WATSON LAKE M.D.

| MAP No. | ASSESSMENT REPORT | TYPE OF |
|---|---|---|
| 105 0 1 | N. M. E. A. P. ☐<br>CONFIDENTIAL ☐<br>OPEN FILE ☐ | WORK: EVALUATION SURVEY |

| | | |
|---|---|---|
| REPORT FILED UNDER | ABERFORD RESOURCES LTD. | DOCUMENT NO. 091790 |
| DATE PERFORMED | JANUARY-DECEMBER 1985 | DATE FILED: MARCH 3, 1986 |
| LOCATION – LAT. | 63°10'N | AREA: MACMILLAN PASS |
| LONG. | 130°15'W | |
| CLAIM NO. | JASON | |
| | ACE | |
| | MIKE | |
| VALUE $ 36,000.00 | | |
| WORK DONE BY | ERS ENVIRONMENTAL RESEARCH, BECHTEL CANADA ENGINEERS LTD. | |
| WORK DONE FOR | ABERFORD RESOURCES LTD. AND HUDSON BAY MINING AND SMELTING CO. LTD. | |

REMARKS
1-TOM
16-JASON

091790

An environmental impact study and a mini feasability study have been completed and documented.

The environmental study focused on the occurrence of GALIUM TRIFOLIUM and OSMORHIZA DEPAUPERATA, which are two small plants which do not usually occur so far north. They are, however, not uncommon plants. As well, a water quality study was done in order to have baseline data on the watercourses before mining commences.

The mine feasibility study estimates and evaluates projected costs, ore reserves, geology and mine development proceedures.

yex 85 p.177 ✓

ABERFORD RESOURCES LTD.

# JASON WATER STUDIES: 1985

## Water Quality and Discharge Measurements

September 1985

Glenn Brown
ERS Environmental Research Services
118 Ninth Street N.W.
Calgary, Alberta, T2N 1S9

091790

This report has been examined by the Geological Evaluation Unit under Section 53 (4) Yukon Quartz Mining Act and is allowed as representation work in the amount of $ 36,000.00 .

26 March 1986

Regional Manager, Exploration and Geological Services for Commissioner of Yukon Territory.

091790

# JASON WATER STUDIES: 1985

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## Summary

In-situ measurements of water quality parameters were conducted on the South Macmillan River and Hoodoo Creek in 1985 in the same manner as in previous years. Data recording water temperature, dissolved oxygen, salinity, conductivity and pH were gathered. In addition, since we installed a graduated plate, water stage measurements were recorded for the South Macmillan River.

Measurements of water discharge were made on the South Macmillan River and Sekie, Tom and Rat Creeks and are related to stream stages as recorded from staff plates installed on each stream. Discharges in early August were 3.475, 0.233, 0.129, 0.080 $m^3$ respectively. Using government data and staff readings to be gathered in late fall of 1985, good estimates of low fall discharges will be possible. At our request, however, the Ross River federal land use officer will be making winter measurements of the depth of the South Macmillan River, thus permitting a more direct indication of the yearly low flow volumes.

# JASON WATER STUDIES: 1985

## Introduction

In 1985 water quality records were made in the same manner as in 1983 and 1984. In addition, records of stream discharge (volume of stream flow) were made on four streams. The results of these projects are described below.

## Water Quality Records

The water quality measurements were continued in the manner established in 1983. That is, in-situ measurements were made in the South Macmillan River and in the Hess tributary sometimes known as Hoodoo Creek at locations previously established. Records of water temperature, dissolved oxygen content, salinity, conductivity and pH were made as in previous years. Since a staff guage was installed this year, see below, the stage of South Macmillan River is also recorded with the daily measurements. Measurements were taken daily in the early evening. For additional details of locations and techniques see Brown (1983).

## WATER QUALITY MEASUREMENTS: 1985

| Date | Location | Temp | Dis'd Oxygen | Temp | Sal'y | Cond't'y | pH | Stage |
|---|---|---|---|---|---|---|---|---|
| **South Macmillan River** | | | | | | | | |
| Aug 9 | Upstream | 7.5 | 9.0 | 8.0 | 0 | 200 | 6.75 | 71 |
| | Bridge | 8.0 | 9.1 | 8.0 | 0 | 200 | 6.80 | 71 |
| Aug 10 | Upstream | 7.0 | 10.0 | 6.0 | 0 | 195 | 6.70 | -- |
| | Bridge | 7.0 | 9.7 | 6.5 | 0 | 200 | 6.60 | -- |
| Aug 11 | Upstream | 7.0 | 8.6 | 7.2 | 0 | 205 | 6.65 | 69 |
| | Bridge | 7.0 | 8.7 | 8.0 | 0 | 200 | 6.70 | 69 |
| Aug 12 | Upstream | 6.8 | 9.2 | 7.0 | 0 | 200 | 6.35 | 67 |
| | Bridge | 7.0 | 8.7 | 7.0 | 0 | 195 | 6.60 | 67 |
| Aug 13 | Upstream | 7.0 | 9.0 | 8.0 | 0 | 190 | 6.60 | 72 |
| | Bridge | 7.0 | 9.1 | 8.0 | 0 | 190 | 6.70 | 72 |
| Aug 14 | Upstream | 7.5 | 9.1 | 8.0 | 0 | 185 | 6.80 | 77 |
| | Bridge | 8.0 | 8.6 | 8.5 | 0 | 185 | 6.75 | 77 |
| Aug 15 | Upstream | 7.0 | 8.3 | 7.0 | 0 | 190 | 6.70 | -- |
| | Bridge | 7.0 | 8.2 | 8.0 | 0 | 185 | 6.70 | -- |
| Aug 16 | Upstream | 7.0 | 7.2 | 8.0 | 0 | 195 | 6.70 | 73 |
| | Bridge | 7.0 | 7.2 | 8.5 | 0 | 190 | 6.80 | 73 |
| Aug 17 | Upstream | 5.5 | 8.3 | 5.0 | 0 | 185 | 6.70 | 72 |
| | Bridge | 6.0 | 8.3 | 5.0 | 0 | 180 | 6.70 | 72 |
| Aug 18 | Upstream | 8.2 | 6.7 | 9.0 | 0 | 210 | 6.85 | 70 |
| | Bridge | 8.5 | 6.8 | 9.5 | 0 | 205 | 6.70 | 70 |
| **Hoodoo Creek** | | | | | | | | |
| Aug 14 | Upstream | 6.5 | 9.9 | 7.0 | 0 | 135 | 7.25 | |
| | Downstream | 7.0 | 9.5 | 8.0 | 0 | 140 | 7.20 | |
| Aug 18 | Upstream | 6.0 | 8.1 | 5.2 | 0 | 150 | 7.65 | |
| | Downstream | 6.0 | 8.0 | 6.2 | 0 | 150 | 7.65 | |

Discharge Measurements

In August 1985 we installed staff plates at one site on each of four streams in the Macmillan Pass area. These plates permit reading water height, or stage, at any time. Readings will be taken weekly by the camp caretaker until the plates are too frozen to be legible. These readings will be submitted when they are completed.

To convert stage measurements into the desired discharge measurements a series of direct measurements of water discharge must be made, at different stages, to create a regression curve. The regression curve can then be used to provide an estimate of discharge for any given stage. Since we were only present at one time of year, during which stage varied little, we can provide only one pair of stage and discharge measurements. However, comparison with data from Water Resources Division (1984) can provide a regression curve for the South Macmillan River, Sekie Creek and Tom Creek. (I have included as an appendix their data on our streams. Sekie Creek and Tom Creek are referred to therein as Sekie Creek #1 and Sekie Creek #2 respectively.)

A current meter and related equipment were provided by the Department of Indian and Northern Affairs, Water Resources Division in Whitehorse. During our stay in Macmillan Pass we spoke with John Jenning, of the Ross River DIAND office. When he indicated that he would be taking winter snow depth measurements in Macmillan Pass, we requested that he also measure the depth of the water in the South Macmillan River, depth being the only feasible measurement in mid-winter. He agreed. Thus by spring of 1986 we will have some direct measurement of the low flow of the South Macmillan River. Since the fall discharge measurements recorded here were intended to estimate that value, this government assistance will provide better data that was expected. Jenning's data will be forwarded when received.

The discharges of the streams measured are below.

MACMILLAN PASS DISCHARGE MEASUREMENTS: 1985

| Date | Location | Stage* | Discharge (m3/sec) |
|---|---|---|---|
| Aug 9 | Sekie Creek (by Jason Camp) | 40 | 0.233 |
| Aug 9 | Tom Creek (by Canol road) | 25 | 0.129 |
| Aug 9 | Rat Creek (by Nipple Mt. road) | 30 | 0.080 |
| Aug 10 | S. Macmillan R (at Aberford Br.) | 70 | 3.475 |

* measured in cm from an arbitrary base

Literature Cited

Brown, G., 1983. Jason Water Quality Studies: 1983. Unpublished report submitted to Aberford Resources Ltd. by Biological Research Services, Calgary.

Water Resources Division, 1984. Yukon Water Resources Hydrometric Program Historical Summary 1975-1983. Department of Indian and Northern Affairs, Whitehorse. 214 pp.

# APPENDIX

## DIAND STREAMFLOW DATA FOR THE SOUTH MACMILLAN RIVER, SEKIE CREEK #1 AND SEKIE CREEK #2

29BB002 - South MacMillan River #2 at Km 438.6 North Canol Highway

Location: 63°06'N 130°12'W
Drainage Area: 190 sq km
Record Length: 1975 - 1980 C
1981 - R
Flow: Natural

Crest Gauge Summary

| Year | Date | Discharge (cms) |
|---|---|---|
| 1975 | June 11 - July 6 | 38.53 |
| 1976 | Before June 8 | 19.95 |
| 1977 | Before June 9 | 22.07 |
| 1978 | June 1 - June 28 | 26.13 |
| 1979 | June 29 - July 17 | 21.21 |
| 1980 | Aug 8 - Sept 14 | 11.45 |

Discharge Summary

| Year | Date | Flow (cms) | Year | Date | Flow (cms) |
|---|---|---|---|---|---|
| 1975 | June 11 | 18.838 | 1979 | June 29 | 16.280 |
| | July 6 | 16.284 | | Aug 3 | 9.894 |
| | Aug 7 | 4.856 | | Aug 13 | 6.044 |
| | | | | Aug 28 | 3.215 |
| 1976 | June 8 | 14.668 | | Sept 10 | 2.327 |
| | June 24 | 13.618 | | | |
| | Aug 28 | 2.930 | 1980 | May 24 | 7.291 |
| | | | | June 22 | 9.026 |
| 1977 | June 9 | 13.709 | | July 20 | 8.184 |
| | July 23 | 8.088 | | Aug 1 | 10.132 |
| | Sept 8 | 2.848 | | Sept 14 | 3.281 |
| 1978 | June 1 | 14.583 | | | |
| | June 28 | 16.404 | | | |
| | July 27 | 6.927 | | | |
| | Aug 23 | 4.564 | | | |
| | Sept 20 | 2.630 | | | |

South MacMillan River #2

Maximum Instantaneous

| Year | Date | Discharge (cms) |
|---|---|---|
| 1981 | June 8 | 20.31 |
| 1982 | June 13 | 24.47 |
| 1983 | June 1 | 51.87 |

Minimum Instantaneous

| Date | Discharge (cms) |
|---|---|
| Sept 5 | 4.00 |
| Aug 31 | 2.57 |
| Sept 12 | 3.87 |

Maximum Daily

| Year | Date | Discharge (cms) |
|---|---|---|
| 1981 | July 3 | 18.79 |
| 1982 | June 14 | 21.52 |
| 1983 | June 1 | 48.41 |

Minimum Daily

| Date | Discharge (cms) |
|---|---|
| Sept 6 | 4.05 |
| Sept 4 | 2.58 |
| Sept 12 | 3.90 |

