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# TAILINGS BASIN CLOSURE CONSENSUS PLAN

FOR

RESERVE MINING COMPANY

SILVER BAY, MINNESOTA

PW0048 2201 AUGUST 16, 1988

**KLOHN LEONOFF**
CONSULTING ENGINEERS

Our File No: PW0048 2201

August 16, 1988

Reserve Mining Company
Silver Bay, MN 55614

Attention: D.E. Carlson, General Manager

Tailings Basin Consensus Closure Report

Dear Doug:

We are pleased to enclose 3 copies of our report "Reserve Mining Company-Tailings Basin Consensus Closure Plan". Copies have also been sent directly to those listed below.

Yours very truly,
KLOHN LEONOFF CONSULTANTS, INC.

Thomas G. Harper, P.E.
Project Manager

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# TABLE OF CONTENTS

## Drawings

| | |
|---|---|
| D-1965 - 299 | Tailings Basin General Arrangement - 1988 |
| D-1965 - 300 | Catchment Diversion: Ditch and Dike Sections |
| D-1965 - 315 | Reclamation Cross Section - Progression |
| B-1965 - 316 | Tailings Basin Reclamation - Year 1 |
| B-1965 - 317 | Tailings Basin Reclamation - Year 2 |
| B-1965 - 318 | Tailings Basin Reclamation - Year 3 |
| B-1965 - 319 | Tailings Basin Reclamation - Year 4 |
| B-1965 - 320 | Tailings Basin Reclamation - Year 5 |
| D-1965 - 321 | Tailings Basin General Arrangement - Reclaimed |
| B-1965 - 322 | Reclaimed Basin Cross Section |
| D-1965 - 323 | Typical Sections |
| D-1965 - 324 | Spillway Layout and Details |
| D-1965 - 325 | Spillway and Channel Cross Sections |

## EXECUTIVE SUMMARY

Reserve Mining Company's taconite mining, concentrating, and pelletizing operations in north-eastern Minnesota were indefinitely suspended in June 1986. Since then, studies have been conducted to determine an acceptable method of closure for the tailings basin. In 1987, four alternative closure schemes were detailed, each involving a different level of water to be left in the tailings basin. None of these alternatives involved startup of mining and concentrating operations.

In May 1988, a fifth alternative closure scheme comprising operation of the concentrator, discharge of tailings to the basin and concurrent removal of water was designed and detailed. The results of the study were presented in the Klohn Leonoff report entitled "Tailings Basin Closure While Operating" dated June 24, 1988.

Subsequently, in an effort to reduce the cost for closure, Reserve has proposed a compromise scheme for closure with operations of the concentrator. At a meeting of the closure committee in Minneapolis on June 24, 1988, Klohn Leonoff was requested to conduct a study for a consensus scheme. This report presents the results of the study based on operating the Reserve facilities at a pellet production rate of 3 million long tons per year. Key issues in the current study are maintenance of dam stability, provision of flood storage, treatment of water for release until direct release is authorized, ongoing dust control, revegetation of reclaimed surfaces, and long term erosion control.

Under the consensus closure plan, fine tailings will be discharged above water from Dams 1 and 2 to fill up cells 1 and 4 respectively to the present water level leaving a pond of water in Cell 2,3. While tailings beaches which are essentially flat are advancing out from the dams, water will progressively be drawn down to maintain flood storage. A 3 foot thick coarse tailings layer will be placed over the fine tailings surfaces to provide an erosion resistant surface on which vegetation will be developed. Two filters will be added to the existing water treatment plant to increase the discharge capacity to 4000 gpm.

Concentrator operations and tailings discharge would continue for 5 years by which time the reclaimed surface would extend across the entire areas of cells 1 and 4 with a lake of about 690 acres in Cell 2,3 at Elevation 1179 feet.

Following cessation of tailings discharge, a dredge will be used to place a layer of coarse tailings over the bottom of the lake to cover the fine tailings and prevent resuspension of particles. A thickened zone of coarse tailings will be placed around the near-shore area of the lake for wave protection.

Water treatment and release will continue after the coarse tailings cover layer has been placed until the lake water is approved for direct release. At that time an operating spillway and an emergency spillway will be excavated near Dam 1E to provide a permanent means of directing water out of the basin. The operating spillway will be constructed with a control section excavated into bedrock at Elevation 1179 to prevent long term degradation. The lake will remain functioning as a sediment trap.

A year by year schedule and cost estimate are presented in the report.

## 1.0 SCOPE OF WORK

Reserve Mining Company (Reserve) requested that Klohn Leonoff Consultants, Inc. (Klohn Leonoff) prepare a report outlining a design for closure of the Reserve tailings basin while operating the concentrator based on a consensus scheme agreed to by the closure committee. This closure method is an additional alternative to the four alternatives studied by Klohn leonoff in 1987, each of which involved no further concentrator operation and a fifth alternative in May and June 1988 which comprised a plan of closure while operating the concentrator plant similar to that described herein but with almost complete elimination of the water pond.

On June 24, 1988, a meeting of the closure committee was held in Minneapolis at which T.G. Harper of Klohn Leonoff verbally presented the highlights of the study on basin closure while operating. Neither this scheme nor the previously developed closure schemes were acceptable to all parties.

Reserve presented a compromise scheme entitled "Operations With Options To Close". A rough cost estimate was presented by Reserve demonstrating that this scheme would substantially reduce the cost of closure. A consensus was reached at the meeting agreeing that the compromise alternative should be studied by Klohn Leonoff.

## 2.0 CLOSURE CONCEPT

The basic concept for the comprise scheme comprised the following:

Fill cells 1 and 4 with tailings to the present water level, and leave a pond in Cell 2,3, an operation requiring approximately 5 years.

Displaced water would be continuously withdrawn from the tailings pond, treated and discharged. In addition, the water level would be progressively lowered so as to maintain flood storage. An essentially level surface would be developed in cells 1 and 4 at the present water level, elevation 1182 feet.

For the consensus alternative there are several criteria which were considered necessary to be met in order that the closure plan would satisfy the environmental standards and engineering standards previously established for the project. These criteria are listed following:

Utilize fine tailings as the bulk fill, then cover the fine tailings with sufficient coarse tailings to provide an erosion-resistant reclaimed surface.

Treat all water to be discharged to appropriate standards

Maintain storage capacity for the Probable Maximum Flood, and the original design freeboard above that, until runoff can be discharged without treatment.

Assume the concentrator plant operates on the same material and water balance basis as when last operating.

Maintain dam stability as needed to contain water and tailings.

Establish vegetation on the coarse tailings surface.

Provide long term erosion control at closure.

Additional goals considered necessary for efficient and orderly closure of the basin are listed below.

Minimize runoff into the pond from upland areas to reduce the volume of water to be treated.

Arrange fine tailings spigotting in such a manner as to create flat beaches above water level to generate workable areas for placement of a cover layer and reclamation.

Separate the tailings spigotting area from the water reclaim area by at least one filter dike to provide primary filtration.

Extend the railroad into cells 1 and 4 to maximize coarse tailings placement efficiency.

Consider the effects of premature closure due to interrupted concentrator operation to ensure that the remaining closure liability does not increase with time.

