section of the main waste dump to collect water.

The waste dump in the Faro Creek channel north of the pit also contains sulphide waste rock. It is expected that this waste rock will be returned to the Faro pit.

There has, reportedly, been movement detected on the southeast slope of the waste dump located adjacent to the Vangorda Haul Road causeway and immediately above the North Fork of Rose Creek. Monitors have been installed to track this movement.

It should be noted that long term stability of the waste dumps was not examined in this report. It is assumed in this report that there is no work required to ensure that the dumps are stable in the long term.

2.1.3 Closure Requirements

In addition to the measures required by the use of the Faro pit as a tailings disposal area outlined in Section 2.3.6, provision must be made for treatment of water flows from the waste dumps.

2.1.3.1 Sulphate Reduction

At the request of Curragh Inc., Steffen, Robertson and Kirsten (B.C.) Inc. (SRK) examined sulphate reduction utilizing sulphate reducing bacteria as an alternative for the treatment of Acid Rock Drainage (ARD) (SRK Report # 60643). The reduction of sulphates is accomplished by specialized strictly anaerobic bacteria, of which there are two genera, Desulfovibrio and Desulfotomaculum. The bacteria occur naturally, but have not as yet been utilized to lower metal concentrations in ARD. A two year research and engineering study is presently underway at the Lo/kken mine in Norway.

The conditions necessary for sulphate reduction include presence of a substrate, sugar in this case; low copper concentration in the contaminated water; and temperatures in the 5^0 to 35^0 C range.

Of the alternatives examined by SRK, the underground workings provide the best location for the sulphate reduction system. The ventilation raise would serve as the inlet for the contaminated water and substrate, while a borehole would be drilled for the outlet.

In their report, SRK also provide for diversion ditches (SRK Report # 60643 Fig. 10) to be constructed in various specified locations around the pit area to minimize infiltration of water into the waste dumps.

Collection ditches would also be installed to channel the contaminated water to sumps. The water would be pumped from these sumps to the underground workings.

One of the sumps proposed by SRK is located in the old Faro Creek channel, the proposed location for the Faro pit outlet spillway. In their report, SRK has located the spillway so that it would discharge into Next Creek. It is assumed in this report that the cost of the spillway in either case is approximately the same.

2.1.3.2 Water Treatment

In the event that the sulphate reduction system can not be utilized, a more conventional treatment plant such as the plant at Vangorda, using proven technology, would be required to treat the contaminated water. The characteristics of the waste rocks in the Faro dumps are not significantly different from the Vangorda waste rock. Testing of typical samples would, nonetheless, be required to ensure that the process is appropriate, and to assess reagent consumptions.

This is the alternative selected for the cost review. The diversion and collection ditches would be required in both cases. Depending on the location of the water treatment plant, there would be some changes in pumping and piping requirements.

2.1.3.3 Cost Review

The closure cost estimates for the Faro pit as a mining operation are shown in Table 2.1.1. The closure cost estimates of the use of the Faro pit as a tailings disposal area are shown in Table 2.3.13.

The quantities were estimated from the plans in the report prepared by Steffen Robertson Kirsten (SRK). These plans are on a large scale, so the quantities are approximate at best.

The capital cost estimate for the water treatment plant is taken from the estimate prepared by PBK Engineering Ltd. for the Vangorda plant (Report # 90086).

2.2 FARO MILL COMPLEX AND SURFACE FACILITIES

These facilities will be required until permanent closure. Curragh Inc. prepared an "Other Facilities Abandonment Plan" in June 1989, which provides a reasonably complete assessment of the work required on permanent closure.

At closure, a site inspection would, nonetheless, be required to prepare an inventory of site facilities, equipment, waste disposal sites and hazardous waste materials. This site inspection would serve as the basis for a detailed site reclamation plan.

2.2.1 Mill Building

The building, a fabricated steel structure with metal cladding, would be cleaned and dismantled. The cladding would be shredded and buried in the mill basement. The structural steel would be transported off site for sale.

The mill basement is a large cavity constructed of reinforced concrete. By pouring concrete in the openings for the doors into the mill, the cavity would be a good facility for disposal of waste materials.

The site would be covered with a 0.5 m layer of glacial till.

2.2.2 Other Buildings

The other buildings on site are, generally, prefabricated steel structures with metal cladding. These buildings would be dismantled and transported off site for sale.

The floors and footings of these buildings are usually constructed of reinforced concrete. These would be broken up and buried.

The site would be covered with a 0.5 m layer of glacial till.

2.2.3 Mine and Shop Equipment

There is a market for used equipment. The value of this equipment depends on a number of factors, including the market for used equipment at the time of sale. Prices on the used equipment market, as with any market, depend on supply and demand. Another factor is the age and condition of the equipment. A third factor is the location.

For the purposes of this report, it is assumed that the value of the equipment is equal to the cost of dismantling it and transporting it to the point of sale.

2.2.4 Mill Equipment

The comments on mine and shop equipment also apply for mill equipment. This equipment would, however, require clean-up.

2.2.5 Sulphide Ore Areas

There are a number of areas in the vicinity of the mill building which have been used for stockpiles of low grade ore, sulphide fines and concentrate-contaminated gravel from Skagway. Curragh Inc. proposes to treat these stockpiles in the mill on or before permanent closure. The material under these stockpiles will also have to be processed through the mill. Since the composition of these materials is unknown, it is assumed that they may contain organic soils or hydrocarbons, in which case recovery of any zinc or lead minerals in the mill would be poor.

In addition, the area around the concentrate load-out is covered with a thin layer of concentrate. The material will also have to be processed through the mill.

2.2.6 Fuel and Lube Storage Areas

The fuel and lubricant tanks, located both above and below ground, should be purged, removed, dismantled and buried. The delivery systems should have a salvage value.

There are contaminated soils around some of these storage areas which will require disposal.

2.2.7 Bulk Explosives Plant

The bulk explosives plant is owned by ICI Explosives. For the purposes of this report, it is assumed that this company will be responsible for its removal, and for site restoration.

2.2.8 Chemical Inventory

There is a wide variety of chemicals and reagents on site. Each chemical must be disposed of in accordance with the guidelines. Most of the chemicals in active use at the time of closure could be returned to the manufacturer. It is expected that at least some of the chemicals are old or obsolete stock.

Spills around the lime and soda ash storage areas would have to be cleaned-up. It is assumed that these chemical spill are dumped into the Faro pit.

2.2.9 Waste Material Disposal

Scrap Metal
Scrap steel and metals, used equipment parts and old equipment is stored in various areas around the site. It is assumed that this material has a scrap value and would be transported off site.

Refuse (Garbage)
There is a landfill for refuse located on one of the waste rock dumps, among others. It is assumed that the landfills do not contain any hazardous materials and will be covered with 1.0 m of glacial till.

Sewage Disposal
Sewage tanks would be uncovered, crushed and re-buried.

2.2.10 Pipelines

It is assumed that the water pipe and fittings have a salvage value. The water pipeline would be dismantled, removed and transported to the point of sale.

The tailings lines and siphon water reclaim lines are covered in the section of this report on the Down Valley Tailings Impoundment.

2.2.11 Fresh Water Reservoir

Since the Fresh water reservoir serves as a wintering fish habitat, in particular for arctic grayling, Curragh Inc. proposes to conserve the reservoir. In order to ensure long term stability, the dam would require reinforcement. The downstream face of the dam would be flattened to a 4H:1V slope and the upstream face to a 3H:1V slope. The concrete spillway would be removed and the channel lowered by 2 m.

In the event that there is a decision to remove the reservoir, it would be necessary to breach the dam and return Rose Creek to its original channel. The cost of this work would be less than the estimated cost of maintaining the reservoir.

2.2.12 Other

There is a chemical manufacturing plant in the town of Faro which was operated briefly by Metafina for the production of xanthates. The process used in the plant proved to be unsuccessful. It is understood that the plant is located on property owned by Curragh Inc.

2.2.13 Cost Review

The closure cost estimates for the mill complex, surface and other facilities at Faro are shown in Table 2.2.1.

2.3 DOWN VALLEY TAILINGS IMPOUNDMENT

Tailings from the processing of ores mined from the Faro open pit were placed in the Down Valley Tailings Impoundment from the start of operations until mid 1992. The impoundment is located below the Faro operations in the valley of Rose Creek. The tailings consist of mineral rejects from the processing and contain sulphide minerals which can oxidize to produce an acidic water discharge from the impoundment.

The quantity of tailings in the Down Valley Tailings Impoundment is estimated to be 50,500,000 tonnes.

Tailings to March 31, 1991 (SRK Report # 60635, Table 3.1)	**45,571,000 t**
Tailings from April 1, 1991 to July 31, 1992 (Estimate).	**4,929,000 t**
Total	**50,500,000 t**

Five alternatives were studied by Curragh Inc. for the decommissioning of the Down Valley Tailings Impoundment. Their selected alternative (No. 5), was presented to the Yukon Territory Water Board (YTWB) in January 1992. This alternative was reviewed by PBK Engineering Ltd in November 1991 (Project # 91116).

As a result of the January 1992 public hearing, the YTWB issued a decision to attach Alternative 4 to the water licence, as a back-up alternative to the Curragh Inc. decommissioning plan. The cost of this alternative was reviewed in April 1993.

In addition, the Ross River band requested during the January 1992 YTWB public hearing, among others, that all the tailings be placed in the Faro pit. As a variant to this request, only the tailings above the 1044.3 m elevation would be placed in the Faro pit.

Four options are examined in this report, in the sections outlined below:

2.3.1 Curragh Inc. Alternative 5,

2.3.2 Curragh Inc. Alternative 4,

2.3.3 Disposal of Tailings in the Faro Pit,

2.3.4 Partial Disposal of Tailings in the Faro Pit.

The acceptability of Alternative 4 has not, as yet, been established by DIAND, Environment Canada nor Fisheries and Oceans Canada.

The long term impact of possible contamination of groundwater from seepage through tailings left in the Down Valley Tailings Impoundment has not been determined in a definitive manner. This would have to be assessed before adoption of the alternatives involving long term storage of tailings in the Down Valley Tailings Impoundment.

Tailings have been deposited in the Faro pit since mid 1992. It is anticipated that tailings will continue to be deposited in the pit until permanent closure. In order to use the Faro pit for tailings disposal, there is certain work required to prepare the pit. This work is outlined in Section 2.3.5. On permanent closure, decommissioning of the pit as a tailings disposal area is required for all four options, as outlined in Section 2.3.6.

When Curragh Inc. stopped disposal of tailings in the Down Valley Tailings Impoundment, there was an increase in the zinc level in the water in the impoundment area. Addition of lime to the water in the impoundment was necessary to increase the pH and decrease zinc concentrations in the water.

2.3.1 Alternative 5

On depletion of mining reserves at the Faro operations, most of the tailings (37,500,000 t) from the Down Valley Tailings Impoundment would be pumped to the mill for reprocessing to produce a bulk zinc-lead concentrate. The tailings after reprocessing would then be pumped to the Faro open pit for permanent storage. Tailings remaining in the Down Valley Impoundment, to a maximum elevation of 1044.3 m, would be covered with water.

To reprocess tailings, a pipeline would be installed from the Down Valley Tailings Impoundment to the mill. In addition, a siphon would be installed to reclaim water from the Faro pit and a water line would be installed from the pit to the mill and, also, to the tailings pond for the hydraulic monitoring operation.

To maintain a water cover over the tailings stored in the Intermediate Impoundment, the following would have to be undertaken:

The Intermediate Dam would have to be raised to an elevation of 1049.3 m. The dam has already been raised to the 1052.7 m elevation,

A side channel spillway, located at the north end of the Intermediate Dam, would be constructed to handle the full flow of Rose Creek. Curragh Inc. proposed to build a concrete spillway,

The Rose Creek diversion channel would be abandoned and the flow would be directed through the tailings impoundment, The Cross Valley pond would be drained and the Cross Valley Dam would be breached. Settled slimes and contaminated soils in the pond area would be removed and deposited in the Intermediate Impoundment, where this material would be under a water cover. A channel would be constructed across the Cross Valley pond area to handle the water flowing from the Intermediate Impoundment side channel spillway and to redirect it back into Rose Creek,

The North Fork of Rose Creek would be returned to its original channel by abandoning the North Fork Diversion, and removing the four sediment control dams. The Pumphouse Dam would also be breached,

Next Creek would be returned to its original channel flowing into Guardhouse Creek, by abandoning the North Wall Interceptor Ditch. This water would flow into the Intermediate Impoundment.