South MacMillan River #2

1981
DAILY DISCHARGE (CMS)

| DAY | MAY | JUNE | JULY | AUG | SEPT | OCT | MEAN |
|---|---|---|---|---|---|---|---|
| 1 | | | 13.00 | 9.29 | 4.84 | | |
| 2 | | | 16.26 | 8.63 | 4.47 | | |
| 3 | | | 18.79 | 9.14 | 4.41 | | |
| 4 | | | 17.79 | 11.88 | 4.22 | | |
| 5 | | | 17.16 | 13.56 | 4.13 | | |
| 6 | | 17.36 | 14.81 | 14.83 | 4.05 | | |
| 7 | | 16.25 | 13.66 | 12.29 | 7.74 | | |
| 8 | | 18.60 | 13.70 | 10.63 | 16.48 | | |
| 9 | | 16.29 | 13.09 | 9.89 | | | |
| 10 | | 15.73 | 13.26 | 9.63 | | | |
| 11 | | 15.00 | 15.04 | 9.07 | | | |
| 12 | | 14.32 | 16.12 | 8.56 | | | |
| 13 | | 15.55 | 13.71 | 7.85 | | | |
| 14 | | 16.59 | 12.08 | 7.72 | | | |
| 15 | | 15.23 | 11.95 | 7.75 | | | |
| 16 | | 13.36 | 13.05 | 7.04 | | | |
| 17 | | 11.47 | 13.09 | 7.37 | | | |
| 18 | | 10.55 | 12.88 | 6.77 | | | |
| 19 | | 9.81 | 12.25 | 6.71 | | | |
| 20 | | 9.66 | 10.90 | 6.77 | | | |
| 21 | | 10.16 | 11.30 | 7.01 | | | |
| 22 | | 11.34 | 11.07 | 6.91 | | | |
| 23 | | 12.33 | 9.85 | 6.68 | | | |
| 24 | | 10.78 | 9.18 | 6.07 | | | |
| 25 | | 10.43 | 9.29 | 5.76 | | | |
| 26 | | 10.78 | 11.03 | 5.61 | | | |
| 27 | | 12.54 | 12.58 | 6.29 | | | |
| 28 | | 14.24 | 11.51 | 6.16 | | | |
| 29 | | 12.75 | 10.27 | 5.85 | | | |
| 30 | | 12.29 | 11.30 | 5.34 | | | |
| 31 | | | 10.75 | 5.13 | | | |
| TOTAL | | 333.41 | 400.73 | 252.18 | | | |
| MEAN | | 13.34 | 12.93 | 8.13 | | | 10.91 |
| MAX. | | 18.60 | 18.79 | 14.83 | 16.48 | | |
| MIN. | | 9.66 | 9.18 | 5.13 | 4.05 | | |

South MacMillan River #2

1982
DAILY DISCHARGE (CMS)

| DAY | MAY | JUNE | JULY | AUG | SEPT | OCT | MEAN |
|---|---|---|---|---|---|---|---|
| 1 | | | 10.15 | 5.84 | 2.73 | | |
| 2 | | | 10.08 | 6.30 | 2.67 | | |
| 3 | | | 10.85 | 5.89 | 2.64 | | |
| 4 | | | 9.17 | 5.26 | 2.58 | | |
| 5 | | | 8.58 | 4.90 | 2.79 | | |
| 6 | | | 7.86 | 5.50 | 2.67 | | |
| 7 | | 8.47 | 7.39 | 5.22 | 3.13 | | |
| 8 | | 10.45 | 7.56 | 4.82 | 3.34 | | |
| 9 | | 12.22 | 7.08 | 4.56 | 3.85 | | |
| 10 | | 13.71 | 9.33 | 4.29 | | | |
| 11 | | 17.68 | 11.38 | 4.56 | | | |
| 12 | | 20.66 | 9.28 | 5.64 | | | |
| 13 | | 20.73 | 7.32 | 5.24 | | | |
| 14 | | 21.52 | 6.47 | 4.72 | | | |
| 15 | | 19.70 | 6.25 | 4.35 | | | |
| 16 | | 14.52 | 6.64 | 4.11 | | | |
| 17 | | 10.87 | 6.94 | 4.03 | | | |
| 18 | | 11.14 | 10.74 | 4.07 | | | |
| 19 | | 15.28 | 8.77 | 3.77 | | | |
| 20 | | 20.67 | 6.90 | 3.56 | | | |
| 21 | | 15.49 | 6.06 | 3.46 | | | |
| 22 | | 11.27 | 5.66 | 3.22 | | | |
| 23 | | 10.78 | 5.42 | 3.15 | | | |
| 24 | | 10.24 | 4.82 | 3.08 | | | |
| 25 | | 10.37 | 4.58 | 2.95 | | | |
| 26 | | 10.41 | 4.56 | 2.81 | | | |
| 27 | | 11.25 | 4.31 | 2.76 | | | |
| 28 | | 11.70 | 4.04 | 2.67 | | | |
| 29 | | 12.04 | 3.93 | 2.71 | | | |
| 30 | | 10.49 | 3.88 | 2.67 | | | |
| 31 | | | 4.36 | 2.67 | | | |
| TOTAL | | 331.65 | 220.33 | 128.79 | | | |
| MEAN | | 13.82 | 7.11 | 4.15 | | | 7.44 |
| MAX. | | 21.52 | 11.38 | 6.30 | 3.85 | | |
| MIN. | | 8.47 | 3.88 | 2.67 | 2.58 | | |

South MacMillan River #2

1983
DAILY DISCHARGE (CMS)

| DAY | MAY | JUNE | JULY | AUG | SEPT | OCT | MEAN |
|---|---|---|---|---|---|---|---|
| 1 | | 48.41 | 19.65 | 5.95 | 5.74 | | |
| 2 | | 40.35 | 17.62 | 8.04 | 5.99 | | |
| 3 | | 20.91 | 15.89 | 6.52 | 6.01 | | |
| 4 | | 15.64 | 14.20 | 5.67 | 5.54 | | |
| 5 | | 15.00 | 13.42 | 5.07 | 5.70 | | |
| 6 | | 14.71 | 10.51 | 4.90 | 5.71 | | |
| 7 | | 14.80 | 8.10 | 4.68 | 5.16 | | |
| 8 | | 13.27 | 7.65 | 4.28 | 4.71 | | |
| 9 | | 11.80 | 7.46 | 4.05 | 4.48 | | |
| 10 | | 11.67 | 6.99 | 4.85 | 4.24 | | |
| 11 | | 15.17 | 7.80 | 5.86 | 4.07 | | |
| 12 | | 18.36 | 9.37 | 6.93 | 3.90 | | |
| 13 | | 16.39 | 11.85 | 6.44 | 4.43 | | |
| 14 | | 16.96 | 10.19 | 5.69 | | | |
| 15 | | 19.51 | 8.19 | 5.47 | | | |
| 16 | | 21.30 | 7.52 | 5.79 | | | |
| 17 | | 21.20 | 6.97 | 6.65 | | | |
| 18 | | 22.88 | 6.17 | 7.10 | | | |
| 19 | | 26.73 | 6.01 | 6.46 | | | |
| 20 | | 24.40 | 5.71 | 5.74 | | | |
| 21 | | 27.45 | 5.34 | 5.64 | | | |
| 22 | | 36.89 | 5.60 | 6.12 | | | |
| 23 | | 35.32 | 5.52 | 7.46 | | | |
| 24 | | 29.21 | 4.96 | 8.94 | | | |
| 25 | | 31.22 | 4.63 | 9.72 | | | |
| 26 | | 32.15 | 4.39 | 8.55 | | | |
| 27 | | 28.99 | 4.41 | 9.36 | | | |
| 28 | | 24.95 | 4.94 | 7.90 | | | |
| 29 | | 22.48 | 4.90 | 6.99 | | | |
| 30 | | 20.34 | 4.76 | 6.32 | | | |
| 31 | | | 4.31 | 6.11 | | | |
| TOTAL | | 698.43 | 255.03 | 199.24 | | | |
| MEAN | | 23.28 | 8.23 | 6.43 | | | 11.60 |
| MAX. | | 48.41 | 19.65 | 9.72 | 6.01 | | |
| MIN. | | 11.67 | 4.31 | 4.05 | 3.90 | | |

29BB003 - Sekie Creek #1 at Km 445.6 North Canol Highway

Location: 63°08'N 130°14'W
Drainage Area: 14.2 sq km
Record Length: 1981 - 1982 C
Flow: Natural

Crest Gauge Summary

| Year | Date | Discharge (cms) |
|---|---|---|
| 1981 | Aug 5 | 1.75 |
| 1982 | June 16 - 18 | 1.49 |

*NOTE: Miscellaneous Data available

Discharge Summary

| Year | Date | Flow (cms) |
|---|---|---|
| 1981 | June 8 | 1.476 |
| | June 22 | 0.589 |
| | July 3 | 1.722 |
| | July 31 | 0.920 |
| | Aug 13 | 0.570 |
| 1982 | June 6 | 0.522 |
| | June 18 | 0.953 |
| | July 2 | 1.148 |
| | July 30 | 0.504 |
| | Aug 13 | 0.445 |
| | Aug 26 | 0.248 |
| | Sept 23 | 0.171 |

29BB004 - South MacMillan River at Pan Ocean Bridge

Location: 63°10'N 130°14'W
Drainage Area: 130 sq km
Record Length: 1981 - 1982 C
Flow: Natural

Crest Gauge Summary

| Year | Date | Discharge (cms) |
|---|---|---|
| 1981 | July 3 | > 8.56 |
| 1982 | June 18 | > 9.21 |

NOTE: Miscellaneous Data Available

Discharge Summary

| Year | Date | Flow (cms) |
|---|---|---|
| 1981 | June 17 | 5.027 |
| | July 3 | 8.557 |
| | July 31 | 4.756 |
| | Aug 13 | 3.286 |
| 1982 | June 6 | 4.619 |
| | June 18 | 9.209 |
| | July 17 | 4.342 |
| | July 30 | 2.542 |
| | Aug 13 | 3.831 |
| | Aug 26 | 2.004 |

29BB005 - MacIntosh Creek at Km 448.3 North Canol Highway

Location: 63°08'N 130°14'W
Drainage Area: 1.3 sq km
Record Length: 1981 - 1982 C
Flow: Natural

Crest Guage Summary

| Year | Date | Discharge (cms) |
|---|---|---|
| 1981 | Sept 3 | 0.21 |
| 1982 | June 18 | 0.33 |

NOTE: Miscellaneous Data Available

Discharge Summary

| Year | Date | Flow (cms) |
|---|---|---|
| 1981 | July 6 | 0.012 |
| | July 31 | 0.010 |
| | Aug 13 | 0.015 |
| 1982 | June 18 | 0.033 |
| | July 2 | 0.026 |
| | Aug 26 | 0.009 |
| | Sept 10 | 0.004 |

29BB006 - Sekie Creek #2 at Km 450 North Canol Highway

Location: 63°10'N 130°12'W
Drainage Area: 5.2 sq km
Record Length: 1981 - 1982 C
Flow: Natural

Crest Gauge Summary

| Year | Date | Discharge (cms) |
|---|---|---|
| 1981 | Sept 8 | 0.78 |
| 1982 | June 18 - July 2 | 0.72 |

NOTE: Miscellaneous Data Available

Discharge Summary

| Year | Date | Flow (cms) |
|---|---|---|
| 1981 | June 8 | 0.344 |
| | June 20 | 0.112 |
| | July 6 | 0.255 |
| | July 30 | 0.134 |
| | Aug 13 | 0.148 |
| 1982 | June 7 | 0.222 |
| | June 18 | 0.274 |
| | July 2 | 0.274 |
| | Aug 13 | 0.147 |
| | Aug 26 | 0.096 |
| | Sept 23 | 0.097 |

ABERFORD RESOURCES LTD.

