Faro Mine
Env
Tailings

007505

TAILINGS DEPOSITION PLAN

OUTLINE OF OPTIONS

CURRAGH RESOURCES INC.
AUGUST, 1990

TABLE OF CONTENTS

PAGE NUMBER

TAILINGS DEPOSITION PLAN
OUTLINE OF OPTIONS

1. INTRODUCTION

The development of new reserves in the Faro area, Yukon requires the provision for disposal of the tailings generated by the process. This report reviews the options for tailings disposal and outlines work ongoing to select the preferred plan and timing. Once a plan is derived, it will be submitted to the Yukon Territory Water Board on July 31, 1991 for review and approval.

2. REQUIRED CAPACITY

The remaining mining reserves to the turn of the century were approximately 58 million tonnes as of July 1, 1989.

	x 1,000 tonnes ore	**(%) Lead**	**(%) Zinc**
Faro Pit	12,011	2.75	4.68
Stockpiles	1,215	2.04	3.26
Underground	1,178	4.11	6.27
Grum Pit	25,161	2.96	5.01
Vangorda Pit	6,935	3.49	4.51
Dy Underground	11,300	5.82	6.84
	57,800	5.23	3.54

47
+16.5

This ore is scheduled to be mined through the early part of the next century. Additionally, there are unquantified additional possible reserves at Dy, Grum Underground and Swim which could add a further ten million tonnes of ore. The potential for discovery of at least one additional ore deposit in the district is excellent.

It is estimated that processing of the remaining quantified reserves will generate approximately 47 million dry tonnes of tailings. A further 20% would be required for additional reserves. Given a bulk density (compacted) of 2.0 tonnes/cu.m., these tailings will require a minimum of 28.2 million cu. m. More volume is required for active sedimentation and water storage in the later years of operation of the facility.

03. EXISTING TAILINGS SYSTEM

The existing tailings system is an impoundment in the valley of Rose Creek downstream from the junction of the north and south forks. There is approximately forty-five million tonnes of tailings stored currently. Approximately 4.3 million dry tonnes of tailings are added annually.

The tailings impoundment is divided into two major areas. The upstream end of the valley is occupied by the Old Tailings. Tailings were deposited in this area from 1969 to 1982 by the previous owner of the mine. This area is essentially full but is used occasionally for emergency deposition. The old tailings are impounded by a series of homogenous earth filled dykes. The bulk of the production by Curragh since resumption of milling in 1986 has been in the area downstream of the Old Tailings in an area known as the Down Valley facility (DVF). The tailings in this area are deposited behind the Intermediate Dam (ID); a till core, earth filled, water retaining structure. The ID has been built by centerline raising (although originally designed for the possibility of down stream raising to attain greater height). Currently, its crest is at 1,078m elevation corresponding to a design pond level of 1,076.5m. The design crest elevation is 1,083m. Since its original construction in 1980 by the previous mine owner, there have been two 5m lifts added by Curragh, one in 1988 raised the crest from 1,068 to 1,073m and the second in 1989 to the current 1,078m.

Downstream from ID is the Cross Valley Dam (CVD) which impounds a large water polishing pond. The CVD is similar to the ID in construction but remains at is original height.

The mill currently processes 4,900,000 tonnes per year and discharges 4,300,000 tonnes per year of tailings as an 8.5% solids slurry with a total volume of 11,700,000 m^3.

The tailings are beached at the toe of the Old Tailings impoundment and flow by gravity to pond behind the Intermediate Dam.

Tailings supernatant water is decanted by three siphons over the Intermediate Dam into the polishing pond. Two larger diameter siphons discharge water from the polishing pond to the environment. There is an emergency spillway on both the ID and CVD for flows in excess of the siphon capacity. Retention is the only treatment currently required to meet discharge objectives.

Mine water is pumped to the tailings impoundment area where it mixes with process water. The contained soluble metals are then precipitated from the

mine water as "hydroxides", due to the higher pH of the tailings supernatant water. Retention in the polishing pond provides sufficient clarification to reduce total metal levels to below discharge requirements.

4. OPERATIONAL CONSTRAINTS

For the foreseeable future the plant will operate at 12,000 - 15,000 tonnes per day. Ore grade will be similar to current operations. Tailings will be produced at 10,500 -13,200 tonnes per day.