2.3.1.1 Reprocessing

Only preliminary work has been conducted by Curragh Inc. on the technical and financial feasibility of reprocessing the Down Valley tailings to produce marketable concentrates. This work indicates that a bulk zinc-lead concentrate could be produced from reprocessing the tailings. However, additional processing test work is necessary to determine the processing parameters such as reagent consumption, concentrate grade and metal recoveries. Curragh Inc. expects to complete a full reprocessing feasibility study by July 1994. Until this study is complete, the revenue and cost estimates can only be considered as indicative, perhaps even speculative.

Based on the preliminary mineral process testing conducted by Curragh Inc., the metallurgical balance is summarized in Table 2.3.1. It should be noted that these results would require confirmation by additional test work.

Curragh Inc.

Alternative 5

Table 2.3.1 Tailings Reprocessing Metallurgical Balance

	Wt (%)	Assay		Recovery	
		Pb (%)	Zn (%)	Pb (%)	Zn (%)
Concentrate	**1.0**	**14.2**	**37.1**	**18.0**	**30.1**
Tailings	**99.0**	**0.65**	**0.87**	**82.0**	**69.9**
Head	**100.0**	**0.79**	**1.23**	**100.0**	**100.0**

Exceptionally, the estimates in this section of the report are based on Curragh Inc. numbers, not contractor costs. In view of the inherent business risks in tailings reprocessing, it seems unlikely that the project would be undertaken by other parties, such as the government.

Metal Prices

Assessment of long term zinc and lead prices must be based on a thorough review of market demand and supply, which is beyond the scope of this report. Nonetheless, the prices of zinc and lead are among the key variables in the financial feasibility of the tailings reprocessing project. Most concentrates are sold to smelters on the basis of prices on the London Metal Exchange (LME). The average annual prices for zinc and lead on the LME from 1960 to 1992 are shown in Appendix II. For the purposes of this report, long term zinc and lead price of U.S. $ 0.56/lb and 0.31/lb respectively were used in the calculations.

In order to meet the hydraulic mining and reprocessing costs, an average zinc price of U.S. $ 0.62/lb would be necessary. A number of strategies could be considered to improve the price received for metals contained in the concentrates.

Exchange Rate
Assessment of realistic long term exchange rates must be based on a thorough review of foreign exchange markets, which is beyond the scope of this report. A rate of C $ 1.00 = U.S. $ 0.80 has been used in this report.

Smelter Treatment Charges
Charges imposed by smelters for processing, in particular, of zinc concentrates to produce zinc metal have increased substantially over the past few years. While these substantial increases are not expected to continue, it is difficult to foresee lower charges in real terms over the next few years. A treatment charge of U.S. $ 205.00 and transport/marketing cost of U. S. $ 54.50 per tonne of concentrate have been used in this report.

Reprocessing Revenues
Based on the concentrate grades projected by Curragh Inc. and the assumptions outlined above, the net smelter return at the mine site is shown in Table 2.3.2.

Total Revenues =
37,500,000 t x $2.02/t = $ 75,750,000

Reprocessing Costs
For the purposes of this report, it is assumed that the reprocessing rate is 4,800,000 tonnes per year (t/y), the rate utilized by Curragh Inc. The reprocessing operation would be conducted during the six month period from May to October.

Capital cost of the modifications required to reprocess tailings in the existing mill circuit are shown below:

Curragh Inc.

Alternative 5

Table 2.3.3 Concentrator Modification
Capital Cost Estimate

Bin Modification	$ 33,000
Agitator Mechanism	165,000
Pump Bases	3,000
Pipeline Modifications	11,000
Refurbishing Allowance	275,000
Subtotal	487,000
Contingency (20 %)	97,000
Subtotal	584,000
EPCM (10 %)	58,000
TOTAL	$ 642,000

Operating costs for tailings reprocessing are estimated as follows:

Curragh Inc.

Alternative 5

Table 2.3.4 Tailings Reprocessing
Annual Mill Operating Cost Estimate

Labour	$ 960,000
Reagents	6,190,000
Supplies	480,000
Electrical Energy	1,490,000
TOTAL	$ 9,120,000
Cost per tonne of tailings	$ 1.90/t

Hydraulic Mining Costs
For the purposes of this report, it is assumed that the hydraulic mining operation is as presented in the Kilborn report (# 3509-62), with a mining rate of 4,800,000 t/y. The pumping operation would be conducted over a six month period each year until the tailings above the 1044.3 m elevation are reprocessed.

Curragh Inc.

Alternative 5

Table 2.3.5 Hydraulic Mining Capital Cost Estimate

Monitors, Slurry pumps	$ 2,350,000
Two stage pumps	970,000
Slurry and water lines	2,300,000
Subtotal	$ 5,620,000
Contingency (20 %)	1,120,000
Subtotal	6,740,000
EPCM (10 %)	670,000
TOTAL	$ 7,310,000

Curragh Inc.

Alternative 5

Table 2.3.6 Hydraulic Mining
Annual Operating Cost Estimate

Labour	$ 700,000
Maintenance Supplies	670,000
Electrical Energy	780,000
Miscellaneous	100,000
TOTAL	$ 2,250,000
Cost per tonne of tailings	$ 0.47/t

Breakeven Metal Price

Based on the annual operating costs for Reprocessing and Hydraulic mining as well as the other assumptions outlined above, the zinc price required to provide sufficient revenues to meet these operating costs is U.S. $ 0.62/lb. (Table 2.3.2.1)

	Operating Cost	Cost/t
Reprocessing	$ 9,120,000	$ 1.90
Hydraulic Mining	2,250,000	0.47
Total	11,370,000	2.37

2.3.1.2 Decommissioning Cost Review

This review draws on the information contained in the review undertaken by PBK Engineering Ltd in November 1991 (Project # 91116).

The basis for the cost estimates is outlined in Section 1.0 of this report.

The quantities were re-estimated from the plans in the report prepared by Steffen Robertson Kirsten (SRK).

The costs are presented in Table 2.3.7.

2.3.2 Alternative 4

Alternative 4 was described by Curragh Inc in the submission to the YTWB, as follows:

The Original and Second Impoundments be covered with a composite soil cover, consisting of three layers - a fresh tailings slimes layer (minimum 0.5 m) overlain by uncompacted till (min. 0.5 m) and then by non acid generating waste rock (min. 0.5 m). Prior to placement of the covers, the tailings would be terraced and divided into paddies with low dykes. A synthetic membrane liner would be used to cover embankment and dyke faces.

The Intermediate Impoundment would be covered with water. The Intermediate Dam would be raised to an elevation 3.0 m above the 2.0 m water cover, or to an elevation of 1055.7 m, based on the elevation of the tailings during April 1991. The dam was reportedly raised to an elevation of 1049.3 m during 1991. The final elevation of the dam would depend on the elevation of the tailings in the Intermediate Impoundment on decommissioning. The dam would be modified to have a 2.5 Horizontal to 1.0 Vertical slope on the downstream side. The dam crest would be 10 m wide.

Curragh Inc. proposed a concrete side channel spillway which would be constructed on the northern abutment of the Intermediate Dam to handle water discharging from the Intermediate Impoundment.

The Rose Creek diversion channel south of the Intermediate Impoundment would be abandoned. The water flow in Rose Creek would be directed through the Intermediate Impoundment by breaching the dam at the southwest corner of the Second Impoundment area. The Rose Creek diversion to the east of the dam would be broadened and covered with riprap to withstand a half PMF event.

The Cross Valley pond would be drained and the Cross Valley Dam would be breached. Settled slimes and contaminated soils in the pond area would be removed and deposited in the Intermediate Impoundment, where this material would be under a water cover. A channel would be constructed across the Cross Valley pond area to handle the water flowing from the Intermediate Impoundment side channel spillway and to redirect it back into Rose Creek.

An armoured channel, the Lower Faro Creek diversion, would be constructed along the north side of the Second Impoundment to handle storm and other flows from the pit and waste dumps. There may be provision for a control structure to allow limited flows from the channel into the Original and Second Impoundments to help maintain a saturated water layer in the composite cover.

The North Fork of Rose Creek would be returned to its original channel by abandoning the North Fork Diversion, and removing the four sediment control dams. The Pumphouse Dam would also be breached.

Next Creek would be returned to its original channel flowing into Guardhouse Creek, by abandoning the North Wall Interceptor Ditch. This water would flow into the Intermediate Impoundment.

Curragh Inc. proposed to spray lime on the exposed tailings to minimize oxidation of the tailings and acid generation. Testing was to be undertaken to assess the effectiveness of lime addition and to determine optimum quantities.

Subsequently, it was decided that all structures, such as the Rose Creek diversion and the Intermediate side channel, would be designed to meet a full PMF event. In addition, Curragh Inc. has indicated that lime addition is not cost effective, since the tailings are similar to hard pan in some areas and the surface is undulating.

2.3.2.1 Cost Review

The basis for the cost estimates is outlined in Section 1.0 of this report.

The quantities were re-estimated from the plans in the report prepared by Steffen Robertson Kirsten (SRK). In some cases such as the Lower Faro Creek diversion, the quantities estimated by SRK were checked and used because it is assumed they had access to more complete plans.

The costs are presented in Table 2.3.8

2.3.3 Disposal of Tailings in Faro Pit

All of the tailings would be pumped without reprocessing to the Faro open pit for permanent storage. As indicated in Section 2.3 above, the total quantity of tailings in the Down Valley Tailings Impoundment is estimated to be 50,500,000 tonnes.

Under this option, the following work would have to be undertaken:

> Installation of a tailings line from the Down Valley Tailings Impoundment to connect with the line from the mill to the Faro open pit. In addition, installation of a siphon and water line would be necessary to reclaim water from the Faro pit for use in hydraulic monitoring operations at the Tailings Impoundment.
>
> The tailings in the impoundment would be remobilized with hydraulic monitors and pumped to the Faro pit. Since at least some of the tailings have a pH of less than 7.0, provision would need to be made for lime addition to the water for the monitors to neutralize the tailings. In order to accurately estimate the quantity of lime required to neutralize the tailings, it would be necessary to thoroughly sample the tailings. For the purposes of this report, it is assumed that lime addition is necessary at a rate of 0.2 kg/tonne.
>
> The Original, Second and Intermediate impoundment areas would then be drained and the Intermediate Dam would be breached. Slimes and contaminated soils in the impoundment areas would be removed and deposited in the Faro Pit, where this material would be under a water cover. A channel would be constructed across the impoundment area to handle the water flowing in Rose Creek.

The Cross Valley pond would be drained and the Cross Valley Dam would be breached. Settled slimes and contaminated soils in the pond area would be removed and deposited in the Faro Pit, where this material would be under a water cover. A channel would be constructed across the Cross Valley pond area to handle the water flowing from Rose Creek,

The Rose Creek diversion channel would be abandoned and Rose Creek would be returned to its original water course in the tailings impoundment,

The North Fork of Rose Creek would be returned to its original channel by abandoning the North Fork Diversion, and removing the four sediment control dams. The Pumphouse Dam would also be breached,

Next Creek would be returned to its original channel flowing into Guardhouse Creek, by abandoning the North Wall Interceptor Ditch. This water would flow into Rose Creek.

2.3.3.1 Cost Review

The capital and operating costs of pumping tailings from the Down Valley Tailings Impoundment to the Faro open pit are dependent on the rate of pumping tailings. The capital cost will vary directly, and the operating cost inversely, with the pumping rate. For the purposes of this report, it is assumed that the pumping rate is 4,800,000 tonnes per year (t/y), which is the rate utilized by Curragh Inc. for reprocessing in Alternative 5. The pumping operation would be conducted over a six month period each year until the tailings impoundment was empty. The capital and operating cost estimates for the hydraulic mining operation are shown in Tables 2.3.9 and 2.3.10 respectively.

There was no attempt to optimize the pumping rate in this study.

The decommissioning cost for the Down Valley tailings impoundment area includes many of the items outlined in the options examined above. The most significant differences are the breaching of the Intermediate Dam and the larger area to clean-up tailings.

The costs are presented in Table 2.3.11

2.3.4 Partial Disposal of Tailings in Faro Pit

Under this option, only the tailings above the 1044.3 m elevation would be pumped without reprocessing to the Faro open pit for permanent storage.