RECEIVED
MINING RECORDER
WATSON LAKE, Y.T.
I.A. & N.D.

# OCCURRENCE OF GALIUM TRIFLORUM AND OSMORHIZA DEPAUPERATA IN THE MACMILLAN PASS AREA, YUKON

OFFICE OF THE REGIONAL MANAGER
MINERAL RIGHTS
FEB 17 1986
WHITEHORSE
YUKON TERRITORY

November 1985

Glenn Brown
ERS Environmental Research Services
118 Ninth Street N.W.
Calgary, Alberta, T2N 1S9

091790

# GALIUM AND OSMORHIZA IN MACMILLAN PASS

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## SUMMARY

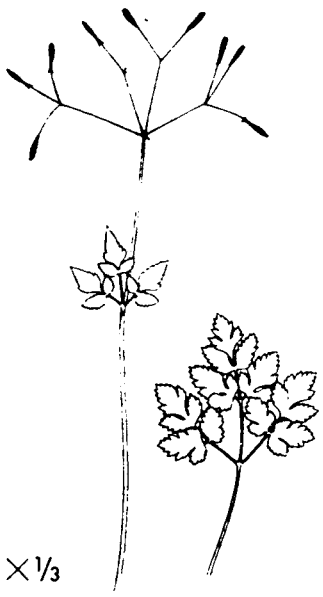
Early work in the Macmillan Pass area showed that two rare plant species are found there. Both species, Galium triflorum and Osmorhiza depauperata are several hundred kilometres farther north than any previous discovered occurrence. Initially they were found together, only on south-facing slopes of a calcareous mountainside. Such sites provide conditions favourable to northern occurrences of many plant species. Since these plants were recorded on the list of Yukon rare plants, they seemed likely to present complications for development.

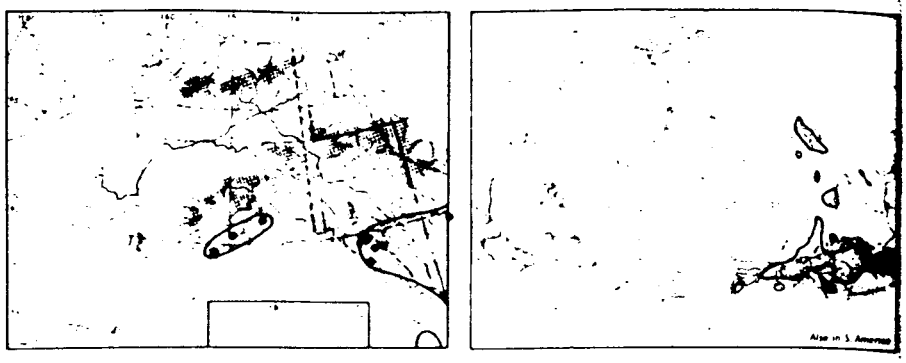
This study was initiated because the presence of several other south-facing calcareous slopes in the Macmillan Pass area offered the possibility that the two species might be locally common, even if they were rare at the scale of the Territory. Field work in 1985 revealed that the two species were both widespread, although nowhere abundant, on the site of the first discovery, Nipple Mountain. One of the two, Galium was also discovered on another site several kilometres away. Given the limited amount of territory that was examined and the difficulty of finding small, rare plants in dense willow thickets, these results tend to confirm the assumption that the plants are locally common. While more detailed study would be desirable if development was imminent, including verification of Osmorhiza in another site, this conclusion is adequately supported for the present. No additional work is needed in the near future.

## Introduction

In 1983 I identified the presence of two species in the Macmillan Pass area that were on the list of Yukon rare species (Douglas et al 1981). These were Galium triflorum Michx. (Sweet-Scented Bedstraw) and Osmorhiza depauperata Phill. (Sweet Cicely) (Figure 1). Both plants are also several hundred kilometres farther north than previously recorded (Hulten 1968, Porsild and Cody 1980). The plants were found very close together, in the same vegetation type, and in only one place: on the south-facing slope of Nipple Mountain. With these rare plants present in very small numbers and only in one place it was clear that they could be a particularly sensitive element of the environment in the case of development.

The study outlined here was designed to test the possibility that the plants were not restricted only to one place on Nipple Mountain but were more widespread. We hoped that by carefully examing a few special environments where the species were likely to occur that we could find additional populations. Such a find would reduce the botanical significance of the original discoveries and thus reduce the likelihood that the plants would complicate development plans.



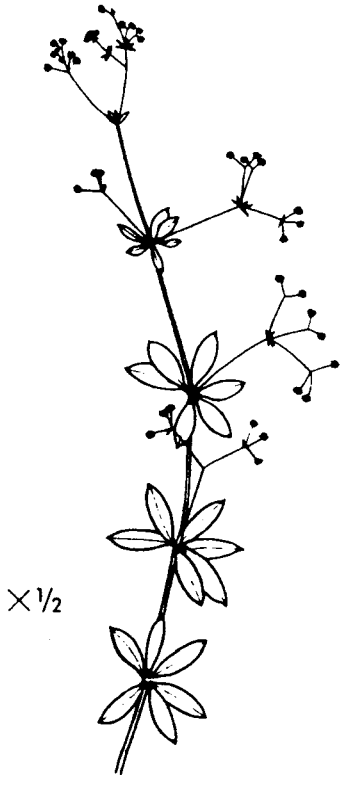



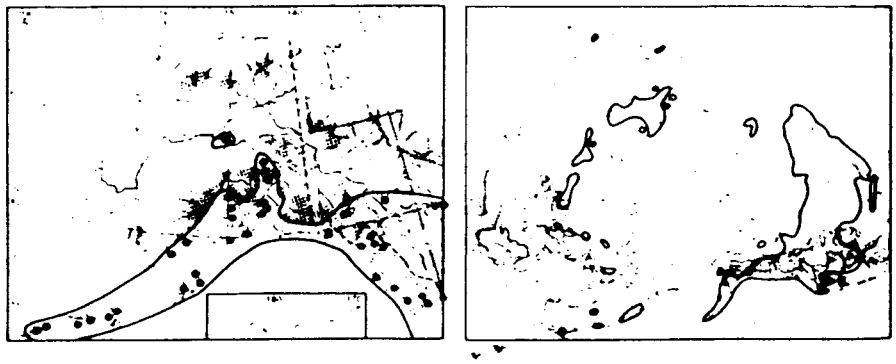
**3. Osmorhìza depauperàta** Phill.

*Washingtonia obtusa* Coult. & Rose; *Osmorhiza obtusa* (Coult. & Rose) Fern.

Similar to *O. chilensis*, but rays and pedicels divaricate; fruit clavate, with narrow base, densely hispid at base.

Woods. Described from Valle de las Nieblas, Chile.



**4. Gàlium triflòrum** Michx. Sweet-Scented Bedstraw

Dark-green plant; stems from creeping rhizome, more or less retrorsely scabrous, decumbent, simple or remotely forking; leaves elliptic-lanceolate, cuspidate, 1-nerved, 6 in a whorl; peduncles axillary, mostly 3-flowered; flowers pedicellated, small, greenish-white; fruit densely hooked, bristly.

Moist woods, thickets. Described from Canada.

Coumarin-scented after drying.

Figure 1: Galium triflorum and Osmorhiza depauperata

From: Hulten 1968

Likely Habitats and Areas Examined

The attributes of the site where both species were discovered are typical of those of plants at the northern edge of their range. A south-facing slope provides a warmer microenvironment, representative of conditions farther south, and is often a location for northern outliers. Furthermore, the calcareous nature of the soils on Nipple Mtn. provides both a particularly nutrient-rich environment and a type of environment relatively unusual in the eastern Yukon. Both conditions contribute to the likelihood that the mountain would support species that are not common in the Macmillan Pass region. In trying to find additional populations of the two species, the first step was to identify sites which have similar characteristics.

It seemed likely that the hospitable conditions provided by calcareous soils were essential to the growth of the two species. In four years of studies of the Jason property the plants had been found nowhere else. So only calcareous sites were considered. The local geological map (Abbott 1983) provided an indication of those outcropings of the Road River Group (limestones and calcareous shales-SlDl) where appropriate soils could be expected just downslope of the bare outcrops. Of all such locations, those with southfacing slopes and those that were accessible to the existing road system were identified.

In the available time, four different sites were examined (Figure 2). First, Nipple Mountain was examined in greater detail, since the plants were known to be present there but the pattern of distribution was not known. A south-facing exposure on Jason Mountain and another on the mountain just to the west of Nidd Creek, within the Cominco claims, were visited. The other accessible calcareous area, just off the Canol Road near the NWT border, did not have any south facing slopes but offered a large amount of territory and a variety of potential habitats. All sites were reached by walking and were inspected by hiking within appropriate vegetation types (willow-dominated slopes with herbaceous understory). The extreme difficulty of movement within willow stands made progress slow and thus reduced the amount of territory that could be examined.

Figure 2: Location of Sites Studied

Calcareous Outcrop

Possible Habitat

Populations Found and Probable Habitats

The discovery of plants in a site is positive evidence that the habitat there supports them. Failure to find them in a sampled portion of a large area otherwise typical of sites of their presence does not prove that they are not there somewhere. Our studies were not detailed enough to make that second conclusion, especially in light of the sparseness with which the two species grow on Nipple Mt. The chart (Table 1) summarises the principal data collected at the sites studied. From the locations where plants were found, a map of potential habitat has been prepared (Figure 3). The potential habitat is tentatively identified based upon the locations of identified populations, the existence of similar overstory vegetation and other site characteristics as identified from base maps and by the site visits.

Table 1: Characteristics of Potential Galium and Osmorhiza Sites

| Spec. Pres | Site | Aspect | Elev'n | Slope | Top.Posn | Seed/Flower(#) | Veg.Rep. |
|---|---|---|---|---|---|---|---|
| Osm/Gal | Nipple | 180 | 1500 | 45 | up/mid | S,F | -- |
| Osm | Nipple | 220 | 1480 | 45 | up/mid | S(1) | Yes |
| Osm | Nipple | 164 | 1375 | 30 | mid | S(31) | Yes |
| Osm/Gal | Nipple | 114 | 1375 | 20 | mid | S(200+)/F(20+) | Yes |
| Osm/Gal | Nipple | 106 | 1375 | 30 | mid | S,F | Yes |
| Osm/Gal | Nipple | 100 | 1375 | 30 | mid | S,F | Yes |
| Osm | Nipple | 92 | 1375 | 30 | mid | S | Yes |
| None | Nipple | 84 | 1375 | 30 | mid | 0 | 0 |
| None | Nipple | 28 | 1375 | 30 | mid | 0 | 0 |
| Gal | Cominco | 210 | 1400 | 30 | mid | F | Yes |
| None | Jason | 210 | 1500 | -- | up/mid | 0 | 0 |
| None | Canol | 270 | 1350 | 20 | mid | 0 | 0 |

The vegetation at all sites of Galium and Osmorhiza occurrence was dominated by willow (Salix spp., including Salix glauca and Salix lanata), since only such sites were searched. The two species seem to prefer the understory although in three locations Osmorhiza was found in small openings and in one place Galium was found in an open-grown patch of Epilobium. A small percentage of fir Abies lasiocarpa is common at most sites of occurrence. Common associated herbs are Valeriana sitchensis, Mertensia paniculata, Epilobium angustifolium, Rubus arcticus, Viola epipsila and Hieracleum lanata.

The two species seem to prefer very similar habitats, with Osmorhiza found in a slightly greater latitude of conditions. Most occurrences were around 1400 meters in elevation. Even though that is the elevation of the Nipple Mountain road, near which most of this year's observations were made, last year's observations and the occurrences away from the road were also about that elevation. All occurrences were on fairly deep deposits (over 1 m wherever measurements were possible) of loose materials downslope from exposures of calcareous bedrock. Aspects varied from south-west to almost directly east-facing.