## 3.0 DESIGN CONSIDERATIONS

### 3.1 GENERAL

Design of the closure encompasses a number of different areas of engineering and environmental design. These areas are discussed in detail below with the exception of water treatment requirements to meet discharge quality standards. This report presents the rates of water discharge required, means of getting the water to the water treatment plant, and pre-filtering of the water through a filter dike.

3.2 Rate and Geometry of Filling

At a pellet production rate of 3 million long tons per year (LTPY), tailings would be produced at rates of:

Fine Tailings: 3,720,000 (LTPY)
Coarse Tailings: 2,505,000 (LTPY)

From the work done in 1987 to sample fine tailings in place an average settled dry density of 83.6 pcf was determined. Coarse tailings placed and compacted will have a dry density of 143 pcf. Using these figures produces volumetric rates of placement of:

Fine Tailings: 3,690,000 Cubic Yards Per Year (CYPY)
Coarse Tailings: 1,450,000 CYPY

The Reserve fine tailings when spigotted into pond water have been observed to adopt an average underwater profile comprising:

0-14 feet of water depth, slope is 4 percent
14-25 feet of water depth, slope is 2 percent
25 plus feet of water depth, slope is 0.4 percent

In order to develop reclaimable area it is considered necessary to first spigot sufficient fine tailings to develop a beach above water. To form fine tailings surfaces that are essentially flat requires the water level to be kept high while progressively advancing the spigot points outward on narrow flat beaches. It should be pointed out that due to the high water level, these areas would not be well drained, and would be difficult to reclaim and vegetate. Following a period of long term settlement, the surfaces could deteriorate into a myriad of swampy undrained pools.

Spigotting would begin at Dams 1 and 2 with spigot points advancing towards splitter dikes 1 and 3 respectively. The fine tailings surfaces formed will be kept flat or near - flat at elevation 1182 (present water level). A permanent lake would form in Cell 2,3 as shown on drawing B-1965-321. The essentially flat beaches will be progressively covered with coarse tailings and followed by development of vegetation. No topsoiling is planned.

At the present water level, placement of the coarse tailings will encroach on the design flood storage in both the short and long term, requiring additional dam freeboard. In order to maintain the required flood storage without dam raising, the water level will have to be progressively lowered through the 5 years by a total of 3 feet to Elevation 1179 feet.

It should be noted that the closure design is based on acceptance of the MNDNR generated hydrographic plan prepared in 1985. This has been shown to have some locally incorrect contours but, as agreed in the 1987 closure engineering, will be assumed as the basis for this design.

In order to keep an average fine tailings surface at elevation 1182 it will be necessary to keep the spigot points at a higher elevation on the side of the railroad spur line embankments. Fine tailings beaches will tend to slope down from the spigot locations and the surface developed will in fact be a series of long, low mounds.

3.3 Water Drawdown

Several factors affect the tailings basin water balance during closure. At low pellet production, the closed-circuit plant and tailings basin system will be a net accumulator of water. Additional diversions will be required to direct uphill runoff away from the pond, thereby minimizing the inflow and reducing the volume of water to be treated and released. As tailings are discharged into the pond, water will be displaced requiring discharge just to maintain a constant water level; additional discharge will be required to draw the water level down. As new beaches are formed and the water level is drawn down, the pond surface area will diminish, reducing the evaporative loss and increasing the rate of discharge required to maintain a water balance.

Assumptions made for the water balance are as follows:

- Existing water treatment plant continues in operation with an average release rate of 3000 gpm.
- Water treatment plant discharge capacity will be increased to 4000 gpm and could commence operations with this increased capacity 18 months after the closure plan is commenced.
- Pond water will be at elevation 1182.0 when the closure plan is commenced.
- Additional catchment diversions will be constructed in the first 3 months after the closure plan is commenced.

A seasonal deviation in the rate of water level drawdown is expected because of the large seasonal variation in runoff at the site. The runoff during the months of April-June comprises approximately 65 percent of the total annual runoff for average hydrologic conditions. During those months the pond level will stay nearly constant or rise slightly as the hydrologic inflow is greater than the release rate. During the months of low runoff (December-March) the rate of pond drawdown will increase, enabling pond levels to reach the scheduled drawdown levels.

## 3.4 Safety of Dams 1 and 2

In the Klohn Leonoff report "Dam Stability for Tailings Basin Closure" dated November 23, 1987 it was shown that, while the existing three tailings dams are sufficiently safe for ongoing operations, some limited downstream slope work would be required to raise factors of safety to levels deemed acceptable in the original design for final closure.

Because of the flat slopes and low permeability of the fine tailings, lowering of the pond level will not significantly lower the water level in the tailings close to the dams and will therefore not materially increase the stability of the dams.

In view of the fact that the pond level will be lowered by only $\boxed{\text{3 feet}}$ it is deemed necessary to raise the factors of safety by implementing the previously recommended downstream slope regrading on dam 1 and addition of a toe berm on dam 2. Detailed requirements of the downstream slope work for the dams are presented in the November 1987 Klohn Leonoff report. 1179'

With the flat beaches and continuing high ground water levels in the reclaimed areas, stability of the upstream slopes of the dams is not a concern.

### 3.5 Tailings Slope and Splitter Dike Stability

A drawdown rate of about half a foot per year will not give rise to any serious overall instability of the fine tailings slopes.

Towards the end of the closure, fine tailings will be deposited in cell 1 and 4 against the splitter dikes. Stability of the splitter dikes was evaluated with a tailings differential across the dikes. Results reveal that the splitter dikes are stable against a potential massive failure which could cause a loss of tailings into Cell 2,3.

### 3.6 Placement of Coarse Tailings

Following development of the fine tailings beaches, coarse tailings will be placed to create a stable surface on which to develop vegetation. Coarse tailings will be placed as the beaches are formed and as material supply and beach surface conditions allow. The beaches will be saturated during and after spigotting. A minimum of 3 foot thickness of coarse tailings is planned to provide a stable reclaimed surface that will support people, animals and light vehicular traffic and will resist erosion from local drainage flows.

Initially, coarse tailings will be dumped alongside the tracks on Dams 1 and 2 to provide cover material for beaches initially formed. As the beaches expand toward the splitter dikes, tracks will need to be moved towards the splitter dikes.

A successive series of rail spurs will be constructed parallel with the dams. On the basis that efficient bulldozing can move coarse tailings about 200 feet each way from the rail, spurs would be at 400 feet intervals.

Structural support for the 70 ton (load capacity) side dump cars is expected to require an embankment built of coarse tailings in the order of 10 feet thick with a minimum crest width of 70 feet. In order to provide space alongside the tracks for dumping coarse tailings off the side sump cars, the railroad track needs to be raised by about 3 feet above the adjacent grade. To achieve this, the section of the embankment underneath the railroad ties will locally be raised to have a total embankment thickness of 13 feet. After the embankment has served its purpose of supporting the train, it would then be graded down to form the 3 foot cover layer.

The embankment will be constructed by a continuous advancement of its cross section into the cells and a series of railroad extensions. As the embankments advancement tracks will be laid which would allow more coarse tailings to be brought in by train for further embankment construction. Bulldozers will be used to doze the material away from alongside the tracks to built the embankment ahead .