The following work would have to be undertaken:

Installation of a tailings line from the Down Valley Tailings Impoundment to connect with the line from the mill to the Faro open pit. In addition, installation of a siphon would be necessary to reclaim water from the Faro pit for use in hydraulic monitoring operations at the Tailings Impoundment.

The tailings in the impoundment would be remobilized with hydraulic monitors and pumped to the Faro pit. As indicated in Section 2.3.3.1, it is assumed that lime addition to the water for the monitors is required for tailings neutralization.

Tailings remaining in the Down Valley Impoundment, to a maximum elevation of 1044.3 m, would be covered with water. To maintain a water cover over the tailings stored in the Intermediate Impoundment, the Intermediate Dam would have to be raised to an elevation of 1049.3 m. The dam has already been raised to the 1052.7 m elevation.

A side channel spillway, located at the north end of the Intermediate Dam, would be constructed to handle the full flow of Rose Creek. Curragh Inc. proposed to build a concrete spillway,

The Rose Creek diversion channel would be abandoned and the flow would be directed through the impoundment area,

The Cross Valley pond would be drained and the Cross Valley Dam would be breached. Settled slimes and contaminated soils in the pond area would be removed and deposited in the Intermediate Impoundment, where this material would be under a water cover. A channel would be constructed across the Cross Valley pond area to handle the water flowing from the Intermediate Impoundment side channel spillway and to redirect it back into Rose Creek,

The North Fork of Rose Creek would be returned to its original channel by abandoning the North Fork Diversion, and removing the four sediment control dams. The Pumphouse Dam would also be breached.

Next Creek would be returned to its original channel flowing into Guardhouse Creek, by abandoning the North Wall Interceptor Ditch. This water would flow into the Intermediate Impoundment.

2.3.4.1 Cost Review

The costs for this option are a combination of the tailings pumping costs and the decommissioning cost for Alternative 5. For the hydraulic mining operation, it is assumed that the capital cost and unit operating cost are the same as the costs derived in Section 2.3.3.1. The cost estimates are presented in the Summary Table 2.3.15.

2.3.5 Faro Pit Preparation

The work undertaken to prepare the open pit for tailings deposition included installation of the tailings pipeline from the mill to the pit. This work has been completed, and no cost estimate has been included in the closure cost estimate.

In addition, a plug dam is to be constructed at the south end of the Faro open pit to allow the water in the pit to rise to the 1173.5 m (3850') elevation. Construction of the plug dam is necessary to prevent water flow from the pit into Zone II. The Curragh Inc. schedule provided for construction during 1993. There was also provision for construction of a temporary inlet to allow water to flow from Faro Creek into the pit and installation of a siphon to reclaim water from the Faro pit for use in the mill. The dam and temporary inlet have not been constructed and the siphon has not been installed as yet.

Other work includes restoration of the Faro Creek channel below the outlet spillway described in Section 2.3.6 (below) of this report. The channel would require regrading and installation of drop weirs in the steep section to attenuate the impact of the flows.

2.3.5.1 Cost Review

The costs are presented in Table 2.3.12

2.3.6 Faro Pit Decommissioning

Tailings have been deposited in the Faro pit since mid 1992. It is anticipated that tailings will continue to be deposited in the pit until permanent closure. On closure of the operations, the mitigation work required for the Faro pit tailings impoundment will be essentially as outlined in the report prepared by PBK Engineering Ltd in November 1991 (Report # 91116).

This section of the report covers only those elements related to use of the Faro pit as a tailings disposal area. It does not include any costs associated with pit closure, such as the waste dumps, which are covered in Section 2.1 of this report.

For decommissioning, a permanent Faro Creek inlet spillway will be constructed to maintain a water cover over the tailings in the Faro pit. The Faro diversion channel would be abandoned.

An outlet spillway would be constructed to handle the discharge from the Faro pit. From the information in reports submitted by Curragh Inc., it appears that the spillway would be constructed at the end of operations. From the information contained in the Kilborn report (# 3509-28), there is a net outflow of water from the pit after it is full. The net outflow would be handled through the siphon reclaim.

It is assumed that the flow will be seasonal, and that it is subject to flood events. It is felt, therefore, that this spillway should be constructed before the pit is full of water to ensure control of flood and/or other events.

The tailings and water pipelines from the mill to the Faro open pit and to the Down Valley tailings impoundment will have to be removed.

2.3.6.1 Cost Review

The costs are presented in Table 2.3.13

2.3.7 Other

There has been no provision for revegetation in the Curragh inc. closure plans for the Down Valley. Vegetation is only now re-establishing itself in areas disturbed by Cyrus Anvil early in the operations of the mine. Given the low growth rates prevalent in the Faro area, it is felt that provision should be made for planting of native species to speed re-establishment of ground cover.

The costs are presented in Table 2.3.14

2.3.8 Summary

The closure cost estimates for the four options examined in this section of the report are summarized in Table 2.3.15.

2.4 VANGORDA PLATEAU DEVELOPMENT

The mine closure plan for the Vangorda Plateau Development prepared by Curragh Inc. was reviewed by PBK Engineering Ltd in June 1990 (Report # 90086). This section of the report draws on the information in that review.

2.4.1 Vangorda Open Pit

The Vangorda open pit, located 14 km southeast of the Faro mill, was developed during 1990 to provide ore for the Faro mill during the period between depletion of ore from the Faro pit and development of the Grum open pit. In order to mine the Vangorda deposit, it was necessary to divert Vangorda Creek around the perimeter of the ultimate pit.

An increased volume of waste resulted from a change in the original pit design. Curragh Inc. modified design of the pit by changing the location of the access/haul ramp to the ore on the lower benches of the pit. This additional waste was removed from the northwest side of the pit.

Curragh Inc.

VANGORDA PLATEAU DEVELOPMENT

Table 2.4.1 Vangorda Open Pit

	Quantity (million tonnes)	Revised Volume (million bcm)
Ore	5.93	
Overburden		3.95
Sulphide Waste		0.95
Phyllite	____	4.20
Total	5.93	9.10

Curragh Inc. estimates that there is approximately 1.0 million tonnes of ore and approximately the same quantity of waste remaining in the pit.

On completion of mining, Vangorda Creek would be returned to its original channel and would flow into the open pit. A graded stream outfall would be constructed at the inlet into the pit, and an outlet spillway would handle the flow from the pit. The pit would be flooded to the 1122.5 m elevation.

The pit walls with areas of sulphide rock exposure would be covered with till to minimize acid generation.

2.4.1.1 Cost Review

The work required for closure of the Vangorda pit is shown in Table 2.4.2. The quantities are based on the estimates contained in the PBK Engineering Ltd report (# 90086).

2.4.2 Vangorda Waste Dump

The waste rock from the Vangorda open pit has been placed on the dump located to the southwest of the open pit. From tests conducted by Curragh Inc., most of the waste from the Vangorda open pit has the potential to generate acid. To minimize the quantity of acid generation, Curragh Inc. segregated the high sulphide waste and altered phyllite waste into two separate cells. The cells would be surrounded by glacial till berms and then covered with till when mining of the pit was complete.

Curragh Inc. modified design of the facility to accommodate the larger than anticipated quantity of waste removed from the pit. The modified design, selected as the most desirable, involved increasing the height of the dump to 67 m within the original waste dump configuration. In order to construct this modified waste dump, it would be necessary to place some of the phyllite waste over the sulphide cell. Curragh Inc. does not expect this to have an impact on the quality of water draining from the dump. It is assumed in this report that this is so.

The original design for the waste dump, prepared by SRK provided for construction of the dump in 5 m lifts, with the till berm for the subsequent lift constructed prior to placement of the waste rock on that lift. The waste rock has not been placed in 5 m lifts. The waste rock is now substantially higher than the till berms. In order to construct the till berms around the waste, the dump will have to be reworked.

Berms

The foundation preparation has been completed over the area of the berms. Till has been placed on the lower berms. The quantity of till to be placed on the remaining berms of the dump has been estimated from the plans prepared by SRK.

Rock Drains

The rock drains have been installed under the starter dykes. There is, therefore, no cost estimate for this item.

Collection Ditch

Water draining from the waste dump flows into a collection ditch constructed around the base of the waste dump. The ditch was supposed to direct the water into a collection pond, but difficulties have been encountered because of the flat slope and sloughing. Curragh Inc. plans to install pipe in the ditch between the rock drains to improve collection. The water is pumped from the pond to the water treatment plant.

Dump Covers

As designed, the till cover over the dump would be placed in two layers. The lower layer, 1.0 m thick, would be compacted to 95 % modified Proctor and the upper layer, 2.0 m thick, would be compacted only to 90 % modified Proctor. The surface area of the dump covers will be smaller in the revised design. The revised plan also indicates that alternatives to the till cover, such as "Claymax", are being considered to reduce till requirements.

Selective Waste Placement

There is a cost incurred by Curragh Inc. in selectively placing the sulphide and phyllite waste rock in separate piles on the dump. For this report, it is assumed that 1,000,000 m^3 of waste remains to be placed on the dump. The incremental cost is estimated to be \$ 0.12/m^3.

Erosion Protection

The top of the dump and the cover would slope towards the east to ensure effective drainage. A runoff discharge pipe would handle drainage from the cover. The balance of the dump would be hydroseeded to prevent erosion.

2.4.2.1 Cost Review

For the modified waste dump plan, the quantities were estimated from the plans prepared by SRK in the modified design report. Where possible, the estimates reflect the quantity remaining.

The quantities and estimated costs for the revised plan are shown in Table 2.4.3.

2.4.3 Grum Open Pit

The Grum open pit is significantly larger than the Vangorda pit, as indicated by the quantities in Table 2.4.4. It will be mined in three stages to provide a balance between ore and waste mining. Overburden stripping has commenced on the deposit. Curragh Inc. estimates that five months stripping and waste removal will be required before significant ore quantities will be available from the pit.

Most of the waste in the Grum pit does not have the potential to generate acid. In addition, sulphide waste will not be left exposed in the final pit walls.

Curragh Inc.

VANGORDA PLATEAU DEVELOPMENT

Table 2.4.4 Grum Open Pit

	Quantity (million tonnes)	Volume (million bcm)
Ore	24.0	
Overburden		13.3
Sulphide Waste		2.2
Phyllite		52.5
Total	24.0	68.0

On completion of mining, the pit would be flooded to either the 1265 m or 1240 m elevation, depending the final mining plan. Grum Creek will be directed back into the Grum pit. An inlet spillway should be constructed at the inlet into the pit. An outlet spillway at the western perimeter would handle the flow from the pit. A portion of the haul road would have to be removed to construct the outlet spillway in this location.

As part of the exploration of the Grum deposit, an adit was driven into the deposit. A permanent bulkhead would be required to seal this adit on permanent closure.

2.4.3.1 Cost Review

The work required for closure of the Grum pit is shown in Table 2.4.5. The quantities are based on the estimates contained in the PBK Engineering Ltd report (# 90086).

2.4.4 Grum Waste Dump

The overburden and waste rock from the Grum open pit will be placed on dumps located to the south of the open pit. Based on its tests, Curragh Inc. considers that most of the waste form the Grum open pit is non acid-generating. No mitigation measures, therefore, are required for this waste. It is expected that some 4.6 million tonnes of the waste will be high in sulphides. A number of alternatives were examined for disposal of this sulphide waste. Some of the sulphide waste encountered in the open pit would be placed in a segregated sulphide "cell" located within the waste dump. The sulphide waste would be placed in the "cell" in three lifts, with a till layer separating each lift.

The SRK report indicates that the rest of the sulphide waste would be stored in the pit, where it would eventually be under the water cover. For this report, it is assumed that the waste is stockpiled temporarily, and returned to the Grum pit, where it would be under a water cover.

2.4.4.1 Cost Review

The work required for closure of the Grum waste dump is shown in Table 2.4.6. The quantities are based on the estimates contained in the PBK Engineering Ltd report (# 90086).

2.4.5 Water Treatment

The water treatment plant has been installed and is operated on a periodic basis to treat the drainage from the Vangorda waste dump.

A definitive plan for disposal of the sludge from the water treatment plant has not been adopted as yet.

2.4.6 Other

The other components of the closure plan for the Vangorda Plateau are outlined below. The estimated costs are presented in Table 2.4.7.

2.4.6.1 Dry/Office Building

This building on the Vangorda site is a prefabricated steel structure with metal cladding. The building would be dismantled and transported off site for sale.

The floors and footings of the building are constructed of reinforced concrete. These would be broken up and buried.