Except for the Cominco site, where only a single Galium plant was found, Osmorhiza was found wherever Galium was found and was significantly more abundant than Galium in each of these locations. Nowhere was either species abundant. They exceeded 5% of the ground cover only in one microsite of about one by five meters, where both species occurred and together accounted for 50% or more of cover.

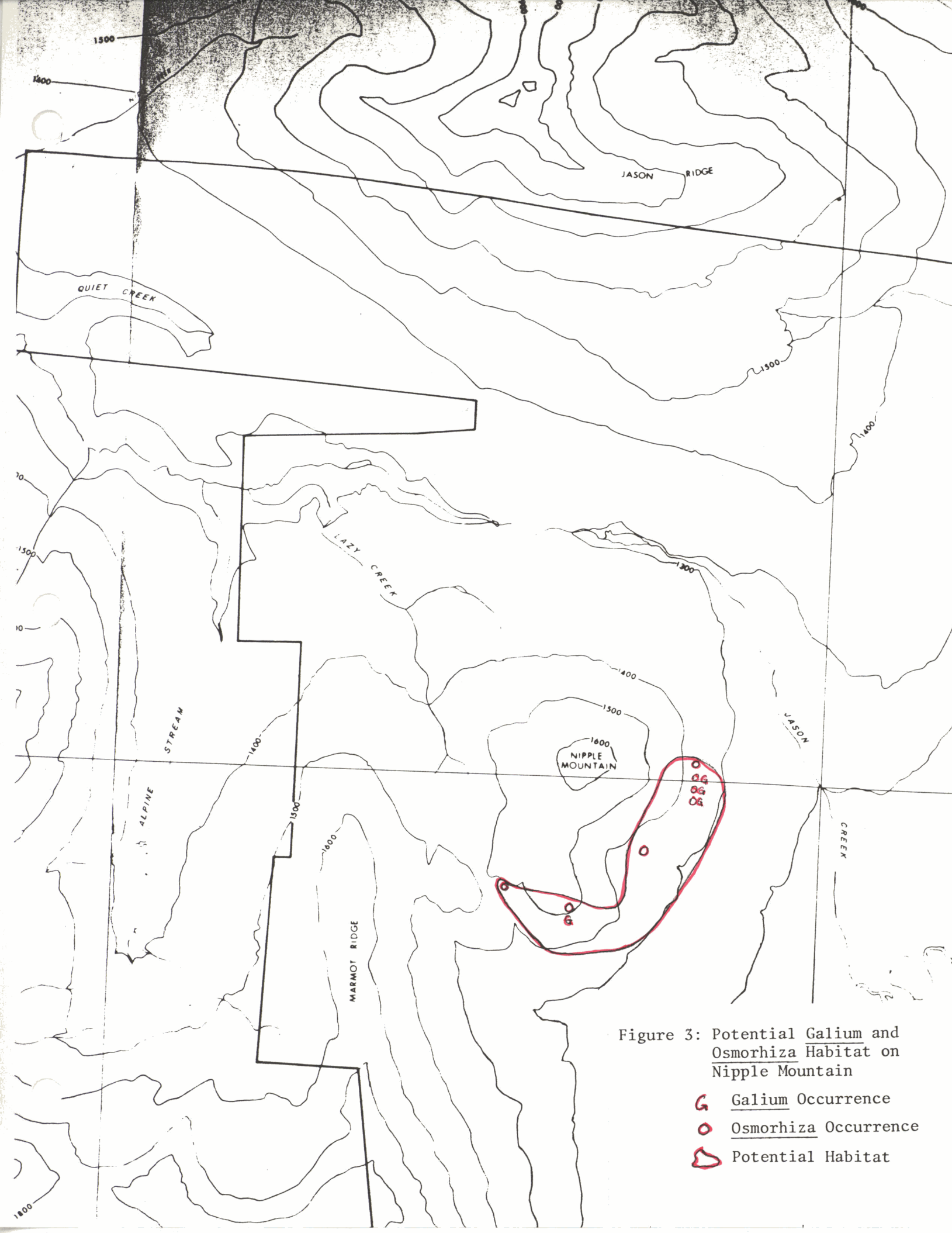



Figure 3: Potential Galium and Osmorhiza Habitat on Nipple Mountain

G Galium Occurrence

O Osmorhiza Occurrence

Potential Habitat

## Conclusions and Recommendations

It is clear that the two species exist over a much wider area, and in much greater numbers on Nipple Mountain than was expected from the conditions at the sites of their original discovery. It appears that Osmorhiza is substantially more common than Galium in locations where they occur together and is more widely distributed on Nipple Mountain. However, the only occurence off that mountain was of Galium and that was of a single plant. Both species were rare plants in all places where found. Thus it can be concluded that the plants are predictibly present in the Macmillan Pass area over an area of at least a square kilometer, including a range of exposures and elevations. In the light of their relative abundance and habitat latitude on Nipple, it is likely that they both exist on other sites nearby as well. Confirmation of this only exists for Galium thus far, but in the light of the very limited time available for field checks,it seems very likely that Osmorhiza would be found if suitable effort was devoted to the search. Both species probably exist in a variety of locations in the Macmillan Pass area.

Having ascertained that the plants exist in relatively substantial numbers and over a variety of landscape conditions, the immediate concern has been addressed. It is not likely that the presence of these plants would be a major complication to development of the Jason property. This conclusion does not mean that they should no longer be considered: they should be an element in the environmental planning if a mine is developed and more detailed studies would be necessary to permit such planning. However, this study provides all the information that seems needed at this time and no further investigations of these species seem warranted without further progress in development plans.

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HUDSON BAY MINING AND SMELTING
CO., LIMITED

AND

ABERFORD RESOURCES LIMITED

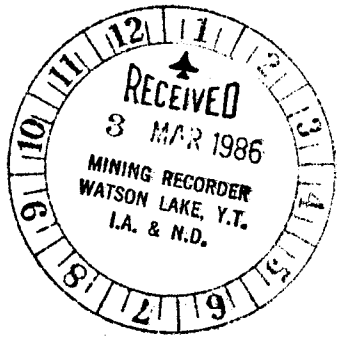
# FEASIBILITY STUDY

ON

TOM/JASON PROJECT

YUKON TERRITORY

091790




December, 1985

091790

# TOM/JASON PROJECT

## SECTION 2 TECHNICAL REPORTS

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2.3 Milling

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Fig. 2.1-16 Jason Main Zone Vertical Longitudinal Section

2.1.6 JASON END ZONE

Fig. 2.1-17 Jason End Zone Vertical Longitudinal Section

2.1.7 POTENTIAL FOR ADDITIONAL RESERVES

## 2.1 GEOLOGY AND ORE RESERVES

### 2.1.1 INTRODUCTION

The Tom and Jason deposits consist of massive to laminated sulphides and sulphates which are rich in lead, zinc, silver, barium and iron. It is believed that the deposits accumulated syndepositionally on the sea floor during the Late Devonian and were precipitated from exhaled hydrothermal brines near the margins of a small graben.

The Tom and Jason deposits are located near the eastern margin of the Selwyn Basin, a large northwest striking trough which contains a several thousand metre thickness of Proterozoic through Middle Paleozoic sedimentary rocks (Figure 1). These lead-zinc-silver deposits are localized within the Macmillan Fold Belt, a west-trending feature 30 x 60 kilometres in size which transects the regional northwest structural trend (Figure 2).

The structure and stratigraphy of the Macmillan Fold Belt are shown in simplified form in Figure 2. The map area is underlain by a diverse assemblage of sedimentary, and to a lesser extent volcanic rocks, ranging in age from Hadrynian to Triassic. The Tom and Jason properties, as well as a number of stratiform barite deposits, occur in the Central Block of the Macmillan Fold Belt. The Central Block is distinguished from the adjacent blocks because it contains a much thicker sequence of Road River and Lower Earn Group rocks, and because coarse clastic turbidite sequences of the Lower Earn Group and volcanic rocks of the Upper Road River Group are restricted to it.