With water level at or near the beach surface, stability of the embankments and hence support of the loaded trains depends heavily on the pore pressures in the fine tailings. Excess pore pressure which will be generated during construction of the embankment and also from the transient loadings of the train could cause a reduction in stability. Support of the embankment and the loaded train will require consolidation of the underlying fine tailings and reduction of pore pressures. As the embankments advance onto the beaches, the transient train loadings are expected to cause a zone of liquefaction in the fine tailings to occur immediately below the rails. Boils of water and fine tailings may developed through cracks in the coarse tailing fills and in the worst case, the liquefied zone could cause instability of the embankment, affecting support of the train. The condition should be transitory and will improve as consolidation progresses.

Study of the stability of the railroad to date is sufficient to allow a conceptual design of the embankment for support of the train. The embankment as described earlier has been designed to allow a certain amount of pore pressure buildup. Prior to closure being initiated, detailed calculations will be required to better defined the geometry of the embankment and the allowable pore pressures. These calculations will then be utilized in conjunction with the instrumentation discussed below.

Recommendations to minimize potential instability of the embankments and the railroad are as follows:

1. The fill should be placed in lifts of between 3 feet and 4 feet to minimize disturbance to the fine tailings.

2. The embankment should be built to an average slope of 3:1 (horizontal to vertical), with a set back distance for each lift.

3. Speed of train movement on the embankment should be held to under 3 mph.

4. Trains should be limited to four cars each initially and they should be pushed by a light locomotive no heavier than the loaded side dump cars. The number of trains should be based on using the minimum number necessary to apply the required amount of fill in the overall project schedule, and as much rest time as practicable should be allowed between trains. Indications are that this will require about six to twelve four-car trains a day depending on the number of areas worked at a time.

5. Action of the cars should be carefully observed for signs of distress, such as swaying or tilting which might indicate possible instability of the zone beneath the track. Between trains the tracks and the fill should be checked for signs of movement; in particular the tracks should be checked for uneven settlement, and reballasted if necessary to maintain the track reasonably level, particularly in a lateral direction.

It is important that instrumentation be set up during construction to monitor the pore pressures in the foundation fine tailings. The objectives of the instrumentation are:

1. To define allowable pore pressures for both embankment construction and train movements.
2. To confirm our assumptions about the extent of the liquefied zone and the extent to which elevated pore pressures extend out laterally from the liquefied zone.

Benefits expected from the instrumentation will be possible relaxation of operating restrictions and a better understanding of conditions in the event that difficulties arise and modifications to the design are required.

Details of the instrumentation program will need to be developed prior to construction, but should at least comprise the following.

1. Piezometers should be installed in the fine tailings at the critical depths on at least two cross sections to monitor the development of pore pressures and the progress of the subsequent drainage.
2. Each section should have at least eight piezometers, one on each side of the track, and three others under the shoulders spaced at about 10 feet centers. Piezometers should be pneumatic, placed in well points.

After sufficient coarse tailings has been brought in, the tracks will be removed and materials in the embankments will be spread out in both directions to form the 3 feet cover layer. Spreading of the coarse tailings from the roads across the beaches will be by bulldozing; a D8 Caterpillar bulldozer on wide tracks is expected to be the largest machine that could be used without causing rutting. Two of these machines working a single shift, 5 days per week would handle dozing to about 200 feet each way from the tracks for a track spacing of 400 feet.

Coarse tailings will need to be greater than 3 feet deep in places to generate a level reclaimed surface over the top of the variable fine tailings surface.

By maintaining sufficient distance back from the edge of the water with the placement operation, construction could continue all year; some experimentation is recommended to determine the practical extent of this in both the freezing and non-freezing seasons. The closure plan will utilize about half of the coarse tailings for covering the fine tailings surfaces. Unused coarse tailings will be left in sloped areas alongside the perimeter railroad. Extra coarse tailings could be required in cover areas that require extra depth for stability.

During operations, fine tailings beaches and unvegetated coarse tailings areas will be kept wet or otherwise treated to control dust emissions until vegetative cover is established.

## 3.7 Consolidation and Settlement

The final reclaimed surfaces in cells 1 and 4 will experience settlement after construction as a result of ongoing consolidation of the fine tailings.

The rate of consolidation of the fine tailings, as indicated by the coefficient of consolidation, varies over a wide range, depending on gradation. Generally speaking, fine tailings deposited in the center of the cells will be finer than that near the edge of the cells and hence would tend to have a slower rate of consolidation. It is estimated that settlement of the final reclaimed surface would continue to occur after construction, primarily in the center of cells 1 and 4 for as much as 30 to 40 years.

The magnitude of settlement of the final surface depends on the percentage of consolidation that has been achieved at the end of construction and hence the remaining consolidation to follow. It is also a function of the compressibility and thickness of the tailings. The final tailings surface is expected to settle progressively more towards the center of the cells, where the tailings are thicker and finer. It is estimated that the post construction settlement in the center pond area would be in the order of 4 feet.

As a consequence of the difference in rate of consolidation and magnitude of post construction settlement, the final reclaimed surface will be irregular with a series of low spots developed, causing localized small ponds to form.

## 3.8 Water Handling

### 3.8.1 General

Hydrologic parameters used in the design of water handling facilities were discussed in the report "Assessment of Hydrologic Parameters for Tailings Pond Water Balance" dated August 1987, and the relevant portions are summarized in the following sections.

It is important that the occurrence of a probable maximum flood (PMF) should not cause overtopping of the tailings dams. The catchment area applicable to this event during the period of water treatment and while the headwater diversions are being maintained is equal to 9.0 square miles which comprises the area tributary to the tailings pond below the headwater diversions and includes the Low Flow Diversion Channel. Following authorization of direct release of water the diversion dikes on Little Thirtynine Creek will be breached leaving 14.8 square miles of catchment area. After commencement of direct spillway release, it is intended that the PMF from the entire original 31 square mile catchment should not cause overtopping of the dams.

3.8.2 Precipitation, Evaporation and Runoff

The design mean annual precipitation rate is 28 inches as discussed in the previous hydrology report. Single and multi-year precipitation rates for the various recurrence intervals are based on a frequency analysis of Two Harbors precipitation data using the 2-parameter log normal frequency distribution. That frequency distribution was found to provide the best fit relative to four other frequency distributions considered. Running averages were used for the multi-year precipitation analysis.

The 24 hour extreme precipitation rates were taken from Technical Paper No. 40, "Rainfall Frequency Atlas of the United States".

The design mean annual runoff rate is 14 inches from uncleared areas and 17 inches from cleared areas as discussed in the previous hydrology report.

Runoff from exposed fine tailings surfaces was assumed in that report at 23 in/yr, on the basis that moderate evaporation would occur from the wetted surface, and the runoff from splitter dikes was taken at 28 in/yr which assumes no evaporation because the water would percolate immediately and report eventually to the pond. For the schemes described in this report it has been assumed that runoff from all beaches and from the splitter dikes would average about 25 in/yr, being a weighted estimate of the combination of exposed fine tailings beaches, covered beaches and the splitter dikes. The above value has been used for all beach surfaces during the period of treatment plant operations even though much of the area will have become vegetated toward the end of the period and hence could be expected to yield less runoff due to increased evapotranspiration. For design of the spillway (after final closure) the assumption used is that the reclaimed areas, including splitter dikes, will have become fully vegetated and will produce runoff approaching that assumed for uncleared areas (i.e. 14 in/yr).