The site would be covered with a 0.5 m layer of glacial till.

2.4.6.2 Fuel and Lube Storage Areas

The fuel and lubricant tanks located above ground, should be purged, removed, dismantled and buried. The delivery systems should have a salvage value.

There are contaminated soils around some of these storage areas which will require disposal.

2.4.6.3 Vangorda Haul Road

The Vangorda haul road would be breached at the North Fork of Rose Creek to accommodate the flow in the creek. Other culverts would be removed to prevent future blockage.

2.4.6.4 Thin-horned (Fannin) Sheep

There was some concern that development of the ore deposits on the Vangorda Plateau would have an impact on the herd of thin-horned (Fannin) sheep which migrate seasonally across the Plateau. Migration has continued during mining of the Vangorda pit without discernable effect on the sheep. They have not followed the alternate trail set up for them, preferring their traditional routes.

CURRAGH INC

FARO MINE DECOMMISSIONING

Table 2.1.1 FARO OPEN PIT
COST ESTIMATE
(Thousand 1993 dollars)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST	
WASTE ROCK BACKFILL					
Excavation	cu. m.	600,000	2.50	1,500	
					1,500
DIVERSION DITCHES					
Excavation	cu. m.	46,000	3.00	138	
Liner	sq. m.	40,000	7.00	280	
					418
COLLECTION DITCHES					
Excavation	cu. m.	49,000	3.00	147	
Liner	sq. m.	42,000	7.00	294	
					441
SUMPS					
Excavation	cu. m.	5,000	3.00	15	
Dams	cu. m.	10,000	3.00	30	
					45
WATER TREATMENT PLANT					
Plant	l.s.			2,500	
Sludge Pond	l.s.			350	
Pumps & Piping	l.s.			250	
					3,100
Subtotal					5,504
Contingency (20 %)					1,101
Subtotal					6,605
EPCM (10 %)					660
TOTAL					$7,265

CURRAGH INC

FARO MINE DECOMMISSIONING

Table 2.2.1 FARO MILL COMPLEX/SURFACE FACILITIES
COST ESTIMATE
(Thousand 1993 dollars)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST	
MILL BUILDING					
Demolition	sq. m.	14,300	55.00	787	
Cover Site	cu. m.	7,500	3.00	23	
					809
OTHER BUILDINGS					
Demolition	sq. m.	9,000	35.00	315	
Cover Site	cu. m.	5,000	3.00	15	
					330
MINE & SHOP EQUIPMENT					
Disposal	l.s.			0	
					0
Mill EQUIPMENT					
Clean-up	l.s.			250	
Disposal	l.s.			0	
					250
SULPHIDE ORE AREAS					
Excavation	cu. m.	37,000	4.00	148	
Treatment	cu. m.	37,000	4.00	148	
					296
FUEL & LUBE STORAGE AREAS					
Excavation	l.s.			200	
Treatment	l.s.			350	
Tanks, Pumps & Piping	l.s.			250	
					800
BULK EXPLOSIVES PLANT					
Disposal	l.s.			0	
					0
CHEMICAL INVENTORY					
Disposal	l.s.			200	
					200
WASTE MATERIAL DISPOSAL					
Scrap metal	l.s.			0	
Refuse (Garbage)	l.s.			25	
Sewage	l.s.			25	
					50
PIPELINES					
Water Line Removal	m.	2,000	20.00	40	
					40

FRESHWATER RESERVOIR					
Shell	cu. m.	100,000	5.00	500	
Channel excavation	cu. m.	10,000	3.00	30	
					530
SITE RECLAMATION					
Power Lines	l.s.			100	
Site Roads	l.s.			50	
Borrow Pits	l.s.			50	
Revegetation	ha.	54	1600.00	86	
					286
OTHER					
MetaFina plant	l.s.			50	
					50
Subtotal					3,641
Contingency (20 %)					728
Subtotal					4,370
EPCM (10 %)					437
TOTAL					$4,807

CURRAGH INC.

Table 2.3.2

BULK ZINC/LEAD CONCENTRATE

NET SMELTER RETURN

	METAL PRICES		CONC GRADE	REC	EXCHANGE RATE	
ZINC	(U.S.$/lb)	0.56	37.1%	30.1%		
LEAD	(U.S.$/lb)	0.31	14.2%	18.0%	U.S. $ 1.00 = C $	1.25
SILVER	(U.S.$/oz)	4.50	165	11.0%		
		METAL PAYABLE	MINIMUM DEDUCTION			
REVENUE						
ZINC		85%	7		U.S. $	371.61
LEAD		95%	3			76.54
SILVER		95%	75			13.02
GROSS REVENUE						461.17
CHARGES						
TREATMENT					205.00 /mt	205.00
ESCALATOR	(Zinc metal price/mt - 1000) x 0.1 x 0.85					19.94
SILVER REFINING CHARGE					0.00 /kg	0.00
PENALTIES					0.00	0.00
OCEAN FREIGHT					20.00 /mt	20.00
TRANSPORT, PORT, REP					54.50 /mt	54.50
TOTAL CHARGES						299.44
NET SMELTER RETURN per tonne of concentrate					U.S. $	161.73
NET SMELTER RETURN per tonne of concentrate					C $	202.17
NET SMELTER RETURN per tonne of tailings					C $	2.02

CURRAGH INC.

Table 2.3.2.1

BULK ZINC/LEAD CONCENTRATE

NET SMELTER RETURN
BREAKEVEN PRICE

	METAL PRICES		CONC GRADE	REC	EXCHANGE RATE	
ZINC	(U.S.$/lb)	0.62	37.1%	30.1%		
LEAD	(U.S.$/lb)	0.31	14.2%	18.0%	U.S. $ 1.00 = C $	1.25
SILVER	(U.S.$/oz)	4.50	165	11.0%		
		METAL PAYABLE	MIN. DEDUCTION			
REVENUE						
ZINC		85%	7		U.S. $	411.42
LEAD		95%	3			76.54
SILVER		95%	75			13.02
GROSS REVENUE						500.99
CHARGES						
TREATMENT					205.00 /mt	205.00
ESCALATOR	(Zinc metal price/mt - 1000) x 0.1 x 0.85					31.18
SILVER REFINING CHARGE					0.00 /kg	0.00
PENALTIES					0.00	0.00
OCEAN FREIGHT					20.00 /mt	20.00
TRANSPORT, PORT, REP					54.50 /mt	54.50
TOTAL CHARGES						310.68
NET SMELTER RETURN per tonne of concentrate					U.S. $	190.30
NET SMELTER RETURN per tonne of concentrate					C $	237.88
NET SMELTER RETURN per tonne of tailings					C $	2.379

CURRAGH INC

DOWN VALLEY TAILINGS IMPOUNDMENT

Table 2.3.7 ALTERNATIVE 5
DECOMMISSIONING
COST ESTIMATE
(Constant 1993 dollars)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST ($ 000)	TOTALS ($ 000)
CROSS VALLEY DAM & POND					
Drain Pond	l.s.			$15	
Clean Pond	cu. m.	209,000	$4.50	941	
Breach Dam	cu. m.	70,000	3.00	210	
Channel Excavation	cu. m.	81,000	3.00	243	
RipRap	cu. m.	10,900	12.60	137	
					$1,546
TAILINGS POND					
Clean up Tailings	cu. m.	450,000	4.50	2,025	2,025
INTERMEDIATE SPILLWAY					
Excavation	cu. m.	62,000	3.00	186	
Concrete Works	cu. m.	1,200	450.00	540	
Other	l.s.			200	
					926
ROSE CREEK					
Soil Excavation	cu. m.	8,000	3.00	24	
RipRap	cu. m.	1,000	12.60	13	
					37
OTHER WORK					
Pumphouse Dam	l.s.			5	
Lower Faro Creek	l.s.			50	
Next Creek	l.s.			50	
North Fork Diversion	l.s.			70	
					175
Subtotal					4,708
Contingency (20 %)					942
Subtotal					5,650
EPCM (10 %)					565
TOTAL					$6,215

CURRAGH INC

DOWN VALLEY TAILINGS IMPOUNDMENT

Table 2.3.8 ALTERNATIVE 4
COST ESTIMATE
(Constant 1993 dollars)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST ($ 000)	TOTALS ($ 000)
CROSS VALLEY DAM & POND					
Drain Pond	l.s.			$15	
Clean Pond	cu. m.	209,000	$4.50	941	
Breach Dam	cu. m.	70,000	3.00	210	
Channel Excavation	cu. m.	81,000	3.00	243	
RipRap	cu. m.	10,900	12.60	137	
					$1,546
INTERMEDIATE DAM					
Foundation Treatment	sq. m.	31,400	2.00	63	
Dam Exterior Shell	cu. m.	563,000	4.50	2,534	
Dam Exterior Filter	cu. m.	20,000	12.00	240	
Dam Core	cu. m.	49,000	11.00	539	
Dam Interior Filter	cu. m.	20,000	12.60	252	
					3,627
INTERMEDIATE SPILLWAY					
Excavation	cu. m.	23,400	3.00	70	
Concrete Works	cu. m.	1,200	450.00	540	
Other	l.s.			200	
					810
TAILINGS COVERS					
Tailings Removal	cu. m.	60,000	2.00	120	
Dykes	m.	5,020	448.00	2,249	
Dyke Spillways		22	360.00	8	
Tailings Placement	cu. m.	406,000	4.00	1,624	
Till Placement	cu. m.	406,000	5.00	2,030	
Mine Rock Placement	cu. m.	406,000	4.00	1,624	
					7,655
ORIGINAL EMBANKMENT					
Regrading	cu. m.	18,600	2.00	37	
Membrane	sq. m.	41,800	10.00	418	
Till	cu. m.	38,800	5.00	194	
Mine Rock	cu. m.	18,600	4.00	74	
Spillways		6	900.00	5	
					729
SECOND EMBANKMENT					
Regrading	cu. m.	17,200	2.00	34	
Membrane	sq. m.	90,300	10.00	903	
Till	cu. m.	45,100	5.00	226	
Mine Rock	cu. m.	137,600	4.00	550	
Spillways		6	1260.00	8	
					1,721

ROSE CREEK DIVERSION					
Soil Excavation	cu. m.	164,000	3.00	492	
Rock Excavation	cu. m.	70,000	8.00	560	
RipRap	cu. m.	31,000	12.60	391	
Thermal Blanket	cu. m.	7,500	10.00	75	
					1,518
LOWER FARO CREEK DIVERSION					
Excavation	cu. m.	111,000	3.00	333	
RipRap	cu. m.	31,000	12.60	391	
Other	l.s.			100	
					824
OTHER WORK					
Pumphouse Dam	l.s.			5	
North Wall Interceptor	l.s.			20	
North Fork Diversion	l.s.			70	
					95
Subtotal					18,524
Contingency (20 %)					3,705
Subtotal					22,229
EPCM (10 %)					2,223
TOTAL					$24,452

CURRAGH INC

MINE CLOSURE COSTS

DISPOSAL OF TAILINGS IN FARO PIT

Table 2.3.9 HYDRAULIC MINING
CAPITAL COST ESTIMATE
(Thousand 1993 dollars)

DESCRIPTION	COST	TOTALS
CAPITAL COST		
Monitors, Slurry Pumps	$2,350	
Lime Addition	100	
Two Stage Pumps	970	
Slurry & Water Lines	2,300	
Subtotal		5,720
Contingency (20 %)		1,144
Subtotal		6,864
EPCM (10 %)		686
TOTAL		$7,550

Table 2.3.10 HYDRAULIC MINING
OPERATING COST ESTIMATE
(Thousand 1993 dollars)

DESCRIPTION	COST	TOTALS
OPERATING COST		
Labour	$1,200	
Reagents	580	
Maintenance Supplies	670	
Electrical Energy	780	
Miscellaneous	100	
ANNUAL OPERATING COST		$3,330
Cost per tonne of Tailings		$0.69