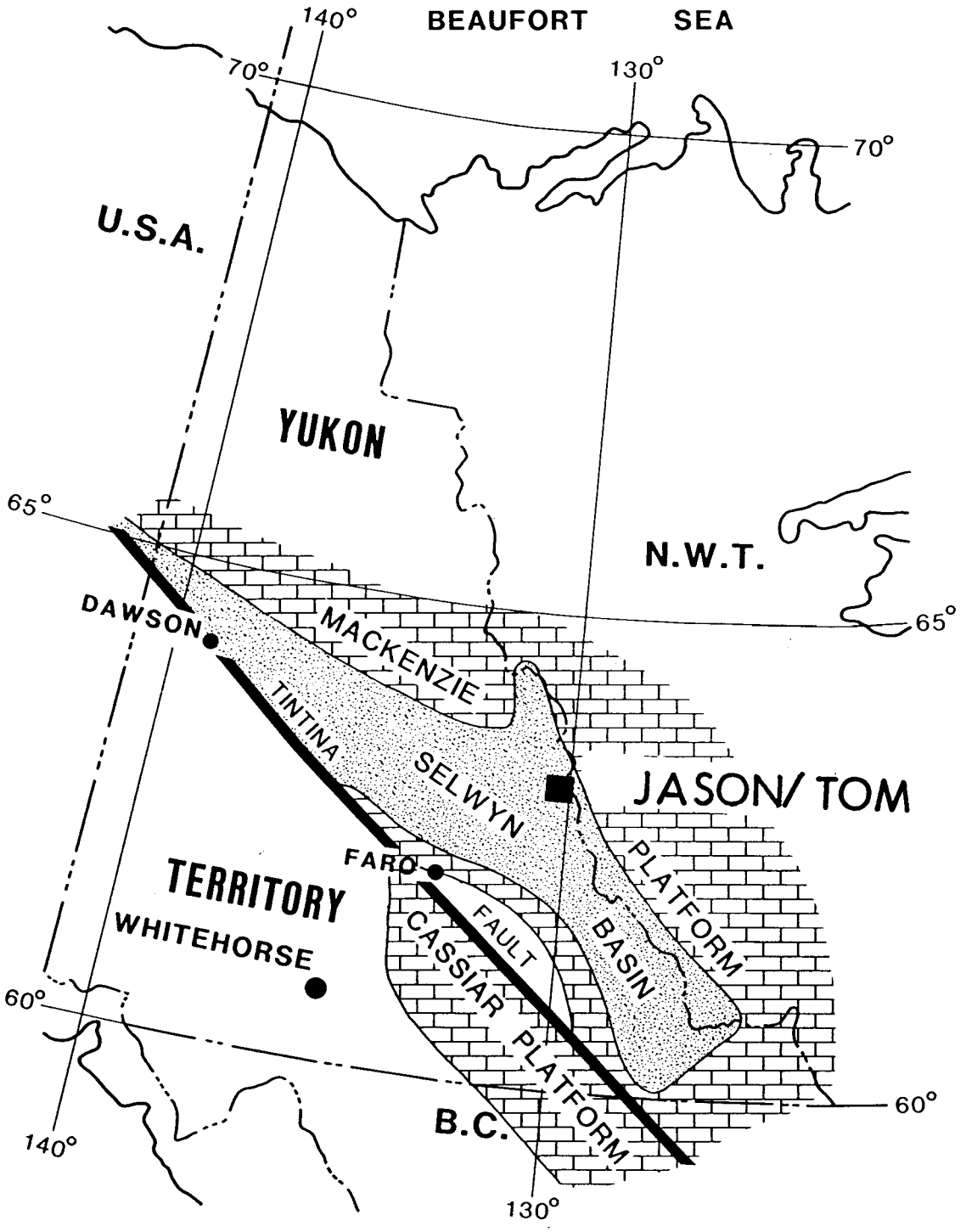



FIGURE 1

# LOCATION AND REGIONAL GEOLOGICAL SETTING

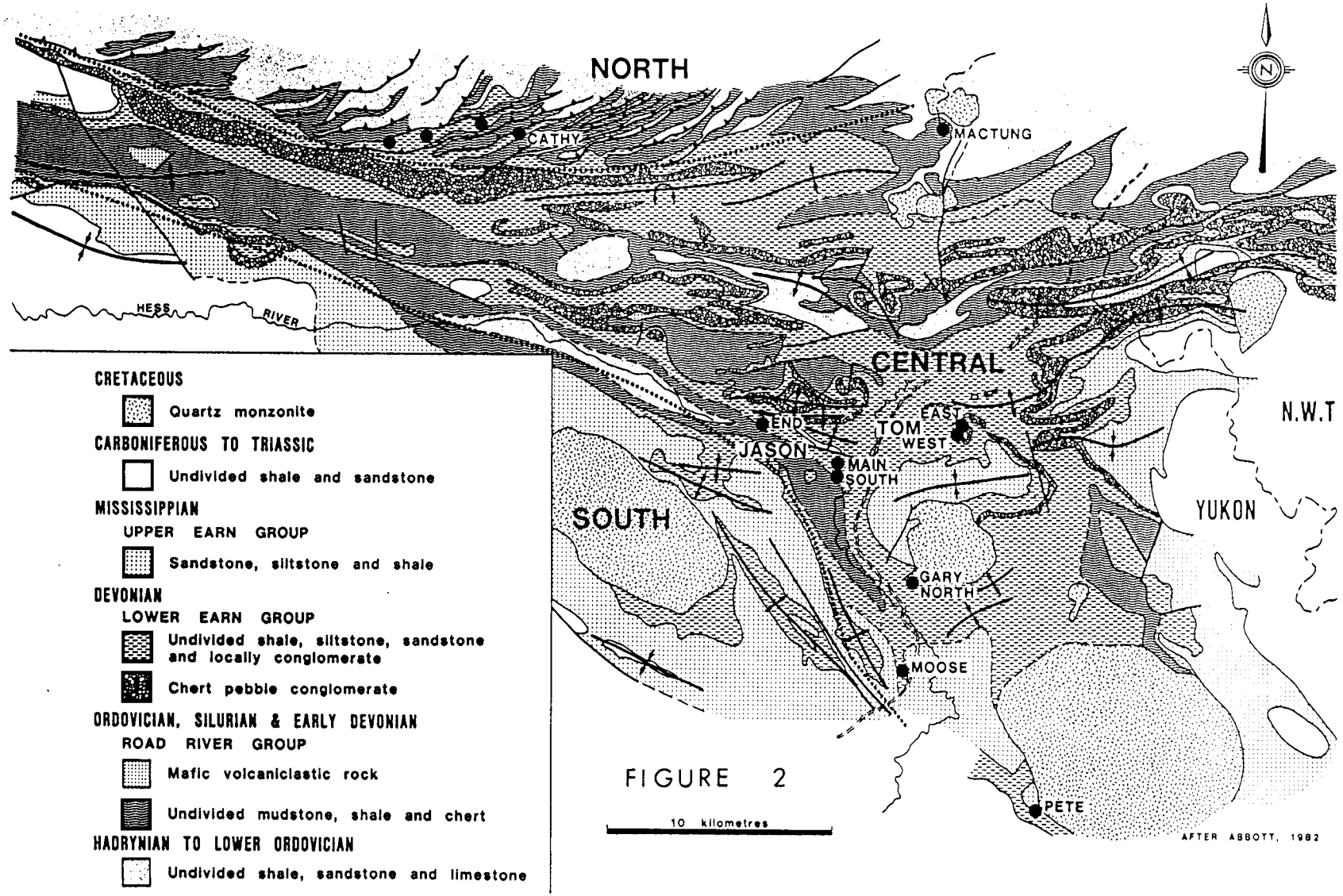


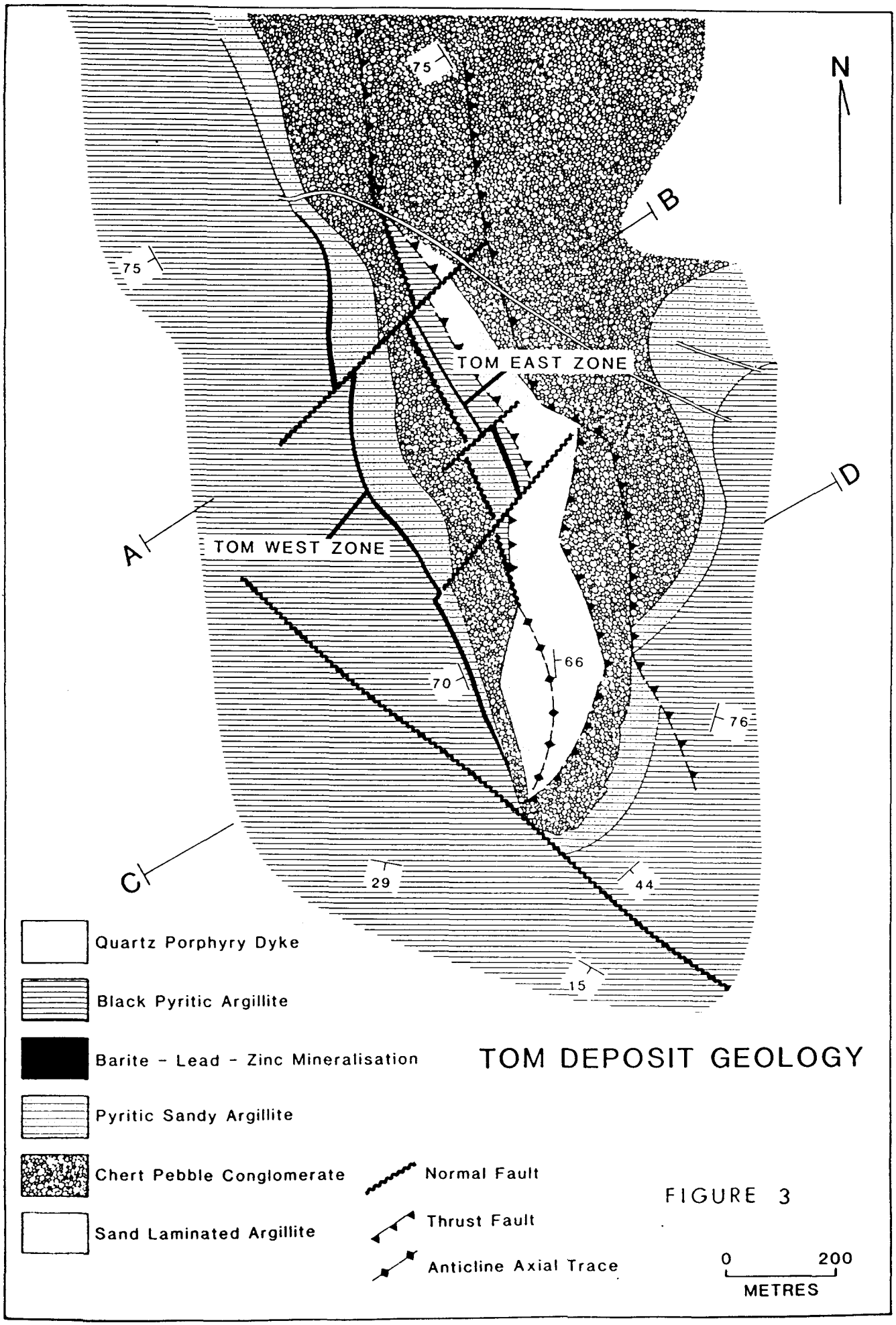

FIGURE 2

# GEOLOGY OF THE MACMILLAN FOLD BELT

The geological features suggest that the Central Block is a submarine fan complex localized within a fault bounded basin. Localization of the Tom and Jason deposits within this graben appears to have genetic significance, as syndepositional faults within, and bounding the basin probably acted as loci for the movement of hydrothermal fluids. The stratiform deposits are underlain by cross-cutting, discontinuous zones of brecciated, silicified and carbonatized rock cut by veinlets of quartz, ankerite, and to a lesser extent, galena, sphalerite, chalcopyrite and pyrrhotite.

Five distinct mineralized zones have been discovered on the two properties: the West Zone and East Zone at Tom; and the South Zone, Main Zone and End Zone at Jason (Figure 2). All of the mineralized zones conform to stratigraphy, dip steeply and are crudely to well laminated. The Tom East and West Zones occur in a southerly plunging anticline (Figures 3, 4, 5 and 6); the Jason Main and South Zones occur in an easterly plunging syncline (Figures 7, 8 and 9); and the Jason End Zone occurs in a steeply dipping slice of rocks bounded by faults. The relative stratigraphic position of the five zones is difficult to determine because of stratigraphic and structural complexities.

Two principal ore mineral facies have been identified both at Jason and Tom: a sulphide facies which is high grade and a chert-barite facies which comprises the bulk of the tonnage. These facies vary considerably both between zones and within a given zone. In addition to the two principal facies, a chert facies which is similar in character to the chert-barite facies occurs in the Main Zone and a zone of footwall alteration occurs stratigraphically below the West, South and End Zones.