The 24 hour, 72 hour, 30 day, and 60 day storm runoff rates were derived by a frequency analysis of Baptism River data using the Type I Extreme Value Distribution. Baptism River data were factored by the ratio of catchment areas. Further adjustment was not deemed necessary even though the 140 square mile Baptism River catchment far exceeds the project catchment, because the flood attenuation of the larger catchment is countered by steeper terrain on the Baptism River watershed. The results of this frequency analysis, based on the 59 year Baptism River record, are in line with the data measured on Big Thirtynine and Little Thirtynine Creeks since 1978. The latter could not be used in a reliable frequency analysis because of the short period of record.

A constant mean annual free water surface (FWS) evaporation rate of 26.5 inches was used in the tailings pond water balance analysis. Reference should be made to the previous hydrology report for a detailed discussion of precipitation, runoff and evaporation parameters.

### 3.8.3 Design Floods

Design flood volumes were used to analyze the effects on water levels in the pond during the period of no spillway release, to insure that adequate freeboard exists.

For the routing of floods after spillway release is authorized, hydrographs were developed for various recurrence intervals in time increments of 1 day or less. Flood event and short duration wet periods were selected such that the routing analysis would be based on the most critical duration of flood or wet period.

In this case the 14.8 square mile total drainage area was considered to represent only uncleared area because the pond area would be relatively small compared to the upland catchment area and because any presently uncleared area and tailings surfaces will eventually become heavily vegetated. The 14.8 square mile catchment is applicable because all diversions, except for the Big Thirtynine Creek diversion, will be deliberately breached after direct release of water is authorized.

Designs for the spillway and for drainage channels have been based on reasonable return period floods; if extreme floods occur some repair of channels and armoring may be required.

3.8.4 Probable Maximum Floods

The original permitted design for the tailings basin during operation allowed for containment of all inflow during a probable maximum flood (PMF) equal to 30 inches of precipitation without losses. The estimated PMF pond level for a catchment of 9 square miles above the existing pond level (1182 ft) is 1192 feet giving a 3 foot freeboard with present dam crest of Elevation 1195. Placement of coarse tailings from Elevation 1182 to 1185 would encroach on the flood storage and therefore require the pond level to be progressively drawn down to Elevation 1179 at the end of the 5 year closure to maintain flood storage for the 9 square miles catchment area.

assumes maintenance of diversions. Otherwise use 14.8 sq.mi.

As noted, the catchment area applicable to the above PMF inflow, 9.0 square miles, comprises all natural drainage area below the head-water diversions. It includes the area above all other diversion ditches and the Low Flow Diversion Channel because those diversions cannot handle the PMF.

At the present water elevation there is just enough freeboard to store a PMF. The flood storage capacity will essentially remain the same as the pond is drawndown.

A PMF hydrograph was required in the long term situation for the spillway flood routing analysis because the sequence of inflows has a significant influence on the pond levels. As proposed in the previous hydrological report, the catchment area applicable to the spillway PMF should be based on the entire original 31 square mile drainage area tributary to the tailings pond, assuming that all diversions fail in the extreme long term.

The inflow hydrograph was based on the following.

Probable Maximum Precipitation (PMP) was obtained from Hydrometeorological Report No. 51 by the National Weather Service, "PMP Estimates, United States East of the 105th Meridian", June 1978, as follows:

| Duration hours | PMP on 10 $mi^2$ inches |
|---|---|
| 6 | 22 |
| 12 | 26.5 |
| 24 | 28.3 |
| 48 | 30.5 |
| 72 | 32.2 |

A PMP hydrograph was developed in terms of 1 hour time increments by the procedures of "Design of Small Dams", US Bureau of Reclamation, 1974.

The inflow hydrograph was derived based on the Soil Conservation Service hydrograph method using a Curve Number of 86 for wet antecedent moisture conditions.

A 10 hour time of concentration was estimated for the project catchment.

The resulting peak inflow to the tailings pond was computed to be 45,000 cfs.

3.8.5 Tailings Pond Water Balance

The mean annual net flow into the existing tailings pond from the 3135 acres acre catchment was calculated, taking into consideration the variation in pond area and the distinct hydrologic conditions of the different types of catchment area.

The variation of pond area with pond level was calculated as the water level was drawn down and tailings deposited.

The assumed mean annual inflow/outflow from the various types of catchments follows:

| | |
|---|---|
| pond precipitation | 28 in/yr |
| pond evaporation | 26.5 in/yr |
| runoff from splitter dike and reclaimed area | 25 in/yr |
| runoff from cleared area | 17 in/yr |
| runoff from uncleared area | 14 in/yr |

A summary of hydrologic inflows for various pond elevations is tabulated below:

| | | INFLOWS | | | | |
|---|---|---|---|---|---|---|
| Pond Elev. (ft) | Pond Area Acre | Uncleared Q, gpm | Cleared Q, gpm | Reclaimed Q, gpm | Pond Precip. -Evap., gpm | TOTAL gpm |
| 1182 | 1325 | 381 | 960 | 74 | 103 | 1518 |
| 1181.4 | 1207 | 381 | 960 | 174 | 98 | 1613 |
| 1180.8 | 1095 | 381 | 960 | 321 | 89 | 1751 |
| 1180.2 | 978 | 381 | 960 | 470 | 80 | 1891 |
| 1179.6 | 854 | 381 | 960 | 625 | 71 | 2037 |
| 1179 | 689 | 381 | 960 | 812 | 60 | 2213 |

During tailings discharge an additional 983 gpm net inflow will be added from tailings solids displacing water and the difference between reclaim and tailings transport water rates. Withdrawal of water is required to offset these inflows and to provide drawdown for design storm surcharge.

The limitation to water withdrawal from the pond is the 3000 gpm release capacity of the existing water treatment plant. It was assumed that two filters will be added to the treatment plant and increase the release capacity to 4000 gpm within 18 months after closure commences. The maximum release rate required, based on average inflow is approximately 3450 gpm for plant operation during closure. It is understood that the 4000 gpm total rated discharge will have ample capacity to deliver the required release even when influent water quality is lowered by tailings discharge operations. The results of the water balance calculations assuming average hydrologic conditions, are given below:

| Year After Closure Commences | Pond Elevation Ft. | Release Rate, GPM |
|---|---|---|
| 0 | 1182 | 3000 |
| 1 | 1181.4 | 3057 |
| 2 | 1180.8 | 3157 |
| 3 | 1180.2 | 3250 |
| 4 | 1179.6 | 3347 |
| 5 | 1179 | 3453 |

After cessation of tailings deposition, the water in Cell 2,3 will continue to be treated until direct release is authorized. It is anticipated that an additional 2 years of water treatment and release will be required after cessation of tailings deposition. The actual duration will depend on hydrological conditions and water quality considerations.