Water consumption will remain similar or larger. Grain size in the tailings will decrease, there will be a larger proportion of fines, thus it is likely there will be more water retention within the settled tailings. The reagent mix will be similar to that used today, consumption will be similar or slightly higher per tonne of feed.

Existing discharge limits will have to be met but there is a possibility of more stringent requirement, the current limits for certain key parameters are:

- 0.5 mg/l total Zinc
- 1.00 mg/l Ammonia
- 0.05 mg/l total (and weak acid dissociable) Cyanide
- 0.2 mg/l total Lead
- 0.2 mg/l total Copper
- 15 mg/l suspended solids

5. OPTIONS FOR FURTHER CAPACITY

There are two main options that should be investigated as potentially feasible, all other options appear to be prohibitive. These are:

1. Continue to use the Down Valley facility by raising the impounding structures to gain sufficient capacity and/or extending the impoundments further down valley.
2. Use the minimum remaining capacity of Down Valley facility, then switch to Faro Pit as soon as the mine plan allows.

Open pit operations at the Faro Pit are scheduled for completion by November of 1991, the underground mine life is however somewhat less certain. The depletion of that mine may actually be prematurely brought on by the need for tailings disposal in the Faro Pit.

A variant of both options is the use of the space behind the Cross Valley pond for tailings deposition, however this option must be carefully investigated as it could create water quality problems. A treatment plant could be required in that case. The CVD would then be a permanent structure requiring stabilization for closure.

Option 1: Does not have any obvious variants beyond that noted above

Option 2: There are a number of variables and scenarios that must be reviewed:

1. **Down Valley Facility**

There are two operating scenarios for extended but limited storage in the Down Valley Facility:

a) The Intermediate Dam can be raised from its current crest of 1,078m to 1,080m (extending life of DVF to approximately January, 1992), 1,081m (extending life of DVF to approximately September, 1992) or to the full 1,083m (extending life of DVF to approximately September, 1993) depending on the length of extension of life required;
b) The tailings discharge point can be moved toward Intermediate Dam so that better use is made of available space behind existing Intermediate Dam;
c) Internal "plug dams" such as that used in 1987 to increase the slope of the tailings behind the Intermediate Dam could add limited capacity and extend the storage slightly.

(T. 7.91)

→ Oct 94 Jack Bowers Rpt page 4

All of these scenarios can provide more space until the pit is available, however there are significant costs in terms of implementation and implications for mine closure. The analysis of options for the tailings deposition plan must consider these implications.

2. **Tailings Deposition System**

The following scenarios on the material handling and deposition of process tailings must be reviewed:

a) Thickening at mill site and pumping less slurry to pit while discharging water and slimes to Down Valley facility;
b) Cycloning the process tailings at pit so the coarse fraction reports to the pit, and the water plus fines report to the Down Valley facility for low permeability capping of the old tailings;

c) No thickening or cycloning, entire tailings and water flow reports to the pit.

3. **Flooding the Pit**

A variable to be investigated is the level of flooding of the pit by tailings and process water - there are at least two scenarios on this option:

a) Fill Zone 1 and 3 Pit to elevation 3920 behind small plug dam as outlined on Faro Mine Abandonment Plan, so that overflow water would exit to southeast over the backfilled Zone 2 Pit;
b) Flood Zone 1 and 3 pit to higher level, 3990 elevation, with larger dam so that overflow water exit is to southwest towards the current tailings impoundment past the current mill site. Although the further capacity is not now required there are advantages in this water exit and the extra capacity would be at low cost.

The space available in the pit is quite large as summarized below:

Available below Elevation	Million Cubic Meters
3,990 feet	66.0
3,920 feet	57.8
3,850 feet	39.6
3,750 feet	24.0
3,690 feet	16.5
3,490 feet	3.0

There is approximately 1.5 million m^3 of additional pit waste dump scheduled to be placed into the southwest part of the pit above 3,690 elevation, most of which will be above 3,830. There is minimal storage available below the levels which will conflict with the underground operations. The underground mine portal elevation is 3,473, the sill elevation into the underground workings is 3,490 but the critical elevation is 3,480 feet where the workings broke through into the pit.

4. Faro Creek

The fate of the Faro Creek diversion will have to be investigated as part of the study of various options. The creek ultimately will be directed to the pit but it may be best to do this after the pit is no longer an active tailings disposal site.