CURRAGH INC

DOWN VALLEY TAILINGS IMPOUNDMENT

Table 2.3.11 DISPOSAL OF TAILINGS IN FARO PIT
DECOMMISSIONING COST ESTIMATE
(Constant 1993 dollars)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST ($ 000)	
CROSS VALLEY DAM & POND					
Drain Pond	l.s.			$15	
Clean Pond	cu. m.	209,000	$4.50	941	
Breach Dam	cu. m.	70,000	3.00	210	
Channel Excavation	cu. m.	30,000	3.00	90	
					$1,256
INTERMEDIATE DAM & POND					
Drain Pond	l.s.			20	
Clean Pond	cu. m.	1,800,000	$4.00	7,200	
Breach Dam	cu. m.	119,000	3.00	357	
Channel Excavation	cu. m.	198,000	3.00	594	
					8,171
ROSE CREEK					
Soil Excavation	cu. m.	8,000	3.00	24	
RipRap	cu. m.	1,000	12.60	13	
					37
OTHER WORK					
Pumphouse Dam	l.s.			5	
Lower Faro Creek	l.s.			50	
Next Creek	l.s.			50	
North Fork Diversion	l.s.			70	
					175
Subtotal					9,638
Contingency (20 %)					1,928
Subtotal					11,566
EPCM (10 %)					1,157
TOTAL					$12,722

CURRAGH INC

DOWN VALLEY TAILINGS IMPOUNDMENT

Table 2.3.12 FARO PIT PREPARATION
COST ESTIMATE
(Constant 1993 dollars)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST ($ 000)	
FARO PIT PREP					
Plug Dam	l.s.			$465	$465
Water Siphon	m.	1,500	125.00	188	188
Faro Creek Rehab	l.s.			100	100
Subtotal					753
Contingency (20 %)					151
Subtotal					903
EPCM (10 %)					90
TOTAL					$993

CURRAGH INC

DOWN VALLEY TAILINGS IMPOUNDMENT

Table 2.3.13 FARO PIT DECOMMISSIONING COST ESTIMATE (Constant 1993 dollars)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST ($ 000)	
FARO INLET SPILLWAY					
Excavation	cu. m.	11,000	$3.00	$33	
					$33
FARO OUTLET SPILLWAY					
Waste Rock Removal	cu. m.	280,000	3.40	952	
Rock Excavation	cu. m.	18,000	8.50	153	
					1,105
PIPELINE REMOVAL	m.	3,400	20.00	68	
					68
OTHER					
Faro Creek Diversion	l.s.			45	
					45
Subtotal					1,251
Contingency (20 %)					250
Subtotal					1,501
EPCM (10 %)					150
TOTAL					$1,651

CURRAGH INC

DOWN VALLEY TAILINGS IMPOUNDMENT

Table 2.3.14 OTHER WORK
COST ESTIMATE
(Thousand 1993 dollars)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST ($ 000)	
REVEGETATION	ha.	154	1,600.00	$246	
					$246
Subtotal					246
Contingency (20 %)					49
Subtotal					296
EPCM (10 %)					30
TOTAL					$325

Table 2.3.15 DOWN VALLEY TAILINGS IMPOUNDMENT
SUMMARY OF CLOSURE COSTS
(Thousand Constant 1993 dollars)

DESCRIPTION	ALTERNATIVE 5	ALTERNATIVE 4	TAILINGS TO PIT	PARTIAL TAILINGS TO PIT
DOWN VALLEY				
TAILINGS COVERS	0	7,655	0	0
ORIGINAL EMBANKMENT	0	729	0	0
SECOND EMBANKMENT	0	1,721	0	0
CROSS VALLEY DAM & POND	1,546	1,546	1,256	1,546
INTERMEDIATE DAM & POND	2,025	3,627	8,171	2,025
INTERMEDIATE SPILLWAY	926	810	0	926
ROSE CREEK DIVERSION	37	1,518	37	45
LOWER FARO CREEK DIVERSION	50	824	50	50
OTHER WORK	125	95	125	125
SUBTOTAL	4,709	18,525	9,639	4,717
TAILINGS REMOBILIZATION				
CAPITAL COST	6,107	0	5,720	5,720
HYD. MINING COST *	17,625	0	34,845	25,875
REPROCESSING COSTS*	71,250	0	0	0
REPROCESSING REVENUES*	(75,750)	0	0	0
SUBTOTAL	19,232	0	40,565	31,595
FARO PIT PREPARATION				
PLUG DAM	465	465	465	465
FARO CREEK REHAB	100	100	100	100
WATER RECLAIM SIPHON	188	0	188	188
SUBTOTAL	753	565	753	753
FARO PIT DECOMMISSIONING				
FARO INLET SPILLWAY	33	33	33	33
FARO OUTLET SPILLWAY	1,105	1,105	1,105	1,105
FARO CREEK DIVERSION	45	45	45	45
PIPELINE REMOVAL	68	34	68	68
SUBTOTAL	1,251	1,217	1,251	1,251
OTHER				
REVEGETATION	246	102	534	246
SUBTOTAL	246	102	534	246
SUBTOTAL	26,191	20,409	52,742	38,562
CONTINGENCY (20 %)	2,613	4,082	3,579	2,537
SUBTOTAL	28,804	24,491	56,321	41,099
EPCM (10 %)	1,568	2,449	2,148	1,522
TOTAL COST	$30,372	$26,940	$58,469	$42,622

* Contingency & EPCM are not applied to Revenues or Operating Costs

CURRAGH INC

VANGORDA PLATEAU DEVELOPMENT

Table 2.4.2 VANGORDA OPEN PIT
COST ESTIMATE
(Thousand 1993 dollars)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST	
INLET STREAMBED					
Excavation	cu. m.	1,200	$3.00	4	
					4
OUTLET SPILLWAY					
Excavation	cu. m.	4,000	3.00	12	
RipRap	cu. m.	4,000	12.60	50	
					62
INLET SPILLWAY (N.E.)					
Excavation	cu. m.	12,000	3.00	36	
RipRap	cu. m.	9,000	12.60	113	
					149
COLLECTION DITCH					
Excavation	cu. m.	2,000	6.00	12	
					12
ROCK BACKFILL					
Haul & Placement	cu. m.	260,000	3.00	780	
					780
TILL COVER					
Haul & Placement	cu. m.	203,000	3.50	711	
					711
OTHER	l.s.			30	
					30
Subtotal					1,748
Contingency (20 %)					350
Subtotal					2,097
EPCM (10 %)					210
TOTAL					$2,307

CURRAGH INC

VANGORDA PLATEAU DEVELOPMENT

Table 2.4.3 VANGORDA WASTE DUMP
COST ESTIMATE
(Thousand 1993 dollars)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST	
TILL BERMS					
Dump Rework	l.s.			450	
Till Placement	cu. m.	1,620,000	$3.00	4,860	
					5,310
TILL COVER					
Lower Layer	cu. m.	105,000	4.00	420	
Upper Layer	cu. m.	210,000	3.50	735	
					1,155
COLLECTION DITCHES					
Excavation	cu. m.	10,000	3.00	30	
Piping	m.	1,300	40.00	52	
					82
OTHER					
Instrumentation	l.s.			20	
					20
Subtotal					6,567
Contingency (20 %)					1,313
Subtotal					7,880
EPCM (7 %)					552
TOTAL					$8,432

CURRAGH INC

VANGORDA PLATEAU DEVELOPMENT

Table 2.4.5 GRUM OPEN PIT
COST ESTIMATE
(Thousand 1993 dollars)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST	
HAUL ROAD REMOVAL					
Excavation	l.s.			$25	
					$25
INLET SPILLWAY					
Excavation	l.s.			30	
RipRap					
					30
OUTLET SPILLWAY					
Excavation	cu. m.	5,000	6.00	30	
RipRap	cu. m.	5,000	12.60	63	
					93
Subtotal					148
Contingency (20 %)					30
Subtotal					178
EPCM (10 %)					18
TOTAL					$195

CURRAGH INC

VANGORDA PLATEAU DEVELOPMENT

Table 2.4.6 GRUM WASTE DUMP
COST ESTIMATE
(Thousand 1993 dollars)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST	
INTERNAL TILL LAYERS					
Till Placement	cu. m.	104,000	$3.00	$312	
					$312
TILL COVER					
Lower Layer	cu. m.	51,000	4.00	204	
Upper Layer	cu. m.	105,000	3.50	368	
					572
SULPHIDE WASTE BACKFILL					
Haul & Placement	cu. m.				
Subtotal					884
Contingency (20 %)					177
Subtotal					1,060
EPCM (10 %)					106
TOTAL					$1,166

CURRAGH INC

VANGORDA PLATEAU DEVELOPMENT

Table 2.4.7 OTHER WORK
COST ESTIMATE
(Thousand 1993 dollars)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST	
DRY/OFFICE BUILDING					
Demolition	sq. m.	500	35.00	18	
Cover Site	cu. m.	250	3.00	1	
					18
FUEL & LUBE STORAGE AREAS					
Excavation	l.s.			50	
Treatment	l.s.			75	
Tanks, Pumps & Piping	l.s.			50	
					175
HAUL ROAD					
North Fork Rose Creek	cu. m.	600,000	3.00	1,800	
Stream Crossings	l.s.			100	
					1,900
RECLAMATION					
Revegetation	ha.	60	1600.00	96	
					96
Subtotal					2,189
Contingency (20 %)					438
Subtotal					2,627
EPCM (10 %)					263
TOTAL					$2,890

CURRAGH INC.

MINE CLOSURE COSTS

SECTION 3.0

SA DENA HES DECOMMISSIONING PLAN COSTS

3.0 SA DENA HES DECOMMISSIONING PLAN COSTS

The Sa Dena Hes mining operation was established as the Mt. Hundere Joint Venture by Curragh Inc. and Hillsborough Resources Inc. in 1989. The mining operation has been in production since 1991. Curragh Inc. manages the operation for the Joint Venture.

The Sa Dena Hes mine is located 50 km north of the town of Watson Lake in southeastern Yukon. Access to the mine is by a 25 km road off the Robert Campbell Highway, 50 km north of Watson Lake.

Although ore production was projected to be 1300 tonnes per day (t/d), the actual rate has been significantly higher. Up to 2000 t/d of ore have been processed in the mill.

Decommissioning of the Sa Dena Hes operations is covered in the Initial Environmental Evaluation (IEE) and other studies prepared by Curragh Inc. and its consultants (Appendix I). The mine closure and reclamation plan presented by Curragh Inc. for the Sa Dena Hes operation is preliminary. As stated in their report, only "general reclamation principles which will be adopted can be discussed". As a general plan, it is generally satisfactory. The mine closure plan was reviewed by PBK Engineering Ltd in October 1990 (Report # 90132). This section of the report draws on information contained in that review.

3.1 SA DENA HES OPEN PIT AND UNDERGROUND MINES

The ore deposits at Sa Dena Hes occur as sphalerite (ZnS) and galena (PbS) mineralization in skarn zones at the contact of metamorphosed limestone. Other than the zinc and lead sulphide minerals, there are few sulphide minerals in the deposits. Test work on the ore and waste rock indicated that these would not be acid-generating. Curragh Inc. considers that no mitigation measures would be required for the open pit walls, waste dumps or tailings impoundment.

Mining was started with small open pits on the Main and Jewelbox zones. An adit was driven between these open pits to mine remnants of ore inaccessible from the open pits. Underground mining on the Jewelbox zone provided the ore for the mill after these open pits. In the original mining plan for the Jewelbox underground mine, a lower portal was to be driven under the deposit for haulage of broken ore to the crusher, and for ventilation. The lower portal was started, but was not completed. It is possible that the portal would be required for the Gribbler zone.

Following mining of the Jewelbox zone, Curragh Inc. expects to mine the Gribbler, Burnick and Attila zones. Underground exploration and development has been undertaken on the Attila and Burnick zones.

In the reclamation plan, it was proposed that the waste dumps be constructed with a 2H:1V slope. The waste rock dump for the Jewelbox underground mine is a side hill dump with the rock at the natural angle of repose. This dump, at least, should be reworked before permanent closure. Collection ditches have been constructed around the toes of the waste dumps to collect water and direct it to creeks flowing to the tailings impoundment.

3.1.1 Closure Requirements

The reclamation for each ore zone can be undertaken after completion of mining of that zone. For the open pits, a spillway should be constructed at the low point in the pit crest to allow for a controlled outflow of water, if it is expected that the pit fills with water.

For the underground mines, the openings should be sealed with concrete bulkheads to prevent access by people and animals. For openings located at the bottom of a zone, the concrete bulkhead should be designed to support the hydrostatic head, in the event that the mine fills with water.

On permanent closure, reclamation would have to be undertaken on the last zones to be mined.

3.1.1.1 Cost Review

The closure cost estimates for the Sa Dena Hes mining operation are shown in Table 3.1.1.