## 3.9 Water Quality

Although water quality in the basin, and treatment and release water quality are beyond the scope of this report there are a number of aspects of the closure design which will influence water quality. The closure design is based on maintaining maximum separation between tailings spigotting and reclaim operations to maximize clarification time, and on having a coarse tailings filter dike upstream of the reclaim pump to further clarify the influent for the water treatment plant.

When tailings operations resume, reclaim from the basin to the concentrator and existing filter plant will be by pumping from the existing floating pump station which is separated from the tailings pond by a coarse tailings filter dike. In the past this system has delivered a maximum of 9000 gpm but with several feet of head drop across the filter dike. It is suspected that the west side of the filter dike has been somewhat blinded by filtered out material thereby restricting flow. Scraping of the face of the dike with a backhoe or Gradall is recommended to improve permeability and thus provide sufficient flow for delivery of water for both the concentrator reclaim (about 6000 gpm) and filter plant (about 3500 gpm).

Release capacity of the existing filter plant is 3000 gpm with influent from the present quiescent tailings pond. Reserve feels that the release capacity could drop to about 2500 gpm as tailings spigotting reduces pond water quality. In order to attain the total 3450 gpm release rate required for closure, two filters will be added to the treatment plant to increase the rated release capacity to 4000 gpm.

Tailings will be discharged into cells 1 and 4 and water will flow through splitter dikes 1 and 3 into cell 2-3. From Cell 2-3 water will flow through the filter dike into the reclaim pond and to the reclaim pump station. Tailings water will be clarified initially by settling of solids in the discharge cells then by filtering through the splitter dikes and filter dike.

As the volumes of Cells 1 and 4 are reduced, the detention time for clarifying tailings water will be shortened, resulting in increased amounts of fines being delivered to the splitter dikes. This may cause blinding of the splitter dikes and thereby restricting flows into Cell 2,3. At that time, a shallow overflow channel 50 feet wide will be excavated in each of the splitter dikes to allow flow into Cell 2,3. Flow through the channel will allow some tailings suspended in the water to be carried into Cell 2,3, but its volume is expected to be insignificant. Based on results of the laboratory sedimentation tests as presented in the Klohn Leonoff report "Geotechnical Investigation of Fine Tailings for Tailings Basin Closure, Part 2 of 2" dated September 1987, approximately 99 percent of the tailings by weight will settle out within a period of about 4 days after spigotting. For cell 1, the detention time for clarifying the tailings water will be well in excess of that until the end of the fifth year of closure. As for cell 4, the detention time will be reduced to 4 days at the end of year 4. By keeping the channels through the splitter dikes just a few inches below water level they will act as skimming weirs allowing only the cleaner portion of water into Cell 2-3. The volume of solids carried into Cell 2-3 is expected to be insignificant.

After spigotting stops, a floating dredge will be used to place a 12 inch thick coarse tailings layer over the bottom of the remaining pond to cover the fine tailings and thus control resuspension of fines. After tailings discharge ceases, natural inflow to the pond will, in combination with release through the filter plant serve to improve water quality. Discharge through the treatment plant will continue until such time as direct discharge of the pond water is authorized and the spillway is put into operation.

A permanent lake of about 690 acres will remain in Cell 2,3 upstream of the spillway with a bottom covered with coarse tailings and with erosion protection in the wave zones to prevent resuspension of fine tailings. This lake will act as a sediment trap and as a means to control flow velocities in floods.

3.10 Dam 5 - Special Considerations

At present, Dam 5 is below the elevation of the outlet to Bear Lake by about 10 feet. Water flow from Bear Lake is diverted around the south end of Dam 5 and into the tailings pond. Local runoff water has ponded between the dam and the East Ridge. Under the current closure scheme, this pool will be left as it is and will continue to accumulate runoff.

A small channel will be excavated in the dam 5 abutment to allow overflow in time into cell 2-3.

## 3.11 Premature Closure

Closure of the tailings basin as proposed requires operation of the concentrator and production of iron pellets over a period of five years. At any time following commencement of operations there exists the possibility of premature closure of the plant for reasons such as a disabling fire, or a major market downturn.

The proposed closure plan involves a steady progression from the present large lake situation to full revegetation in cells 1 and 4 with a central lake. Each year the pond area and volume will be reduced and the vegetated area increased. The effort and cost required to complete a premature closure will be reduced with time. Premature closure at any intermediate time would result in a water pond of some lesser size than at present. Measures required for permanent closure following a premature closure would depend on the pond area at the time of premature closure.

# 4.0 PROPOSED CLOSURE PLAN

A closure plan has been developed based on the design considerations presented in Section 3. This plan is outlined in sufficient detail to demonstrate the feasibility of the work and to estimate costs. Key water handling facilities required for the plan are described in Section 4.1. Operations and schedule are presented in section 4.2.

## 4.1 Water Handling Facilities Required

Water handling facilities designed for the closure plan include catchment diversion ditches, a permanent spillway and an emergency spillway which will be built after direct release of water is authorized.

In design of the various facilities, provision has been made for reasonable return periods floods, and for logical catchment areas, consistent with the importance of the various works and the degrees of risk deemed appropriate in accordance with current good engineering practice. Freeboard against overtopping of the main dams has been based on the worst possible conditions by using the PMF from the original 31 square mile catchment for the permanent spillways. Likewise, the permanent spillway has been sited to cut through a rock ridge so that long term erosion will be minimal. On the otherhand, minor drainage channels can be designed with the expectation that some nominal repairs and maintenance may be required if it is found desireable that they continue to function as designed. In some cases they will not have to continue functioning indefinitely and in others the degree of erosion protection will increase dramatically as the revegetation process progresses.

### 4.1.1 Catchment Diversion Ditches

Four catchment diversion ditches are required to divert runoff from about 800 acres. This will reduce the annual inflow to the tailings pond by an average of 600 gpm and thereby reduce the required water treatment capacity.

The diversion ditches are designed to handle the 10 year flood without incurring significant erosion and should require only nominal maintenance during the planned operating period. After the spillway is in use these diversions do not have to continue to operate.

Two diversion dikes are needed to ensure that the full 800 acres is diverted. It will also be necessary to periodically inspect the road embankment at the former confluence of Big Thirtynine Creek and Little Thirtynine Creek to ensure that the embankment is secure and that significant seepage has not developed.

### 4.1.2 Operating Spillway

The operating spillway will be built once direct release of pond water is authorized.

The concept of an operating spillway supplemented by an emergency spillway for extreme floods, was adopted because a wider operating spillway designed to handle the full range of flows would be much more costly and could not attenuate the floods as effectively as the proposed narrower operating spillway. The proposed operating spillway is designed to handle all flows up to the 10,000 year recurrence interval from the 14.8 square mile catchment. This catchment includes all the original catchment area except for the area upstream of the Big Thirtynine Creek Diversion.

The location of the operating spillway will be through the Dam 1 East saddle area. This location is convenient because it requires little excavation in original ground and no excavation through fine tailings.

The layout of the spillway is shown on Drawing B-1965-324.

Other locations for the operating spillway have been considered, and were eliminated because of excessive depths to bedrock, property boundary constraints and excessive excavation through fine tailings.

The operating spillway will be bedrock controlled for a distance of at least 250 feet as shown on the drawing, to ensure permanence. The upstream approach channel will be wider than the bedrock control section to minimize the head losses and velocities enroute to the control section.