6. UNCERTAINTIES AND POSSIBLE FURTHER INVESTIGATION TO RESOLVE THEM

Preliminary examination of the options for tailings disposal shows several parameters which require further investigation before a plan can be finalized. Some of these are:

Area of Uncertainty	Possible Work to Resolve Questions
Bulk density of tails behind Intermediate Dam	- aerial survey maps before and after Curragh's activities to quantify volume change; - probing beach area for ice lenses.
Geometry of Down Valley facility	- aerial survey map; - sounding of Intermediate Dam and Cross Valley ponds.
Space available in the pit	- final dump design pit limit and surveys.
Date of completion of mining in Faro Underground	- possible drilling (surface or underground); - possible geophysical work (seismic or electrical); - drifting underground to determine limits of economic ore; - cost comparison of Down Valley continuation versus underground mining and premature shut-down of mine.

Water balance around mine in different configurations	- hydrologic monitoring program strengthened - continuous stage recorders; - staff flume or weir stage gauging; - development of stage-discharge relationship at sites.
Water quality in pit after change over to pit	- comparison to other operations employing similar disposal
Percolation through pit walls into Zone 2 buried pit	- possible percolation test in Big Indian Fault between Zone 3 and 2 pits
Availability of construction materials	- test pitting

extra capacity from plug dam

extra capacity from reversing tailings berm

7. DESIGN WORK THAT MAY BE REQUIRED

Depending on the option selected some of all of the following will require examination:

- Pump system and tailings line sizing:
  - mill to pit,
  - mill to DVF,
  - mill to thickening or cycloning facilities and the handling of resultant products
- Thickener facility
- Cyclone sizing and location of facility;
- Cold weather operation;
- Process water reclaim facility;
  - Sizing of pipes for return flow to mill and any pumping required:
    - pit to mill,
    - DVF to mill;
- Dam design (on existing structures and/or new structures);
- Pit overflow spillway - amount of overflow, sizing and design;
- Possible water treatment if required:
  - for reuse of water in process,
  - for environmental compliance;

- Operations manual for the selected option;
- Contingency for power failure/line breakage or other upsets;

8. CAPITAL COST ESTIMATE

The capital cost estimate should include but need not be limited to the following items:

- Option 1 and variations
  - incremental dam raisings taking into account the availability and distance of borrow sources;
  - tailings line extension plus any extra costs of a low gradient line in cold weather;
  - re-establishment of siphon decant;
  - optional treatment plant;
  - reclaim facility at the Cross Valley pond (pumps, pipelines, etc.);
  - additional closure costs related to physical and chemical stabilization of tailings in long term;
  - etc.

- Option 2 and variations
  - tailings line;
  - thickener facility;
  - cyclone banks facility;
  - pumps and ancillaries;
  - process water reclaim facility (pump and pipelines);
  - pit plug dam to 3,990 or 3,930 levels;
  - overflow channel preparation;
  - etc.

Cost estimation of options is only required at a level of detail to allow decision making. The selected option will require a detailed costing.

9. COST BENEFIT ANALYSIS

To allow decision making it will be necessary to derive cost per tonne of tailings storage for each option. The total cost must include the implicit closure costs and any required treatment to achieve environmental compliance in the long term. The environmental benefits and disadvantages should be considered although quantification will be difficult.

10. CLOSURE IMPLICATIONS

A tailings closure plan is under development. Clearly this plan has significant interactions with the closure plan. It will be necessary to carry out these studies together. Once the tailings plan is established then the closure plan can be finalized and the cost implications examined. The closure plan will be finalized in March 1991.

- Option 1
  - impact of higher impoundments on closure scenario;
  - saturation of composite cover/water balance for higher tailings terrace, impact on physical stability;
  - possibility of water cover on higher tailing terrace;
  - extra cost of providing higher spillways;
  - stability of larger dams and extra cost of providing it;
  - final position of Rose Creek;

- Option 2
  - water quality in Faro Pit;
  - pit water exit;
  - saturation of composite cover/water balance on Old Tailings;
  - surge capacity provision for the flows into the pit;
  - depth of water cover on the DVF tailings site;
  - dynamics of pit lake at closure.

11. ENVIRONMENTAL IMPACT

Before an option can be selected its environmental impact will require consideration. Some items which may need to be examined include:

- effect of lost flow to Rose Creek as pit fills;
- effect of zero effluent during filing period on recolonization of Rose Creek on fish and benthic community;
- effect of lower retention time in Down Valley facility if realized;
- effect of water outflow direction depending on pit flooding option.