TOM DEPOSIT GEOLOGY

FIGURE 3

# TOM DEPOSIT SECTION A - B

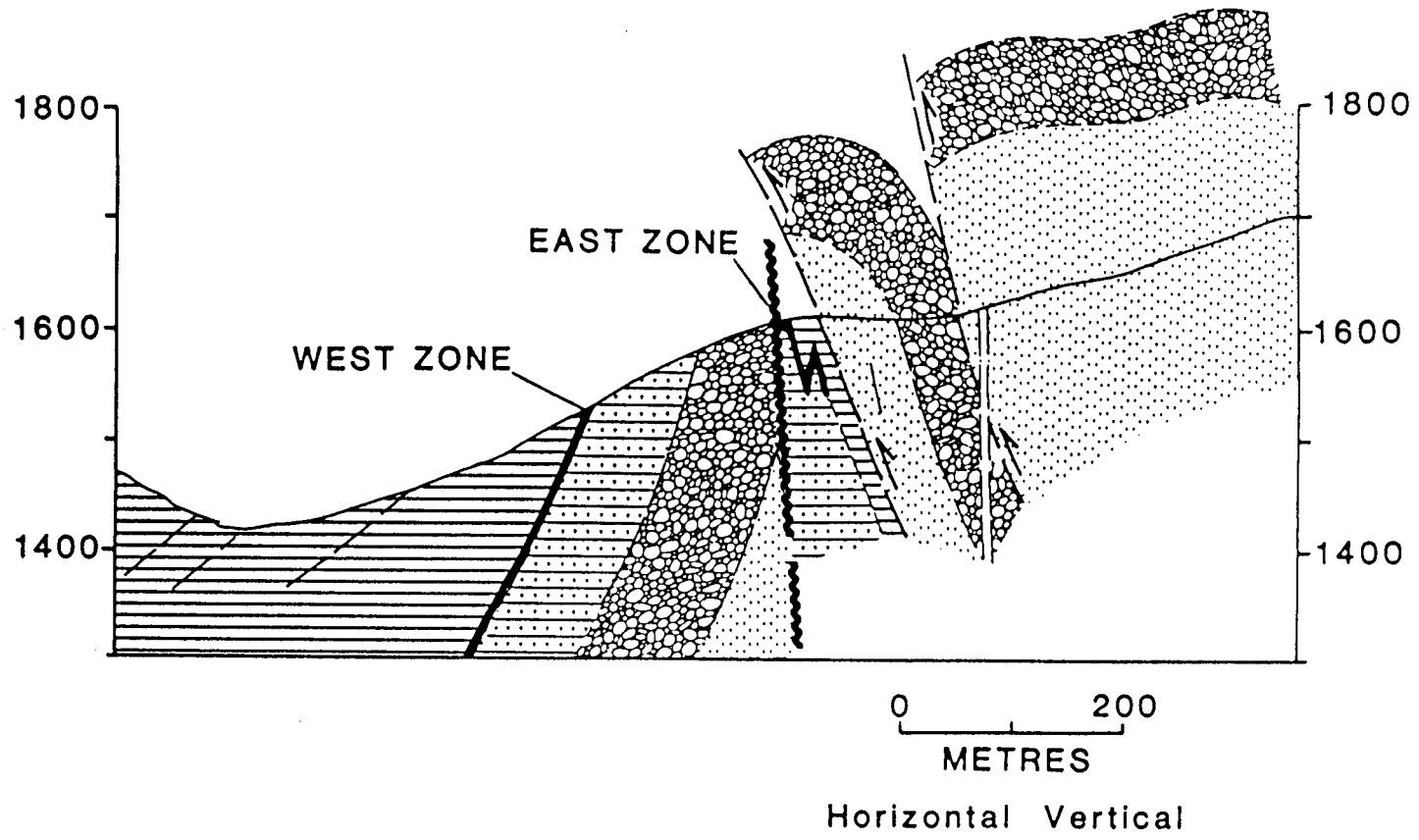



FIGURE 4

Figure 2.1-4

# TOM DEPOSIT SECTION C - D

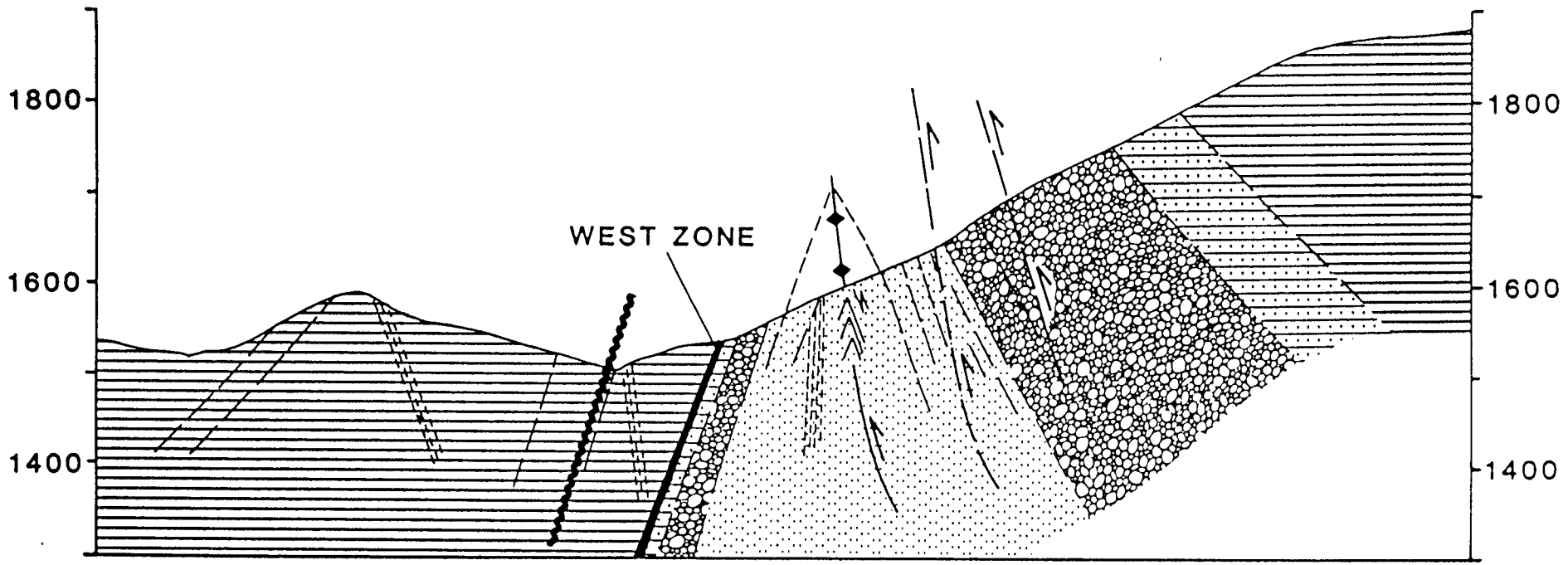



FIGURE 5

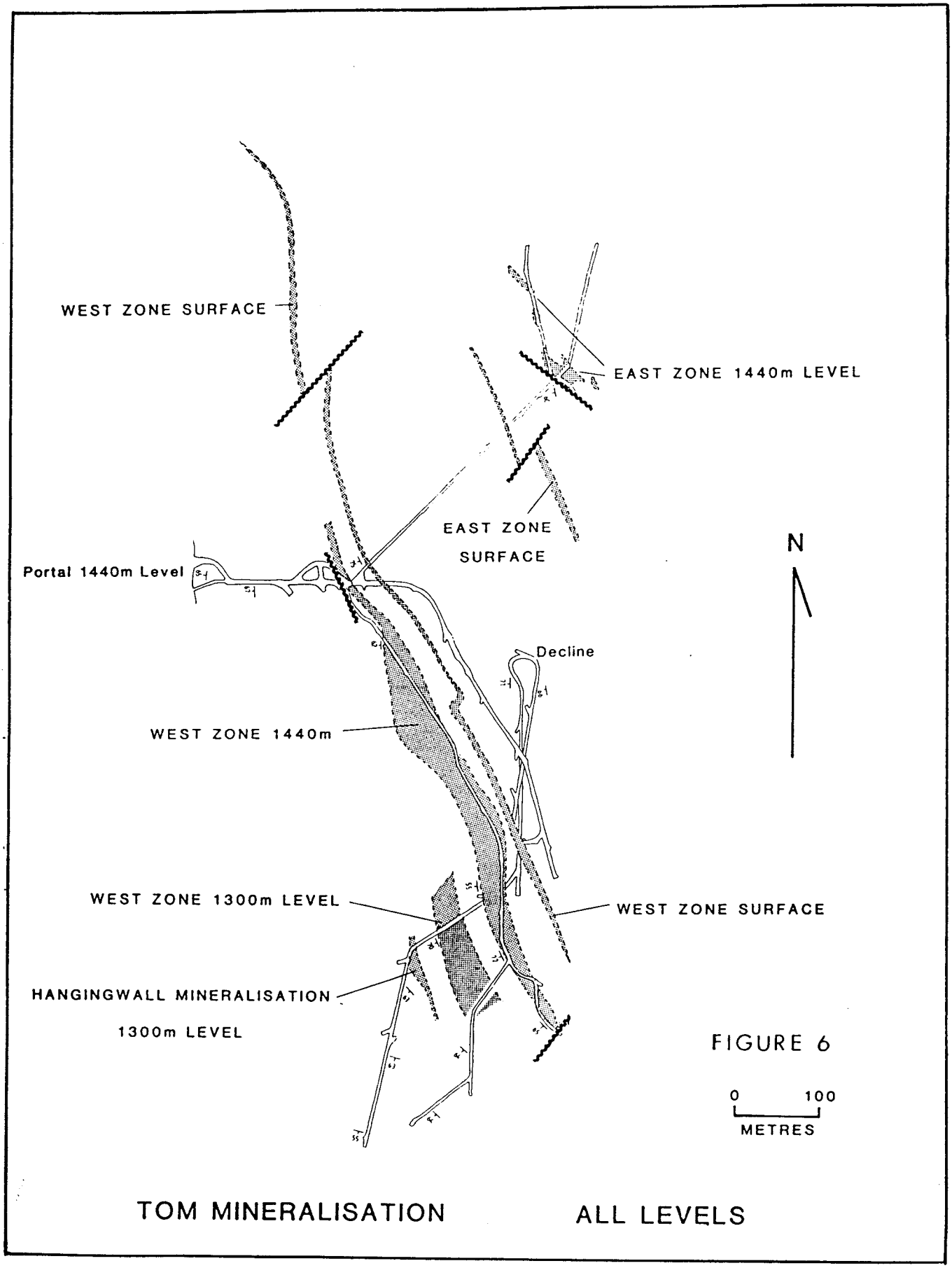
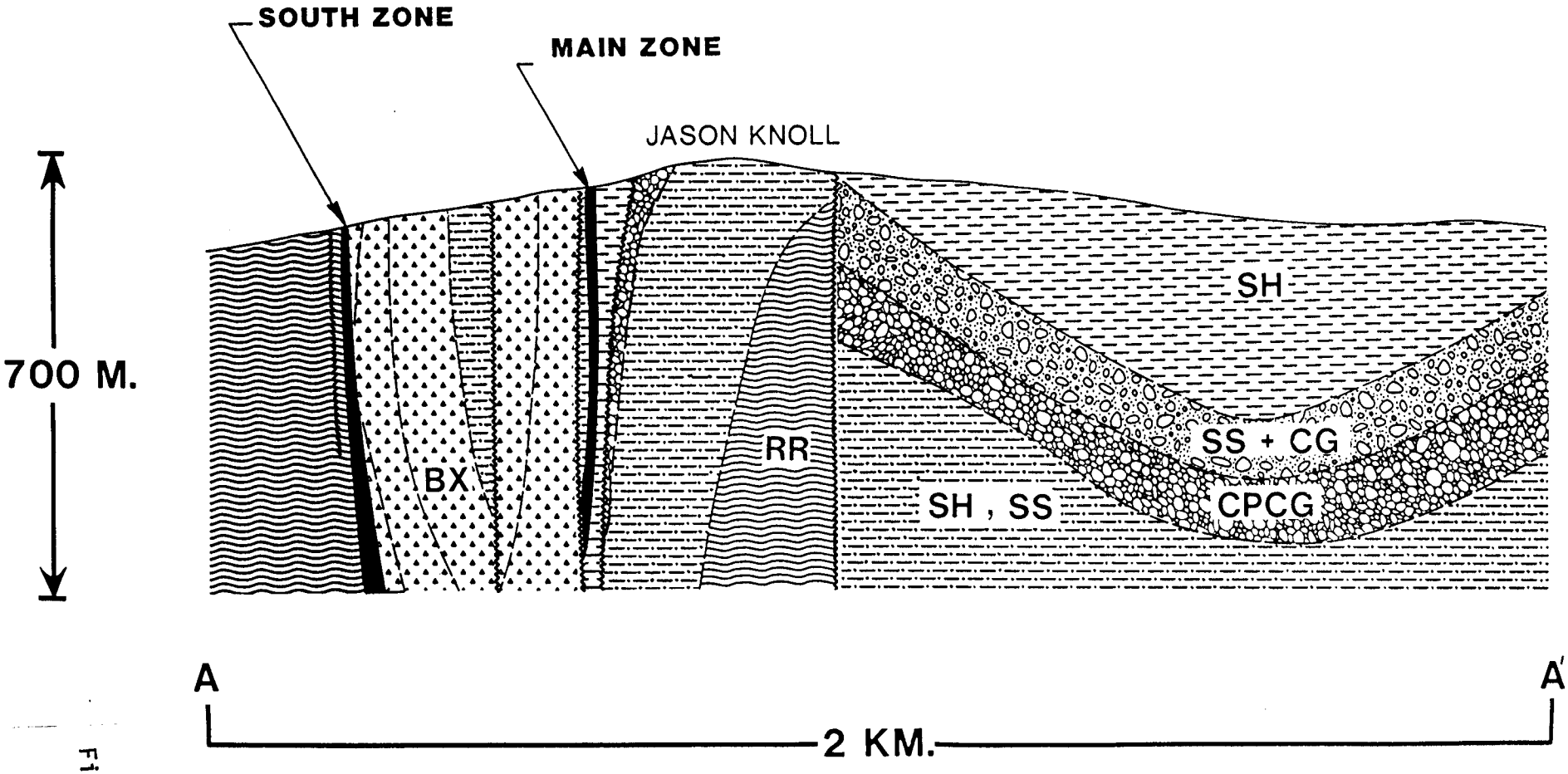