The control section should preferably be as narrow as possible in order to cause maximum attenuation of floods. That would minimize the erosion protection requirements in the outlet channel. However, a minimum width of 40 feet was adopted to minimize the impact of beaver dams that may be built in the channel and to ensure that they wash out easily during floods.

The downstream outlet channel will be armored where required for the 100 year flood from the 14.8 square mile catchment assuming that only Diversion No. 2 is operating. Erosion in this channel caused by larger flood events will not endanger the integrity of the spillway which will be controlled by the rock cut.

### 4.1.3 Emergency Spillway

An emergency spillway is required to handle the excess runoff of floods exceeding the 10,000 year design flood. It will be designed to handle the PMF from the entire original catchment of 31 square miles, assuming that all diversions fail.

The emergency spillway will be located at Dam 1 East so that spillage does not have any potential to cause a major breach which would lead to loss of tailings. The long saddle at Dam 1 East would take a very long time to erode down to its bedrock level of about 1165 feet.

Design details are shown on B-1965-324.

### 4.1.4 Breaching of Diversions

Following authorization of direct release of water from the pond Diversion Dikes 1A and 1B will be breached and the creek crossing at the Alger grade road will be breached. This will take the low flow channel below Dike 1C out of service.

Breaching of these dikes will direct Little Thirtynine Creek back into its natural course thereby avoiding the inevitable long term uncontrolled erosion and failure of a diversion.

The diversion of Big Thirtynine Creek achieved by Diversion Dike 2 will be left intact as this diversion is designed for the long term and is armored against the Probable Maximum Flood.

## 4.2 Closure Schedule

The proposed schedule for closure, shown on Figure 1 presents both operations activities and construction activities. Activities are shown within the year in which they are to be completed; operators of the basin will need to prepare a more detailed schedule to even out and optimize requirements for equipment and people. Several items will probably be contracted out to allow use of specialized resources on a short-term basis. Release of water coordinated with development of fine tailings surfaces for reclamation is essential to the closure schedule. The schedule shown is based on average hydrologic conditions; any wet periods would extend the time required for closure and, if they occurred early in the sequence, could extend the concentrator operations period required.

### Prior to Startup

It is anticipated that, following a decision to implement the closure plan, there will be a period of at least 3 months to prepare the concentrating and pelletizing plants for operations. During this period several activities will be initiated at the tailings basin, as follows:

Continue to treat and discharge 3000 gpm from the existing filter plant.

Commence adding two filters to the existing water treatment plant to increase the discharge capacity to 4000 gpm. Completion is expected to take 18 months.

Install a third pump in the reclaim pump station to supply reclaim water to the concentrator and water to the present water treatment plant.

Construct surface water diversions.

Scarify the face of the existing filter dike.

Year 1 After Startup

Concentrator production will start at time zero and is assumed to run on a steady year-round basis at a pellet production rate of 3 million LTPY. Tailings pond water is expected to be at or below elevation 1182.0 at time zero. Activities in this year will be as listed below:

Discharge 3000 gpm from water treatment plant

Extend railroad dump spurs along dams 1 and 2.

Commence pumping fine tailings and discharge approximately 297 days in cell 1 and 68 days in cell 4 respectively. In order to balance beach development, spigotting should be distributed evenly along the beaches.

Fine tailings will be discharged initially from spigots along Dams 1 and 2 spaced at 400 feet intervals with one spigot operating at a time.

Circulate reclaim water back to the concentrator at 6000 gpm.

Approximately 440 feet and 490 feet of beaches will be built up in cells 1 and 4 respectively, with beach surface at elevation 1182.

Coarse tailings will be hauled to the basin by train and will be used to construct embankments over the beach areas parallel to the dams to support the tracks.

Tracks will be relocated from the dams to form spur lines on the beach embankments.

The coarse tailings in the beach embankments will be spread to form a 3 foot thick cover layer on both sides.

Tailings spigotting and railroad spur embankment construction will need to be alternated from cells 1 to 4.

Vegetation will be developed on the coarse tailings.

Excess coarse tailings will be stockpiled alongside the main track on the west side of the basin.

Coarse tailings will be stockpiled on dam 2 for future use in downstream slope stabilization.

The water pond at year end will be at approximately elevation 1181.4, under average hydrologic conditions.

Potential reclaimed area (total) by year end, 117 acres.

Year 2

Discharge 3000 gpm from water treatment plant until mid-year then increase to 3320 gpm.

Continue fine tailings deposition.

Continue railroad embankment construction over beach areas and spread to form the 3 foot thick cover layer.

Develop vegetation as appropriate.

Spigotting required in cells 1 and 4 will be approximately 257 days and 108 days respectively.

Approximately 430 and 490 feet of beaches will be built up in cells 1 and 4 respectively.

Potential reclaimed area (total) by year end, 229 acres.

The water pond at year end will be at approximately elevation 1180.8 feet, under average hydrologic conditions.

Year 3

Pond water level will continue to be drawn down. Approximately 500 feet and 560 feet of beaches of fine tailings will be developed.

Covering of beaches with coarse tailings will continue with vegetation developed as appropriate.

Discharge 3250 gpm from water treatment plant.

Spigotting required in cells 1 and 4 will be approximately 242 and 123 days respectively.

Water at the end of the year will be at approximately elevation 1180.2 feet.

Potential reclaimed area (total) will be 346 acres.

Construction of connector channels in splitter dikes.

Year 4

Pond water will continue to be drawn down, with pond water level at approximately 1179.6 feet by year end.

Approximately 590 and 670 feet of beaches will be developed.

Covering of beaches with coarse tailings will continue with vegetation developed as appropriate.

Spigotting required in Cells 1 and 4 will be 257 and 108 days respectively.

Discharge at 3350 gpm from water treatment plant.

Potential reclaimed area (total) will be 470 acres.

Year 5

Pond water will continue to be drawn down, with pond water level at Elevation 1179 feet at year end.

Beaches will be developed to meet the splitter dikes.

Covering of beaches with coarse tailings will continue with vegetation developed as appropriate.

Spigotting required in cells 1 and 4 will be 321 and 41 days respectively.

Potential reclaimed area will be 635 acres total.

Concentrator operations and tailings discharge will cease at the end of this year.

Beyond Year 5

By year 5 the deposition of fine tailings will be completed and the tailings pond water level will be at elevation 1179, covering an area of 690 acres. Tailings pond water will continue to be treated through the filter plant.

A floating dredge will be used to place coarse tailings on the pond bottom to cover the fine tailings. A 12 inch layer will be used to trap the fine tailings and provide a cover to control resuspension of fine tailings. A 3 feet thick zone will be placed around the near-shore area as wave protection.

Vegetation will be established on remaining reclaimed beaches as appropriate.

Following establishment of acceptable water quality in the permanent lake the outlet spillways can be completed to allow runoff water to discharge directly.

Some regrading of the surfaces of the splitter dikes will be required to flatten steep faces.

Channels would be excavated through the seepage recovery dams, the pump stations and ancillary structures removed and the sites reclaimed in the last year.