3.2 SA DENA HES MILL COMPLEX AND SURFACE FACILITIES

These facilities will be required until permanent closure. The IEE provides an assessment of the work required on permanent closure.

At closure, a site inspection would, nonetheless, be required to prepare an inventory of site facilities, equipment, waste disposal sites and hazardous waste materials. This site inspection would serve as the basis for a detailed site reclamation plan.

3.2.1 Mill Building

The building, a fabricated steel structure with metal cladding, would be cleaned and dismantled. The cladding and the structural steel would be transported off site for sale.

The site would be covered with a 0.5 m layer of glacial till.

3.2.2 Other Buildings

Some of the other buildings on site are prefabricated steel structures with metal cladding. These buildings would be dismantled and transported off site for sale. The floors and footings of these buildings are usually constructed of reinforced concrete. These would be broken up and buried, and the site would be covered with a 0.5 m layer of glacial till.

The office and camp facilities are portable trailer units, which have a salvage value. These units would be dismantled and transported off site for sale. The site would be covered with a 0.5 m layer of glacial till and revegetated.

3.2.3 Mine and Shop Equipment

There is a market for used equipment. The value of this equipment depends on a number of factors, including the market for used equipment at the time of sale. Prices on the used equipment market, as with any market, depend on supply and demand. Another factor is the age and condition of the equipment. A third factor is the location.

For the purposes of this report, it is assumed that the value of the equipment is equal to the cost of dismantling it and transporting it to the point of sale.

3.2.4 Mill Equipment

The comments on mine and shop equipment also apply for mill equipment. This equipment would, however, require clean-up.

3.2.5 Sulphide Ore Areas

There are areas at the mines and the mill which have been used for stockpiles of ore. Curragh Inc. proposes to treat these stockpiles in the mill on or before permanent closure. The material under these stockpiles will also have to be processed through the mill. Since the composition of these materials is unknown, it is assumed that they may contain organic soils or hydrocarbons, in which case recovery of any zinc or lead minerals in the mill would be poor.

The area around the concentrate load-out is still relatively clean of concentrate. Any contaminated material will, however, have to be processed through the mill.

3.2.6 Fuel and Lube Storage Areas

The fuel and lubricant tanks, located above ground, should be purged, removed, dismantled and buried. The delivery systems should have a salvage value.

There will probably be contaminated soils around some of these storage areas which will require disposal.

3.2.7 Explosives Magazines

For the purposes of this report, it is assumed that the explosives supplier will be responsible for its removal, and for site restoration.

3.2.8 Chemical Inventory

There is a wide variety of chemicals and reagents on site. Each chemical must be disposed of in accordance with the guidelines. Most of the chemicals in active use at the time of closure could be returned to the manufacturer. It is expected that at least some of the chemicals are old or obsolete stock.

3.2.9 Waste Material Disposal

Scrap Metal
Scrap steel and metals, used equipment parts and old equipment are stored on site. It is assumed that this material has a scrap value and would be transported off site.

Refuse (Garbage)
There is a landfill for refuse located on site. It is assumed that the landfills do not contain any hazardous materials and will be covered with 1.0 m of glacial till.

Sewage Disposal
A sewage treatment plant was constructed to treat sewage from the offices and camp.

3.2.10 Pipelines

It is assumed that the tailings lines, water pipe and fittings have a salvage value. The pipelines would be dismantled, removed and transported to the point of sale.

3.2.11 Water Supply

There are three water supply systems. The water in the reclaim pond at the tailings impoundment area is recycled for process water in the mill. Make-up water for losses in the reclaim system and water for other industrial uses comes from water wells drilled in the valley north of the tailings impoundment area. Potable water for the camp and offices is obtained from a water well.

3.2.12 Cost Review

The closure cost estimates for the mill complex, surface and other facilities at Sa Dena Hes as well as the access road are shown in Table 3.2.1.

3.3 SA DENA HES TAILINGS IMPOUNDMENT

Tailings from the processing of ores mined from the mines are placed in the Tailings Impoundment. The impoundment is located below the mill site on a small saddle between two hills. Dams were constructed on the north and south ends of the impoundment area to retain the tailings. These dams will be raised over the life of the mine, as required to hold the tailings. A diversion ditch was constructed to divert a small tributary of False Canyon Creek away from the tailings pond. Interceptor ditches were excavated along the east and west sides of the impoundment to minimize the amount of surface runoff flowing into the impoundment area.

The tailings consist of mineral rejects from the processing and contain little of the sulphide minerals which can oxidize to produce an acidic water discharge from the impoundment. It is assumed that the tailings are, in fact, non acid-generating.

3.3.1 Closure Requirements

On permanent closure, the tailings impoundment and the retaining dams would be recontoured to permit free drainage from the area. A 150 mm cap of topsoil would be placed on the surface to reduce precipitation infiltration and eliminate dust. A permanent spillway would be constructed to accommodate a 200 year flood event. The decant tower would be filled with soil and the overflow pipe plugged with concrete. The interceptor ditches would be removed to restore natural flows.

The dam on the reclaim water pond would be breached to re-establish the original flow channel. Any accumulation of tailings in the reclaim pond should be returned to the tailings impoundment.

3.3.1.1 Cost Review

The closure cost estimates for the Sa Dena Hes tailings impoundment are shown in Table 3.3.1.

3.4 SA DENA HES ACCESS ROAD

Curragh Inc. has proposed to reclaim the access road.

3.4.1.1 Cost Review

The closure cost estimates for the Sa Dena Hes access road are shown in Table 3.2.1.

CURRAGH INC

SA DENA HES MINE DECOMMISSIONING

Table 3.1.1 OPEN PIT AND UNDERGROUND MINES
COST ESTIMATE
(Thousand 1993 dollars)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST	
WASTE DUMPS					
Rework	l.s.			$100	
					$100
OPEN PITS					
Spillways	l.s.			40	
					40
UNDERGROUND MINES					
Lower Portal Bulkheads	l.s.			300	
Vent/Other Raise Bulkheads	l.s.			40	
					340
Subtotal					480
Contingency (20 %)					96
Subtotal					576
EPCM (10 %)					58
TOTAL					$634

CURRAGH INC

SA DENA HES MINE DECOMMISSIONING

Table 3.2.1 MILL COMPLEX/SURFACE FACILITIES COST ESTIMATE (Thousand 1993 dollars)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST	
MILL BUILDING					
Salvage	sq. m.	2,100	50.00	105	
Cover Site	cu. m.	1,100	3.00	3	
					108
OTHER BUILDINGS					
Salvage	sq. m.	1,500	35.00	53	
Cover Site	cu. m.	750	3.00	2	
					55
MINE, POWER GEN & SHOP EQUIPMENT					
Disposal	l.s.			0	
					0
Mill EQUIPMENT					
Clean-up	l.s.			80	
Disposal	l.s.			0	
					80
SULPHIDE ORE AREAS					
Excavation	cu. m.	6,000	4.00	24	
Treatment	cu. m.	6,000	4.00	24	
					48
FUEL & LUBE STORAGE AREAS					
Excavation	l.s.			60	
Treatment	l.s.			60	
Tanks, Pumps & Piping	l.s.			50	
					170
EXPLOSIVES MAGAZINES					
Disposal	l.s.			0	
					0
CHEMICAL INVENTORY					
Disposal	l.s.			50	
					50
WASTE MATERIAL DISPOSAL					
Scrap metal	l.s.			0	
Refuse (Garbage)	l.s.			10	
Sewage	l.s.			10	
					20
PIPELINES					
Water Line Removal	m.	2,600	20.00	52	
Tailings Line Removal	m.	1,200	20.00	24	
					76

Table 3.2.1 (Cont'd)

ACCESS ROAD					
Stream Crossings	l.s.			60	
Culvert Removal	l.s.			100	
Revegetation	ha.	70	1600.00	112	
					272
SITE RECLAMATION					
Power Lines	l.s.			80	
Site Roads	l.s.			40	
Borrow Pits	l.s.			20	
Revegetation	ha.	18	1600.00	29	
					169
Subtotal					1,048
Contingency (20 %)					210
Subtotal					1,257
EPCM (10 %)					126
TOTAL					$1,383

CURRAGH INC

SA DENA HES MINE DECOMMISSIONING

Table 3.3.1 TAILINGS IMPOUNDMENT COST ESTIMATE (Constant 1993 dollars)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST ($ 000)	
TAILINGS POND					
Soil Cover	cu. m.	94,000	$4.00	$376	
Decant Tower	l.s.			12	
Spillway	l.s.			75	
Interceptor Ditches	l.s.			20	
					$483
RECLAIM POND					
Breach Dam	cu. m.	4,500	3.00	14	
Clean Pond	cu. m.	20,000	3.00	60	
Channel Excavation	cu. m.	4,000	3.00	12	
RipRap	cu. m.	500	12.60	6	
					92
OTHER WORK					
Revegetation	ha.	6	1600.00	10	
					10
Subtotal					584
Contingency (20 %)					117
Subtotal					701
EPCM (10 %)					70
TOTAL					$771

CURRAGH INC.

MINE CLOSURE COSTS

SECTION 4.0

MONITORING, MAINTENANCE AND ADMINISTRATION COSTS

4.0 MONITORING, MAINTENANCE AND ADMINISTRATION COSTS

To ensure that there is no long term impact on the environment, a monitoring programme would need to be implemented to assure the effectiveness of the reclamation. Structures remaining after closure will require maintenance. Operation of the water treatment plants would form part of the long term monitoring and maintenance programme.

Long term monitoring and maintenance programmes have been presented by Curragh Inc. for some of the components, but not the operations as a whole. Drawing on the information presented by Curragh Inc., the monitoring for the various components has been combined to obtain a total for the whole operation.

It is assumed that the monitoring is carried out by technical personnel specialized in the particular field. It is also assumed this is carried out by third parties. The rates utilized in the estimates are based on the PBK Engineering Ltd. report (# 91116).

An issue which has been raised is the replacement of plant and structures, such as the concrete spillways, at the end of their useful life. Provision has been made in the funding for replacement (Section 4.1.5).

Maintenance of the road to the Faro mine site will also be required.

4.1 FARO OPERATIONS

The monitoring and maintenance requirements and costs for the Down Valley Tailings Impoundment and the Vangorda Plateau Development are presented in the Curragh Inc. reports, but not for the Faro mine.

4.1.1 Faro Open Pit and Underground Mines

4.1.1.1 Water Treatment Plant

As indicated in Section 2.1.3.2, it is assumed in this report that a water treatment plant is installed at Faro to treat the ARD from the waste dumps. Based on the estimates of water flow from the dumps, it is assumed that a plant similar to the plant at Vangorda would be required. The plant would be operated on an one shift basis for six months of the year.

Curragh Inc.

Long Term Monitoring and Maintenance

Table 4.1.1 Faro Mine Water Treatment Plant Operating Cost Estimate (1993 constant dollars)

Labour		
Operating	$ 55,000	
Supervision	35,000	
Maintenance	28,000	
		$ 118,000
Supplies		
Reagents	18,000	
Operating	12,000	
Maintenance	41,000	
Power	35,000	
		106,000
Sludge Pond Maintenance and Sludge Disposal	25,000	
Sampling and Analysis	10,000	
		35,000
TOTAL ANNUAL COST		**$ 259,000**

4.1.1.2 Monitoring

The monitoring would be coordinated with the monitoring required for the Down Valley Tailings Impoundment. It is assumed that the biological monitoring and physical inspection cover both sites.

Curragh Inc.

Long Term Monitoring and Maintenance

Table 4.1.2 Faro Mine
Monitoring Cost Estimate
(1993 constant dollars)

Water Quality			
	Sample Collection	$ 7,500	
	Sample Analysis	1,600	
	Travel and Lodging	1,500	
	Report Preparation	2,500	
			$13,100
Biological Monitoring			
	Site Work	7,800	
	Sample Enumeration	2,500	
	Helicopter	9,000	
	Report Preparation	2,500	
			21,800
Physical Inspection			
	Site Work	6,000	
	Travel and Lodging	1,800	
	Report Preparation	2,500	
			10,300
TOTAL ANNUAL COST			**45,200**

4.1.1.3 Physical Maintenance

Maintenance will be required for the diversion ditches, collection ditches and sumps, all of which could be subject to damage from freeze-thaw cycles, erosion or other problems.

It is probable that the maintenance would require five days work every two years. An estimate of the cost is shown in Table 4.1.3

Curragh Inc.