WEST ZONE SURFACE
EAST ZONE 1440m LEVEL
EAST ZONE
SURFACE
N
Portal 1440m Level
Decline
WEST ZONE 1440m
WEST ZONE 1300m LEVEL
WEST ZONE SURFACE
HANGINGWALL MINERALISATION
1300m LEVEL
FIGURE 6
0
100
METRES
TOM MINERALISATION
ALL LEVELS



Figure 2.1-6

UPPER EARN GROUP
Sandstone, siltstone, shale
LOWER EARN GROUP
Siliceous shale
Chert pebble conglomerate
Slump breccia
Shale, siltstone, sandstone
ROAD RIVER GROUP
Shale, limey mudstone, local volcanics
JASON MTN
END ZONE
MAIN ZONE
SOUTH ZONE
NIPPLE MTN
Macmillan
ROAD
CANOL
South
FIGURE 7
1 kilometre
JASON
LOCAL GEOLOGY

Figure 2.1-7




JASON STRUCTURAL CROSS SECTION THROUGH
THE MAIN & SOUTH ZONES LOOKING WEST
SECTION A A' ON FIGURE 7

FIGURE 8

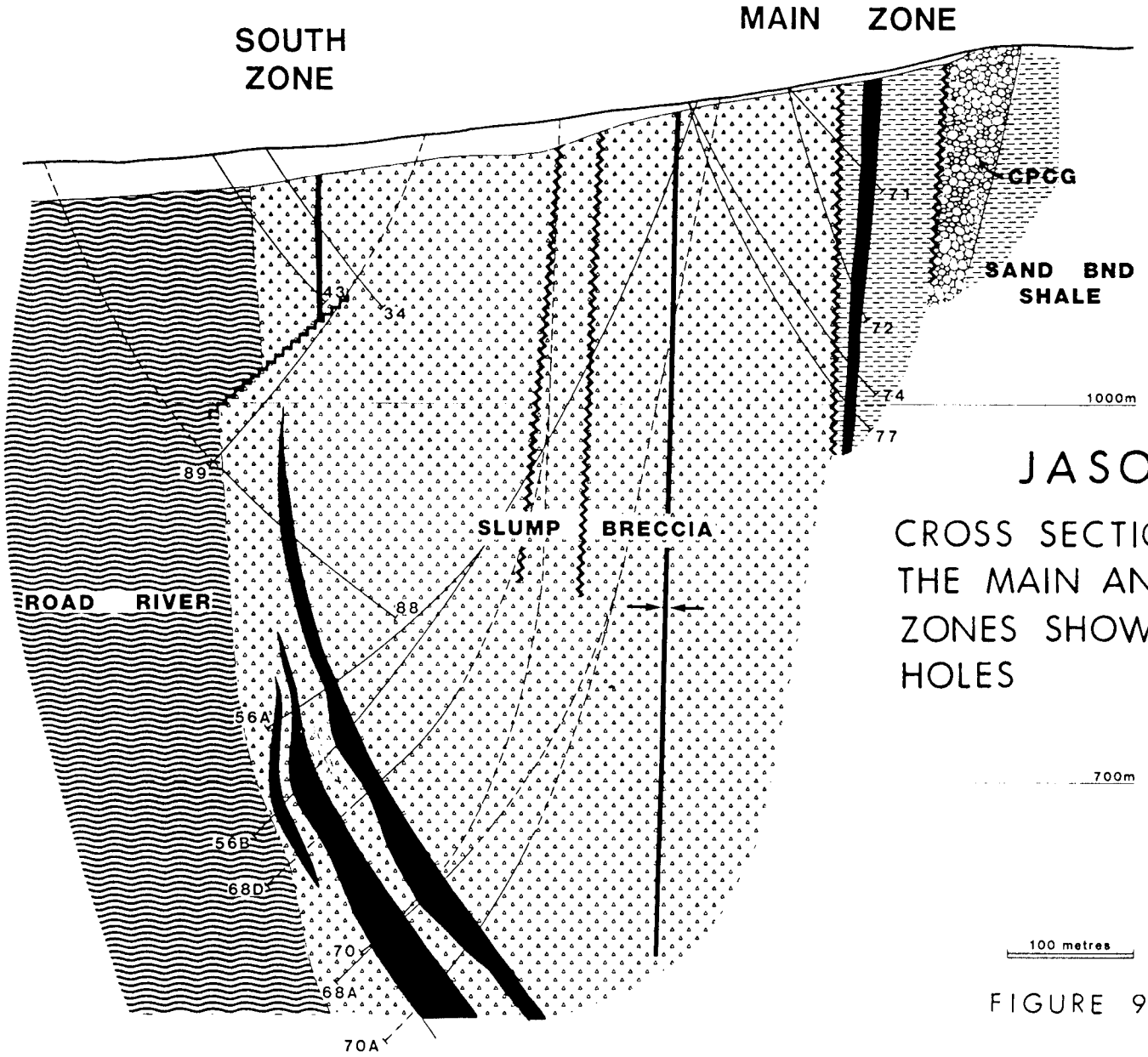

SOUTH ZONE
MAIN ZONE
CPCG
SAND BND SHALE
1000m
JASON
CROSS SECTION THROUGH THE MAIN AND SOUTH ZONES SHOWING DRILL HOLES
700m
100 metres
FIGURE 9
SLUMP BRECCIA
ROAD RIVER
43
34
71
72
74
77
89
88
56A
56B
68D
70
68A
70A

Figure 2.1-9

The sulphide facies is highly variable, massive to banded and contains varying amounts of sulphides, iron-rich carbonate, barite and quartz. Sulphide minerals are relatively coarse grained (commonly 500-1000 um) and consist of galena, sphalerite, pyrite, pyrrhotite, chalcopyrite and tetrahedrite. Gangue minerals include quartz, barite, ankerite, siderite, kaolinite and illite. The sulphide facies provides the bulk of the high grade, silver-rich tonnage in the Tom East Zone, the south portion of the Tom West Zone and east portion of the Jason South Zone.

The chert-barite facies is the most extensive and thickest facies in the Tom West Zone, the Jason South Zone and it comprises about 50% of the Jason Main Zone; it is absent in the Tom East Zone and the Jason End Zone. The facies is characterized by interbeds of chert and barite containing well defined layers of disseminated, fine grained, predominantly iron-poor sphalerite with minor galena, pyrite and pyrrhotite. Individual laminae are parallel to mildly convoluted and are locally interbedded with argillite.

Ore reserve calculations were carried out by determining areas of influence around diamond drill hole intercepts on longitudinal sections constructed on the various ore lenses. Areas of influence were calculated by measuring the areas of polygons around each drill hole piercement point. The polygons were constructed by connecting the internal perpendicular bisectrices of lines joining adjacent drill holes. The areas of influence around drill intercepts of the various zones are shown on Figures 10 to 17.

Table 2.1-1 summarizes the geological reserves on both the Jason and Tom Properties. A total of 21.9 million tons of proven, probable and possible ore grading 6.91% lead, 7.76% zinc and 2.29 opt silver has been delineated.

### 2.1.2 TOM WEST ZONE

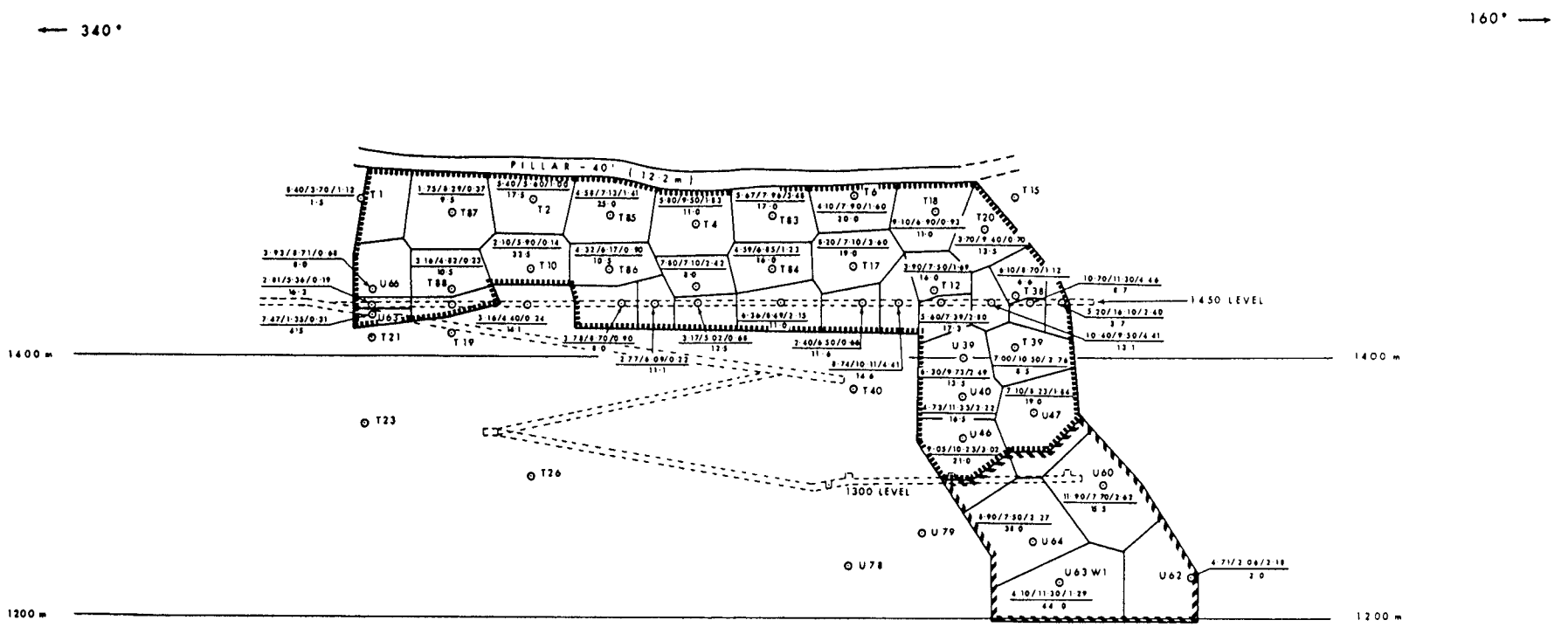
The Tom West Zone is a slightly folded tabular body dipping 70° to the west (Figures 4 and 5). It is up to 41 metres thick (averages about 24 metres), 600 metres long and extends from surface to 360 metres down dip where it is open (Figures 10 and 11). The Tom West Zone conformably overlies pyritic sand banded shale and is conformably overlain by laminated cherty shale. The zone contains two principal facies: a sulphide facies at its southern end which is higher grade and presumed to be proximal to the source of hydrothermal fluids, and a more distal, lower grade baritic facies which comprises the majority of the mineralization.

The sulphide facies consists of massive sulphides at the base overlain by laminated sulphides. The basal section is massive to poorly laminated anhedral galena and sphalerite of variable grain size, commonly 500-1000 um, with subordinate barite. Small euhedral pyrite grains occur as a minor phase. Stratigraphically higher in the sulphide facies the grain size decreases (200-400 um) and barite becomes more abundant. The stratigraphic top of the sulphide facies of the West Zone consists of laminated chert with thin laminae of sphalerite, minor fine grained galena and laminae of spheriodal pyrite.