Removal and reclamation of the railroad, pipelines and other tailings handling facilities should be done after tailings deposition ceases at year 5.

Borrow pit slope grading and reseeding should be done after the tailings deposition ends.

## 5.0 COST ESTIMATE

Quantities associated with the closure have been estimated and summarized in Figure 1. Unit costs have been determined and the totals by year and item presented in Figure 2 .

Several sources of unit costs have been utilized as appropriate. Operating costs have been provided by Reserve for items requiring labor and equipment at the tailings basin. Earthwork items have been taken from the 1987 Dames and Moore reports on closure, and special items such as the new pump in the pump station have been developed on the basis of enquiries to suppliers.

Costs are presented on an annual basis for simplicity, recognizing that several activities will be seasonal. All costs are shown in constant uninflated 1987 dollars to allow comparison to the 1987 reported closure alternatives.

Costs have been separated into operating and closure costs.

Interim costs for current shut-down activities are not shown. Post-closure costs are not shown.

## 6.0 ONGOING OPERATIONS

Plans presented in this report are based on the mining, concentrating, and pelletizing operations running long enough to provide the tailings infill necessary to bring the tailings basin geometry to a shape consistent with the final closure and reclamation committment. It is possible that with a change of ownership the new owners would want to continue operations on a commercial basis, beyond the five year closure period. Presumption of how new owners would run the operation and for what period is not possible, however the general concept of ongoing operations and the effects of closure on these operations are discussed below.

A major consideration for ongoing operations is the integrity and storage capacity of the tailings dams. Integrity of the tailings dams will not be affected by the closure plan. Storage capacity of the tailings reservoir will be reduced as the closure work continues and tailings are discharged; at final closure the remaining storage capacity of the reservoir would permit discharge of tailings for several more years. At no time during the closure operation would ongoing operations be precluded.

A continuation of operations would fill up Cell 2,3 and eventually bury the reclaimed areas in cells 1 and 4 in fresh tailings. With pond water in Cell 2,3 at elevation 1179 spillway backfilling and seepage recovery facility reconstruction would be required at the beginning of continuation of operation. Items such as borrow pit reclamation have been scheduled late in the closure sequence to allow maximum time for a positive decision on an ongoing operation.

Should the new owners plan to continue operations beyond the time required to infill the present reservoir to the design flood storage elevation of 1179, major planning would be required. Freeboard during operations would have to be provided by raising the dams. Should operations continue with the reduced pond size then the dams could be raised by the "centerline" method with construction of wide beaches of fine tailings to act as seepage controls. Completion of the present reservoir design to elevation 1315 is still possible giving storage capacity for over 100 years at 3 million LTPY pellet production.

Yours very truly,
KLOHN LEONOFF CONSULTANTS, INC.

David Lam
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KLOHN LEONOFF

FIGURE 1: RESERVE MINING---SCHEDULE AND QUANTITIES FOR CLOSURE OF TAILINGS BASIN OVER A SEVEN YEAR PERIOD.

| ITEM DESCRIPTION | UNIT | YEAR | | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| | | PRE-STARTUP | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| GENERAL: | | | | | | | | | | |
| FINE TAILINGS PLACEMENT | LTON | | 3720000 | 3720000 | 3720000 | 3720000 | 3720000 | | | 18600000 |
| FILTER PLANT | | | | | | | | | | |
| ---EXISTING | MO | 3 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 87 |
| ---EXPANSION | MO | | | 6 | 12 | 12 | 12 | 12 | 12 | 66 |
| DUST CONTROL | YR | 0.25 | 1 | 1 | 1 | 1 | 1 | 0.5 | | 5.75 |
| MISC., ADMINISTRATION AND OVERHEAD | YR | 0.25 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 7.25 |
| ENGINEERING, MONITORING AND INSPECTION | YR | 0.25 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 7.25 |
| CONSTRUCTION: | | | | | | | | | | |
| SURFACE RUNOFF DIVERSION DITCHES | LS | 1 | | | | | | | | 1 |
| NEW PUMP IN EXISTING PUMP STATION | LS | | 1 | | | | | | | 1 |
| EXPAND EXISTING FILTER PLANT | LS | | 0.5 | 0.5 | | | | | | 1 |
| COARSE TAILINGS: | | | | | | | | | | |
| ---COVER PLACEMENT AND RAIL MOVEMENT | LTON | | 976000 | 934400 | 976000 | 1034500 | 1376500 | | | 5297400 |
| ---GRADE AT RAIL DUMP AREA | LTON | | 1529000 | 1570600 | 1529000 | 1470500 | | | | 6099100 |
| ---LOAD AND HAUL TO DREDGE | LTON | | | | | | 2031500 | | | 2031500 |
| VEGETATION OF RECLAIMED SURFACE | ACRE | | 117 | 112 | 117 | 124 | 165 | | | 635 |
| CUT SPLITTER DIKES 1 AND 3 | CY | | | | 8800 | | | | 14800 | 23600 |
| REVEGETATION: U/S FACE DAMS 1,2 AND 5 | ACRE | | | | | | 70 | | | 70 |
| COARSE TAILS COVER-FINAL POND (24" DREDGE) | LS | | | | | | | 1 | | 1 |
| SPILLWAYS: | | | | | | | | | | |
| ---OPERATING SPILLWAY | LS | | | | | | | | 1 | 1 |
| ---EMERGENCY SPILLWAY | LS | | | | | | | | 1 | 1 |
| STABILIZE DOWNSTREAM SLOPES OF DAMS: | | | | | | | | | | |
| ---GRADE D/S SLOPE OF DAM 1 | LS | | | | | | | | 1 | 1 |
| ---CONSTRUCT TOE BERM-DAM 2 | LTON | | | | | | | | 115000 | 115000 |
| ---REVEGETATE DISTURBED AREAS | ACRE | | | | | | | | 300 | 300 |
| BORROW PIT AND RECLAIM POND REGRADING AND RECLAMATION | | | | | | | | | | |
| ---REGRADING | LS | | | | | | | | 1 | 1 |
| ---VEGETATE | ACRE | | | | | | | | 385 | 385 |
| VEGETATE EXCESS COARSE TAILINGS (NEAR RR) | ACRE | | | | | | | | 190 | 190 |
| BREACH SEEPAGE RECOVERY DAMS | LS | | | | | | | | 1 | 1 |
| RECLAMATION OF ACCESS AND HAUL ROADS | LS | | | | | | | | 1 | 1 |
| REVEGETATE BUILDING, STORAGE AREAS AND PARKING LOTS | ACRE | | | | | | | | 43 | 43 |
| REVEGETATE ACCESS AND HAULROADS AND PIPELINE CORRIDORS | ACRE | | | | | | | | 130 | 130 |
| REVEGETATE RAILROAD TRACK | ACRE | | | | | | | | 120 | 120 |

3.4 million tons

NOTES:

LTON = LONG TON (2240 LBS.); CY = CUBIC YARD; LS = LUMP SUM; LF = LINEAR FOOT; MO = MONTH; YR = YEAR

FIGURE 1: SCHEDULE AND QUANTITIES

: installed
PP : postponed

FIGURE 2: RESERVE MINING---ESTIMATE OF COSTS FOR CLOSURE OF TAILINGS BASIN OVER A SEVEN YEAR PERIOD.