Long Term Monitoring and Maintenance

Table 4.1.3 Faro Mine Site Maintenance Cost Estimate (1993 constant dollars)

Mobilization and Demobilization		$ 2,000	
Equipment (including operators)			
Loader	50 hr x $ 150/hr	7,500	
Backhoe	50 hr x $ 120/hr	6,000	
Truck	50 hr x $ 100/hr	5,000	
Travel and Subsistence			
4 men x 5 days x $ 100/day		2,000	
Contractor's Supervisor			
5 days x $ 700/day		3,500	
Travel and Subsistence		1,000	
Pick-up		2,000	
Miscellaneous		2,200	
			$ 31,200
Contingency (20 %)			6,200
Construction Management (7 %)			2,600
TOTAL			**$ 40,000**
ANNUAL COST	**$ 40,000/2**		**$ 20,000**

4.1.2 Faro Mill Complex and Surface Facilities

There would be no long term monitoring and maintenance requirements for the Faro mill complex and surface facilities.

4.1.3 Down Valley Tailings Impoundment

The monitoring and maintenance requirements vary with the option selected for decommissioning of the tailings impoundment. For the purposes of this report, it is assumed that Alternative 5 is the selected option.

The monitoring and maintenance costs for Alternative 5 are presented in the Curragh Inc. reports. The monitoring required for Alternative 4 should not be significantly different, although maintenance requirements would be higher. Disposal of all the tailings in the Faro pit in essence returns Rose Creek to its original state, so there are no long term monitoring and maintenance requirements. With partial disposal of tailings in the Faro pit, the monitoring and maintenance requirements would be the same as for Alternative 5.

4.1.3.1 Monitoring

The estimate is based on the monitoring outlined in the SRK report (Report # 60635 Section 13) prepared for Curragh Inc.

The monitoring would be coordinated with the monitoring required for the Faro Mine site. It is assumed that the biological monitoring and physical inspection in Table 4.1.2 covers both sites.

Curragh Inc.

Long Term Monitoring and Maintenance

Table 4.1.4 Down Valley Tailings Impoundment Monitoring Cost Estimate (1993 constant dollars)

Water Quality			
	Sample Collection	$ 7,500	
	Sample Analysis	1,600	
			$ 9,100

4.1.3.2 Physical Maintenance

The maintenance requirements for Alternative 5 are outlined by Curragh Inc in its reports. Maintenance required for Alternative 4 will be higher than the maintenance for Alternative 5. The composite soil covers and dykes, in particular, could be subject to rupture from freeze-thaw cycles or local liquefaction of the underlying tailings.

Curragh Inc. had projected eight days work every two years for Alternative 5. It is probable that this would double for Alternative 4.

Curragh Inc.

Long Term Monitoring and Maintenance

Table 4.1.1 Down Valley Tailings Impoundment Maintenance Cost Estimate (1993 constant dollars)

Mobilization and Demobilization	$ 2,000	
Equipment (including operators)		
Loader 80 hr x $ 150/hr	12,000	
Backhoe 80 hr x $ 120/hr	9,600	
Truck 80 hr x $ 100/hr	8,000	
Travel and Subsistence		
4 men x 8 days x $ 100/day	3,200	
Contractor's Supervisor		
8 days x $ 700/day	5,600	
Travel and Subsistence	2,100	
Pick-up	3,200	
Miscellaneous	4,000	
		$ 49,700
Contingency (20 %)		9,900
Construction Management (7 %)		4,200
TOTAL		**$ 63,800**
ANNUAL COST	**$ 63,800/2**	**$ 31,900**

4.1.4 Vangorda Plateau Development

4.1.4.1 Water Treatment Plant

The water treatment plant installed at Vangorda would treat the ARD from the waste dumps. Based on the estimates of water flow from the dumps, it is assumed that the plant would be operated on an one shift basis for six months of the year.

Curragh Inc.

Long Term Monitoring and Maintenance

Table 4.1.6 Vangorda Mine Water Treatment Plant Operating Cost Estimate (1993 constant dollars)

Labour		
Operating	$ 55,000	
Supervision	35,000	
Maintenance	28,000	
		$ 118,000
Supplies		
Reagents	18,000	
Operating	12,000	
Maintenance	41,000	
Power	35,000	
		106,000
Sludge Pond Maintenance and Sludge Disposal	25,000	
Sampling and Analysis	10,000	
		35,000
TOTAL		**$ 259,000**

4.1.4.2 Monitoring

The SRK report on the modified design for the waste dump outlines instrumentation requirements and a program for monitoring of the dump. In addition to monthly monitoring of the instrumentation, SRK recommends monthly visual inspections of the crest and toe of the dykes. The visual inspection involves checking the dykes and dump for tension cracks, bulges, seeps and erosion, and recording any of these or other occurrences. The visual inspection includes checking the rock drains for blockage and other problems as well as estimating the flows from each drain.

SRK recommends monthly monitoring of the instrumentation and monthly visual inspections, but does not indicate the time frame for this monitoring. Monitoring must be more frequent during the construction period. In addition, post-closure monitoring will depend on the results of monitoring during construction.

Curragh Inc.

Long Term Monitoring and Maintenance

Table 4.1.7 Vangorda Plateau Monitoring Cost Estimate (1993 constant dollars)

Water Quality			
	Sample Collection	$ 7,500	
	Sample Analysis	1,600	
			$ 9,100
Biological Monitoring			
	Site Work	7,800	
	Sample Enumeration	2,500	
	Helicopter	5,000	
			15,300
Physical Inspection			
	Site Work	6,000	
			6,000
TOTAL			**$30,400**

4.1.4.3 Physical Maintenance

Maintenance will be required for the till covers, till berms and collection ditches for the Grum and Vangorda waste dumps, all of which could be subject to damage from freeze-thaw cycles, erosion or other problems.

It is probable that the maintenance would require five days work every two years. An estimate of the cost is shown in Table 4.1.8.

Curragh Inc.

Long Term Monitoring and Maintenance

Table 4.1.8 Vangorda Plateau Maintenance Cost Estimate (1993 constant dollars)

Mobilization and Demobilization		$ 2,000	
Equipment (including operators)			
Loader	50 hr x $ 150/hr	7,500	
Backhoe	50 hr x $ 120/hr	6,000	
Truck	50 hr x $ 100/hr	5,000	
Travel and Subsistence			
	4 men x 5 days x $ 100/day	2,000	
Contractor's Supervisor			
	5 days x $ 700/day	3,500	
	Travel and Subsistence	1,000	
	Pick-up	2,000	
Miscellaneous		2,200	
			$ 31,200
Contingency (20 %)			6,200
Construction Management (7 %)			2,600
TOTAL			**$ 40,000**
ANNUAL COST	**$ 40,000/2**		**$ 20,000**

4.1.5 Cost Summary and Funding Requirements

The summary of the cost estimates presented above for long term monitoring and maintenance is shown in Table 4.1.9.

At a real interest rate of 2.75 %, the amount (in constant 1993 dollars) of the fund required to finance the annual expenditures is presented in Table 4.1.9. This rate of real interest is the rate forecast by Deloitte & Touche in their report prepared for DIAND Northern Affairs - Whitehorse in June 1990.

At a real interest rate of 4.25 %, the amount (in constant 1993 dollars) of the fund required is also presented in Table 4.1.9. This is the rate of real interest currently paid by the Government of Canada on long term real interest rate bonds.

These fund amounts do not include any provision for taxes, administration or trustee fees.

4.1.5.1 Capital Replacement

The equipment in the water treatment plants, the pumps and piping and structures, such as the concrete spillway proposed for the Intermediate Spillway would require replacement on a periodic basis.

Based on the assumption that the useful life is 50 years, the amount of the fund required to meet these expenditures at a real interest rate of 2.75 % is $ 1.2 million, as shown below.

Water Treatment Plant Equipment	$ 2,400,000
Pumps and Piping	500,000
Concrete Spillway	540,000
TOTAL	**$ 3,440,000**

PRESENT VALUE

Real Interest Rate of 2.75 %.

(Capital Replacement + Subsequent Fund) x PV factor =

($ 3,440,000 + Y) x 0.2640 = **$ 1,200,000**

Real Interest Rate of 4.25 %.

(Capital Replacement + Subsequent Fund) x PV factor =

($ 3,440,000 + Y) x 0.1202 = **$ 470,000**

4.2 SA DENA HES OPERATIONS

Long term monitoring and maintenance programmes have not been presented by Curragh Inc., but there is a need to ensure that there is no long term impact on the environment and to assure the effectiveness of the reclamation.

At closure, the monitoring programme should be continued over a minimum two year period. The exact nature of the programme should be established prior to closure. For the purposes of this review, a typical programme is presented to provide a cost estimate.

Curragh Inc.

Long Term Monitoring and Maintenance

Table 4.2.1 Sa Dena Hes Mine Monitoring Cost Estimate (1993 constant dollars)

Water Quality			
	Sample Collection	$ 7,500	
	Sample Analysis	2,500	
	Travel and Lodging	3,000	
	Report Preparation	5,000	
			$18,000
Physical Inspection			
	Site Work	6,500	
	Travel and Lodging	3,000	
	Report Preparation	2,500	
			12,000
TOTAL COST			**$30,000**

CURRAGH INC

LONG TERM MONITORING AND MAINTENANCE

Table 4.1.9 SUMMARY OF ESTIMATED COST
(Thousand 1993 dollars)

DESCRIPTION	COST	
WATER TREATMENT		
Faro	259	
Vangorda	259	
		518
MONITORING		
Faro	45	
Down Valley	9	
Vangorda	30	
		85
MAINTENANCE *		
Faro	16	
Down Valley	25	
Vangorda	16	
		56
Subtotal		659
Contingency (20 %)		11
Subtotal		670
EPCM (7 %)		5
TOTAL		$675

FUNDING REQUIREMENT (Interest Rate 2.75 %)	$24,536

FUNDING REQUIREMENT (Interest Rate 4.25 %)	$15,876

* Contingency & EPCM on Maintenance only

CURRAGH INC.

MINE CLOSURE COSTS

SECTION 5.0

SUMMARY OF CLOSURE COST ESTIMATES

5.0 SUMMARY OF CLOSURE COST ESTIMATES

5.1 FARO OPERATIONS

The closure cost estimates for the Faro Operations outlined in Section 2.0 of this report represent, for the most part, a liability which has already been incurred and which must be met before, or on, permanent closure. One exception is the Grum Waste Dump where sulphide waste has not as yet been removed from the pit.

The estimated closure costs are summarized in Tables 5.1.1 to 5.1.4, depending on the option selected for the Down Tailings Impoundment.

Table 5.1.1 **Summary of Closure Costs based on Curragh Inc.'s Alternative 5.**

Table 5.1.2 **Summary of Closure Costs based on Curragh Inc.'s Alternative 4.**

Table 5.1.3 **Summary of Closure Costs based on disposal of the tailings in the Faro pit.**

Table 5.1.4 **Summary of Closure Costs based on partial disposal of the tailings in the Faro pit.**

Monitoring and maintenance fund requirements are shown in Table 5.1.5.

5.2 SA DENA HES OPERATIONS

In the case of the Sa Dena Hes operations, only some of the closure cost estimates outlined in Section 3.0 represent a liability which has already been incurred and which must be met before, or on, permanent closure. In addition, the reclamation of each ore zone can be undertaken after completion of mining of that zone.

A summary of the estimated costs is shown in Table 5.2.