| ITEM DESCRIPTION | UNIT | UNIT COST | PRE-STARTUP | YEAR: 1 | 2 | 3 | 4 | 5 | 6 | 7 | OPERATIONS SUBTOTAL | CLOSURE SUBTOTAL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. ADMINISTRATION AND MISC. | | | | | | | | | | | | | |
| ENGINEERING, MONITORING AND INSPECTION | YR | $253,000 | $63,000 | $253,000 | $253,000 | $253,000 | $253,000 | $253,000 | $253,000 | $253,000 | (1-5) $1,328,000 | (6,7) $506,000 | $1,834,000 |
| MISC., ADMINISTRATION AND OVERHEAD | YR | $302,000 | $76,000 | $302,000 | $302,000 | $302,000 | $302,000 | $302,000 | $302,000 | $302,000 | $1,586,000 | (6,7) $604,000 | $2,190,000 |
| 2. WATER TREATMENT | | | | | | | | | | | | | |
| SURFACE RUNOFF DIVERSION DITCHES | LS | $65,000 | $65,000 | | | | | | | | $65,000 | | $65,000 |
| EXPAND EXISTING FILTER PLANT | LF | $750,000 | | PP $375,000 | PP $375,000 | | | | | | | (1,2) $750,000 | $750,000 |
| FILTER PLANT OPERATION | | | | | | | | | | | | | |
| ---EXISTING PLANT | MO | $24,000 | $72,000 | $288,000 | $288,000 | $288,000 | $288,000 | $288,000 | $167,000 * | $167,000 * | | (1-7) $1,846,000 | $1,846,000 |
| ---EXPANSION PLANT | MO | $8,000 | | | $48,000 | $96,000 | $96,000 | $96,000 | $56,000 * | $56,000 * | | $448,000 | $448,000 |
| NEW PUMP IN EXISTING PUMP STATION | LS | $20,000 | installed | $20,000 | | | | | | | | (1) $20,000 | $20,000 |
| CUT SPLITTER DIKES 1 AND 3 (1 in / 3 Sp '94) | CY | $2 | | 663,000 | 711 | $18,000 | | | | 223,000 | $18,000 | | $18,000 |
| 3. BASIN OPERATIONS | | | | | | | | | | | | | |
| — FINE TAILINGS PLACEMENT | LTON | $0.05 | | $185,000 | $186,000 | $186,000 | $186,000 | $186,000 — | | | $930,000 | | $930,000 |
| COARSE TAILINGS: | | | | | | | | | | | | | |
| ± ---COVER PLACEMENT AND RAIL MOVEMENT | LTON | $0.72 | | $215,000 | $206,000 | $215,000 | $228,000 | $303,000 ± | | | $1,167,000 | | $1,167,000 |
| ---GRADE AT RAIL DUMP AREA | LTON | $0.22 | | $336,000 | $346,000 | $336,000 | $324,000 | | | | $1,342,000 | | $1,342,000 |
| + ---LOAD AND HAUL TO DREDGE (2,031,500 tons) | LTON | $0.22 | | | | | | $447,000 + | | | $447,000 | | $447,000 |
| ± DUST CONTROL | YR | $200,000 | $50,000 | $200,000 | $200,000 | $200,000 | $200,000 | $200,000 — | $100,000 | | $1,050,000 | (6) $100,000 | $1,150,000 |
| 4. REVEGETATION AND FINAL CLOSURE MEASURES | | | | | | | | | | | | | |
| ± REVEGETATION: U/S FACE DAMS 1,2 AND 5 | ACRE | $600 | | | | | | $42,000 | | | | (5) $42,000 | $42,000 |
| + BREACH SEEPAGE RECOVERY DAMS | LS | $470,000 | | | | | | | | $470,000 | | (7) $470,000 | $470,000 |
| — VEGETATION OF RECLAIMED SURFACE | ACRE | $600 | | $70,000 | $67,000 | $73,000 | $73,000 | $97,000 | | | | (1-5) $380,000 | $380,000 |
| BORROW PIT AND RECLAIM POND REGRADING AND RECLAMATION | | | | | | | | | | | | | |
| ---REGRADING | LS | $18,400 | | | | | | | | $18,000 | | (7) $18,000 | $18,000 |
| ---VEGETATE | ACRE | $600 | | | | | | | | $231,000 | | (7) $231,000 | $231,000 |
| VEGETATE EXCESS COARSE TAILINGS (NEAR RR) | ACRE | $600 | | | | | | | | $114,000 | | (7) $114,000 | $114,000 |
| RECLAMATION OF ACCESS AND HAUL ROADS | LS | $422,000 | | | | | | | | $422,000 | | (7) $422,000 | $422,000 |
| REVEGETATE BUILDING, STORAGE AREAS AND PARKING LOTS | ACRE | $600 | | | | | | | | $26,000 | | (7) $26,000 | $26,000 |
| REVEGETATE ACCESS AND HAULROADS AND PIPELINE CORRIDORS | ACRE | $600 | | | | | | | | $78,000 | | (7) $78,000 | $78,000 |
| REVEGETATE RAILROAD TRACK | ACRE | $600 | | | | | | | | $72,000 | | (7) $72,000 | $72,000 |
| COARSE TAILS COVER-FINAL POND (24" DREDGE) | LS | $3,000,000 | | | | | | | $3,000,000 | | | (6) $3,000,000 | $3,000,000 |
| SPILLWAYS: | | | | | | | | | | | | | |
| ---OPERATING SPILLWAY | LS | $1,102,000 | | | | | | | | $1,102,000 | | (7) $1,102,000 | $1,102,000 |
| ---EMERGENCY SPILLWAY | LS | $42,000 | | | | | | | | $42,000 | | (7) $42,000 | $42,000 |
| STABILIZE DOWNSTREAM SLOPES OF DAMS: | | | | | | | | | | | | | |
| ---GRADE D/S SLOPE OF DAM 1 | LS | $10,000 | | | | | | | | $10,000 | | (7) $10,000 | $10,000 |
| ---CONSTRUCT TOE BERM-DAM 2 | LTON | $0.53 | | | | | | | | $63,000 | | (7) $63,000 | $63,000 |
| ---REVEGETATE DISTURBED AREAS | ACRE | $600 | | | | | | | | $180,000 | | (7) $180,000 | $180,000 |
| CUT SPLITTER DIKES 1 AND 3 | CY | $2 | | | | | | | | $30,000 | | (7) $30,000 | $30,000 |
| YEARLY TOTALS | | | $326,000 | $2,245,000 | $2,271,000 | $1,764,000 | $1,951,000 | $2,216,000 | $3,878,000 | $3,636,000 | $7,933,000 | $10,554,000 | $18,487,000 |

$7,514,000
Filtration 750,000
$8,264,000
yrs 6-7

NOTES: LTON = LONG TON (2240 LBS.); CY = CUBIC YARD; LS = LUMP SUM; LF = LINEAR FOOT; MO = MONTH; YR = YEAR
* REDUCED TO REFLECT REDUCED FILTRATION RATE REQUIRED AFTER PLANT IS SHUT DOWN

FIGURE 2: COSTS

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