CURRAGH INC

MINE CLOSURE COSTS

FARO OPERATIONS

Table 5.1.1 SUMMARY OF ESTIMATED COST
based on ALTERNATIVE 5
(Thousand 1993 dollars)

DESCRIPTION	COST	TOTALS
FARO OPEN PIT		$5,504
FARO MILL/SURFACE FACILITIES		3,641
DOWN VALLEY TAILINGS (Alternative 5)		
Hyd. Mining (Capital)	$5,620	
Reprocessing (Capital)	487	
Hyd. Mining *	17,625	
Reprocessing (Operating Cost) *	71,250	
Reprocessing Revenue *	(75,750)	
Decommissioning	4,709	
Faro Pit Prep	753	
Faro Pit Decom	1,251	
Other	246	
		26,191
VANGORDA PLATEAU DEV		
Vangorda Open Pit	1,748	
Vangorda Waste Dump	6,567	
Grum Open Pit	148	
Grum Waste Dump	884	
Other	2,189	
		11,536
Subtotal		46,872
Contingency (20 %)		6,749
Subtotal		53,621
EPCM (10 %)		4,050
TOTAL		$57,671

* Contingency & EPCM are not applied to Revenues or Operating Costs

CURRAGH INC

MINE CLOSURE COSTS

FARO OPERATIONS

Table 5.1.2 SUMMARY OF ESTIMATED COST
based on ALTERNATIVE 4
(Thousand 1993 dollars)

DESCRIPTION	COST	TOTALS
FARO OPEN PIT		$5,504
FARO MILL/SURFACE FACILITIES		3,641
DOWN VALLEY TAILINGS (Alternative 4)		
Tailings Covers	$7,655	
Embankments	2,450	
Cross Valley Dam & Pond	1,546	
Intermediate Dam, Spillway & Pond	4,437	
Diversions	2,342	
Other	95	
		18,525
Faro Pit Prep	565	
Faro Pit Decom	1,217	
Other	102	
		1,884
VANGORDA PLATEAU DEV		
Vangorda Open Pit	1,748	
Vangorda Waste Dump	6,567	
Grum Open Pit	148	
Grum Waste Dump	884	
Other	2,189	
		11,536
Subtotal		41,090
Contingency (20 %)		8,218
Subtotal		49,308
EPCM (10 %)		4,931
TOTAL		$54,239

CURRAGH INC

MINE CLOSURE COSTS

FARO OPERATIONS

Table 5.1.3 SUMMARY OF ESTIMATED COST
based on
TAILINGS TO PIT
(Thousand 1993 dollars)

DESCRIPTION	COST	TOTALS
FARO OPEN PIT		$5,504
FARO MILL/SURFACE FACILITIES		3,641
DOWN VALLEY TAILINGS TO FARO PIT		
Hyd. Mining (Capital)	$5,720	
Hyd. Mining *	34,845	
Decommissioning	9,639	
Faro Pit Prep	753	
Faro Pit Decom	1,251	
Other	534	
		52,742
VANGORDA PLATEAU DEV		
Vangorda Open Pit	1,748	
Vangorda Waste Dump	6,567	
Grum Open Pit	148	
Grum Waste Dump	884	
Other	2,189	
		11,536
Subtotal		73,423
Contingency (20 %)		7,716
Subtotal		81,139
EPCM (10 %)		4,629
TOTAL		$85,768

* Contingency & EPCM are not applied to Operating Costs

CURRAGH INC

MINE CLOSURE COSTS

FARO OPERATIONS

Table 5.1.4 SUMMARY OF ESTIMATED COST
based on
PARTIAL TAILINGS TO PIT
(Thousand 1993 dollars)

DESCRIPTION	COST	TOTALS
FARO OPEN PIT		$5,504
FARO MILL/SURFACE FACILITIES		3,641
PORTION OF DOWN VALLEY TAILINGS TO FARO PIT		
Hyd. Mining (Capital)	$5,720	
Hyd. Mining *	25,875	
Decommissioning	4,717	
Faro Pit Prep	753	
Faro Pit Decom	1,251	
Other	246	
		38,562
VANGORDA PLATEAU DEV		
Vangorda Open Pit	1,748	
Vangorda Waste Dump	6,567	
Grum Open Pit	148	
Grum Waste Dump	884	
Other	2,189	
		11,536
Subtotal		59,243
Contingency (20 %)		6,674
Subtotal		65,917
EPCM (10 %)		4,004
TOTAL		$69,921

* Contingency & EPCM are not applied to Operating Costs

CURRAGH INC

MINE CLOSURE COSTS

FARO OPERATIONS

Table 5.1.5 FUND REQUIREMENTS
(Thousand 1993 dollars)

REAL INTEREST RATE = 2.75 %	
MONITORING & MAINTENANCE FUND	24,536
CAPITAL REPLACEMENT FUND	1,200
TOTAL - FUNDS	$25,736

REAL INTEREST RATE = 4.25 %	
MONITORING & MAINTENANCE FUND	15,876
CAPITAL REPLACEMENT FUND	470
TOTAL - FUNDS	$16,346

CURRAGH INC

MINE CLOSURE COSTS

Table 5.2 SA DENA HES OPERATIONS
SUMMARY OF ESTIMATED COST
(Thousand 1993 dollars)

DESCRIPTION	COST
OPEN PIT & UNDERGROUND MINES	$634
MILL/SURFACE FACILITIES	1,383
TAILINGS IMPOUNDMENT	771
TOTAL - DECOMMISSIONING	$2,788
MONITORING & MAINTENANCE	30
TOTAL	$2,818

CURRAGH INC.

MINE CLOSURE COSTS

APPENDIX I

REFERENCES

APPENDIX I

REFERENCES

FARO OPERATIONS

1. FARO OPEN PIT

1.1 Curragh Resources Inc.
Faro Mine Abandonment Plan
April 1988

1.2 Curragh Resources Inc.
Faro Temporary Abandonment Plan
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1.3 Curragh Resources Inc.
Development of the Zone 2 Waste Dump
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1.4 Curragh Resources Inc.
Faro Pits and Waste Rock Dumps
1987 and 1988 Seep Surveys
Steffen, Robertson, Kirsten (B.C.) Inc. Report # 60612
June 1989

2. DOWN VALLEY TAILINGS

2.1 Curragh Resources Inc.
Groundwater Contingency Plans
Steffen, Robertson, Kirsten (B.C.) Inc. Report # 60603
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2.2 Curragh Resources Inc.
Conceptual Plans for Stabilization of Rose Creek Tailings Facilities, Rose Creek Diversion and North Wall Interceptor in the Event of Temporary Closure.
Steffen, Robertson, Kirsten (B.C.) Inc. Report # 60604
April 1988

2.3 Curragh Resources Inc.
Down Valley Tailings Impoundment Decommissioning Plan.
Steffen, Robertson, Kirsten (B.C.) Inc. Report # 60635
Volumes I to IV
April 1991

2.4 Curragh Resources Inc.
Faro Decommissioning - Overview of the Environmental Plans
Volumes I and II
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2.5 Yukon Territory Water Board IN89-001-PH91
Curragh Resources Inc.
Exhibit V and VIII

2.6 Curragh Resources Inc.
Amendment # 1 to Water Licence # IN89-001
Faro Mine Water Recycle and Tailings Deposition Plan.
Volumes I and II
Kilborn Inc. Report # 3509 28

2.7 Northern Affairs Program
Down Valley Tailings Impoundment Decommissioning Plan.
Evaluation Report and Addendum
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November 1991

2.8 Environmental Protection Environment Canada
Critical Evaluation of Curragh, Down Valley Tailings
Acid Mine Drainage Modelling, 1986 - 1991
Ronald V. Nicholson and Jeno M. Scharer
Draft Final Report
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2.9 Northern Affairs Program
Curragh Resources - Faro Mine
Report on 1992 Inspection.
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September 1992

3. VANGORDA PLATEAU DEVELOPMENT

3.1 Curragh Inc.
Vangorda Plateau Development
Expansion of the Vangorda Mine Rock Containment Facility.
Steffen, Robertson, Kirsten (Canada) Inc. Letter Report # 160649
December 1992

3.2 Curragh Resources Inc.
Vangorda Plateau Development
Review of Alternative Abandonment Plans and Water Quality Prediction Methods.
Steffen, Robertson, Kirsten (B.C.) Inc. Report # 60609
February 1990

3.3 Curragh Resources Inc.
"Stage Two" Initial Environment Evaluation
Volumes I, II and III
July 1989

3.4 Curragh Resources Inc.
"Stage Two" Initial Environment Evaluation
Addendum
May 1990

3.5 Curragh Resources Inc.
Vangorda Plateau Development
Projected Mitigation and Treatment Costs for Closure.
CRI Report # WH003.
Steffen, Robertson, Kirsten (B.C.) Inc. Report # 60609
June 1990

3.6 Northern Affairs Program
Vangorda Plateau Development
Mine Abandonment Plan Evaluation Report
PBK Engineering Ltd. Project # 90086
June 1990

4. FARO SURFACE FACILITIES

4.1 Curragh Resources Inc.
Other Facilities Abandonment Plan

SA DENA HES MINE

1. Initial Environmental Evaluation
   Mt. Hundere Joint Venture
   Volume I to V
   Steffen, Robertson & Kirsten (B.C.) Ltd.
   May 1990

2. Initial Environmental Evaluation
   Mt. Hundere Joint Venture
   Volume VI Summary and Overview
   September 1990

3. Northern Affairs Program
   Mt. Hundere Joint Venture
   Mine Closure Plan Evaluation Report
   PBK Engineering Ltd. Project # 90132
   October 1990

YUKON TERRITORY WATER BOARD

1. Water Licence # IN89-001

   Licence issued to Curragh Resources Inc. for Rose Creek., with,

   Amendment # 1, and

   Amendment # 2.

2. Water Licence # IN89-002

   Licence issued to Curragh Resources Inc. for Vangorda Creek.

3. Water Licence # IN90-002

   Licence issued to Curragh Resources Inc. for False Canyon Creek.

DIAND

1. Mine Reclamation in Northwest Territories and Yukon.
   Northern Water Resources Studies
   April 1992

CURRAGH INC.

MINE CLOSURE COSTS

APPENDIX II

METAL PRICES

LONDON METAL EXCHANGE

ANNUAL ZINC PRICES
(U.S. $/lb)

YEAR	ZINC PRICE (CURRENT $)	GNP DEFLATOR (1992 = 100)	ZINC PRICE (CONSTANT) (1992 $)
1960	0.112	22.073	0.507
1961	0.097	22.284	0.435
1962	0.084	22.779	0.369
1963	0.096	23.107	0.415
1964	0.147	23.486	0.626
1965	0.141	24.090	0.585
1966	0.128	24.933	0.513
1967	0.124	25.636	0.484
1968	0.119	26.913	0.442
1969	0.130	28.371	0.458
1970	0.134	29.974	0.447
1971	0.140	31.650	0.442
1972	0.171	33.160	0.516
1973	0.386	35.332	1.092
1974	0.562	38.487	1.460
1975	0.337	42.301	0.797
1976	0.323	44.983	0.718
1977	0.268	47.983	0.559
1978	0.269	51.505	0.522
1979	0.337	56.032	0.601
1980	0.345	61.131	0.564
1981	0.384	67.012	0.573
1982	0.338	71.321	0.474
1983	0.347	74.040	0.469
1984	0.418	76.837	0.544
1985	0.355	79.126	0.449
1986	0.342	81.255	0.421
1987	0.362	83.920	0.431
1988	0.563	86.815	0.649
1989	0.752	90.392	0.832
1990	0.686	94.080	0.729
1991	0.506	97.561	0.519
1992	0.563	100.000	0.563
AVERAGE	0.340		0.58
ADJUSTED AVERAGE			0.52
AVERAGE (1977-92)			0.56

NOTE: LME GOB Price to 1984
LME SHG Price from 1985 to 1992

LONDON METAL EXCHANGE

ANNUAL LEAD PRICES
(U.S. $/lb)

YEAR	LEAD PRICE (CURRENT $)	GNP DEFLATOR (1992 = 100)	LEAD PRICE (CONSTANT) (1992 $)
1960	0.090	22.073	0.407
1961	0.080	22.284	0.358
1962	0.070	22.779	0.306
1963	0.079	23.107	0.341
1964	0.126	23.486	0.536
1965	0.144	24.090	0.598
1966	0.119	24.933	0.476
1967	0.104	25.636	0.405
1968	0.109	26.913	0.405
1969	0.131	28.371	0.462
1970	0.156	29.974	0.520
1971	0.115	31.650	0.363
1972	0.137	33.160	0.413
1973	0.200	35.332	0.565
1974	0.269	38.487	0.699
1975	0.189	42.301	0.447
1976	0.202	44.983	0.449
1977	0.280	47.983	0.583
1978	0.300	51.505	0.582
1979	0.548	56.032	0.978
1980	0.411	61.131	0.672
1981	0.330	67.012	0.492
1982	0.247	71.321	0.346
1983	0.193	74.040	0.261
1984	0.201	76.837	0.262
1985	0.179	79.126	0.226
1986	0.184	81.255	0.227
1987	0.270	83.920	0.322
1988	0.298	86.815	0.343
1989	0.306	90.392	0.339
1990	0.371	94.080	0.395
1991	0.253	97.561	0.259
1992	0.246	100.000	0.246
AVERAGE	0.232		0.433
AVERAGE (81-92)			0.310