## TOM AND JASON
## GEOLOGICAL RESERVES

| Zone | TONNAGE (Short Tons) Proven | Probable | Possible | Grade % Pb | % Zn | opt Ag |
|---|---|---|---|---|---|---|
| | | **TOM** | | | | |
| TOM EAST | 2,576,217 | | | 12.80 | 9.68 | 4.88 |
| TOM WEST | | | | | | |
| Footwall | 3,764,523 | | | 5.38 | 7.78 | 1.72 |
| | | 2,008,010 | | 7.26 | 9.20 | 1.94 |
| Hanging wall | 1,030,730 | | | 1.74 | 7.69 | 0.10 |
| | | 507,916 | | 0.96 | 7.22 | 0.03 |
| TOM TOTAL | 9,887,396 | | | 7.09 | 8.53 | 2.33 |
| | | **JASON** | | | | |
| JASON SOUTH | | | | | | |
| Upper Lens | | 4,255,771 | | 10.40 | 6.66 | 4.71 |
| Middle Lens | | | 1,859,457 | 10.04 | 2.27 | 2.28 |
| Lower Lens | | | 245,209 | 5.82 | 8.67 | 3.74 |
| JASON MAIN | | 5,011,516 | | 2.08 | 9.75 | 0.06 |
| JASON END | | | 605,619 | 10.30 | 2.78 | 2.34 |
| JASON TOTAL | 11,977,572 | | | 6.76 | 7.12 | 2.25 |
| | | **COMBINED** | | | | |
| TOTALS | | | | | | |
| Proven | 7,371,470 | | | 7.46 | 8.43 | 2.60 |
| Probable | | 11,863,213 | | 5.92 | 8.44 | 2.06 |
| Possible | | | 2,710,285 | 9.72 | 2.96 | 2.43 |
| GRAND TOTAL | 21,864,968 tons | | | 6.91 | 7.76 | 2.29 |

TABLE 2.1-1




LEGEND

Proven Ore Outline

Probable Ore Outline

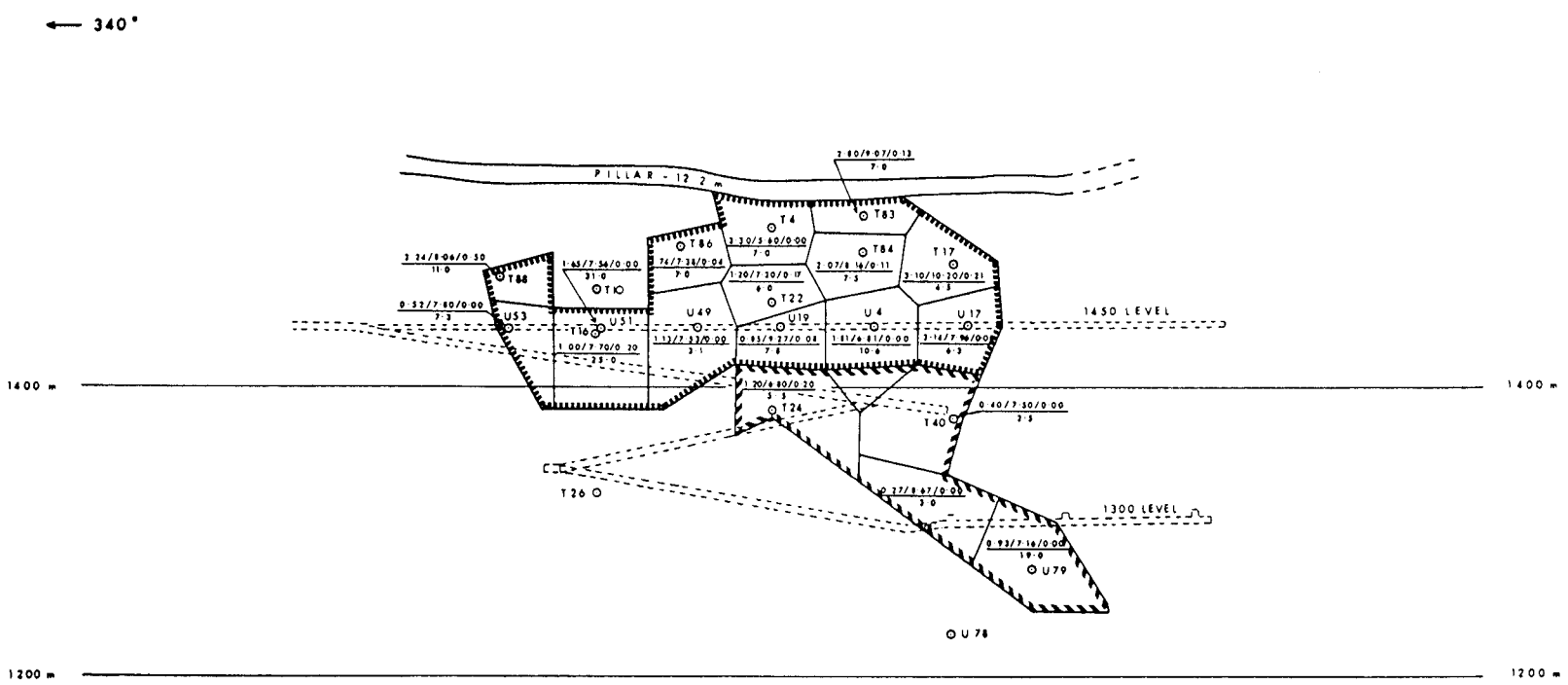
T 39 — Drill Hole Intercept and Number

7·00/10·30/2·76 / 8·5 — % Pb / % Zn / oz/t Ag / Horizontal Width in Metres

FIG. 10

VERTICAL LONGITUDINAL SECTION
WEST ZONE - FOOTWALL
TOM VALLEY PROJECT

| DATE | SCALE | NTS | DWG. NO. |
|---|---|---|---|
| FEB. 1986. | | | |




LEGEND

- Proven Ore Outline
- Probable Ore Outline
- ⊙ T 17 — Drill Hole Intercept and Number
- 0.93/7.16/0.20 / 8.5 — % Pb / % Zn / oz/t Ag; Horizontal Width in Metres
- ▭ — Drift

0 50 100 150 200 m

FIG. 11

VERTICAL LONGITUDINAL SECTION
WEST ZONE - HANGING WALL
TOM VALLEY PROJECT

| DATE | SCALE | NTS | DWG. NO. |
|---|---|---|---|
| FEB. 1986. | | | |

The chert-barite facies comprises the bulk of the Tom West Zone mineralization. Barite is the dominant mineral; chert is abundant at the stratigraphic base and top of the zone. Barite generally occurs as equant grains up to 150 um in size either in monomineralic bands or with galena and sphalerite grains. Where folded, the barite commonly exhibits a preferred shape orientation axial planar to the folds. Galena (50-250 um) occurs as isolated grains or patches in a baritic matrix or rarely as monogranular laminae. Sphalerite is generally pale honey coloured and shows a similar distribution to galena but occurs more frequently as monomineralic layers. Minor euhedral grains of pyrite are commonly associated with chert layers. Witherite is commonly found associated with chert layers, particularly towards the stratigraphic top of the West Zone. It is dominantly interstitial to the quartz and chalcedonic spheriods of the chert. Large idioblastic celsian crystals which overgrow and displace the bedding fabric are spectacularly developed in the baritic facies. At the stratigraphic top of the chert-barite facies pyrite occurs in chert layers. The pyrite occurs principally as small (<60 um) spheroids commonly displaying radial and concentric zoning with incorporated sphalerite and galena. These textures, together with the large celsian crystals attest to significant diagenetic growth of both sulphide and silicate phases.

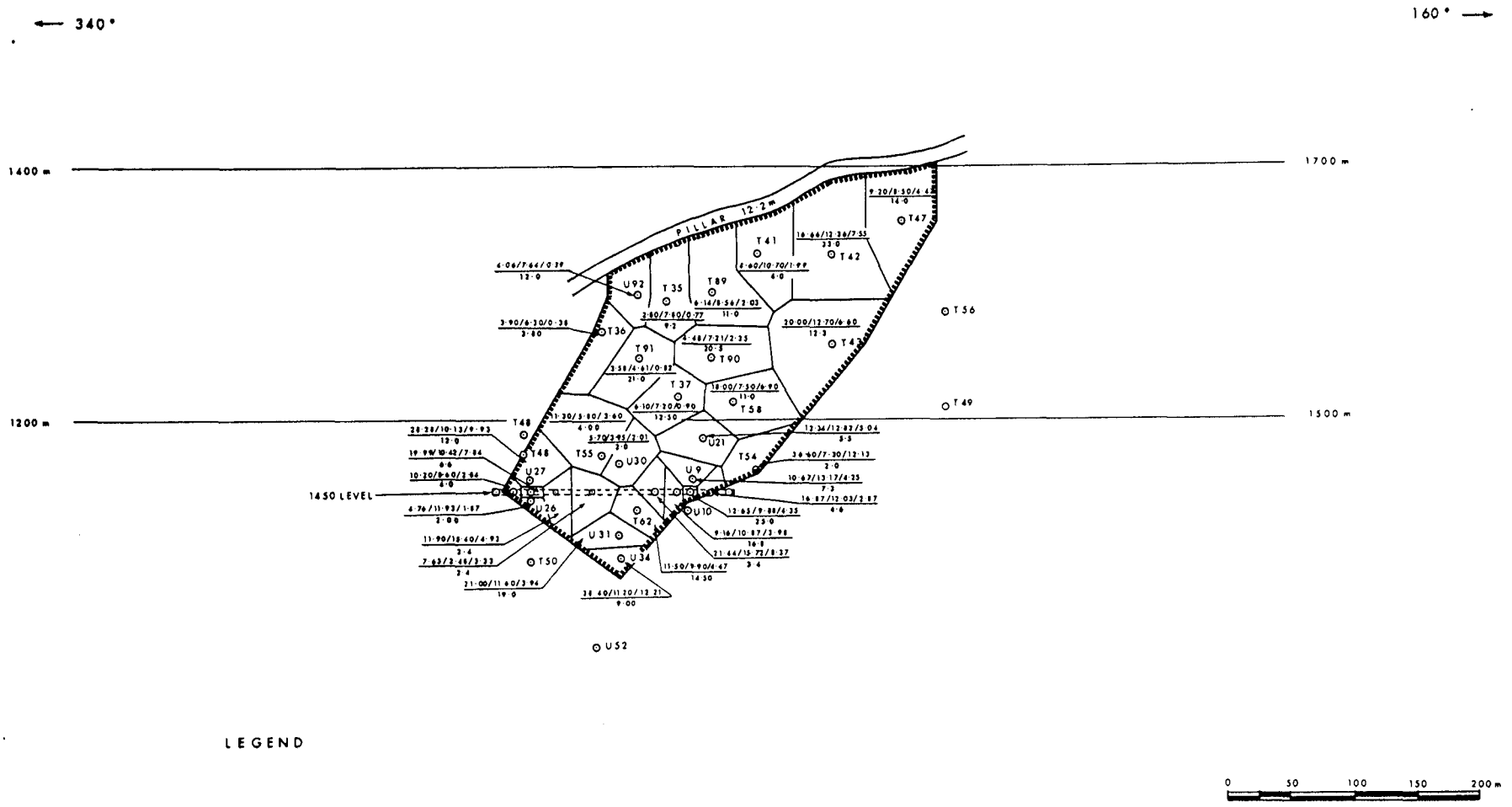
The Tom West Zone has been tested by 49 drill holes and about 550 metres of underground workings. The reserves are summarized in Table 2.1-1. In view of the apparent geological continuity and persistent distribution of metal values in the West Zone, the reserves are classified as proven where the distance between piercement points of intercepts of acceptable width and grade is 60 metres or less and probable where the

distance is 60 to 90 metres. A cut-off grade of 7% lead plus zinc has been used in the West Zone. In the high grade (proximal), southern portion of the West zone, the metal values are generally well above cut-off and the zinc to lead ratio is about 1:1. Further to the north, lead values are markedly lower while zinc values gradually decrease. This results in zinc/lead ratios of approximately 3.5:1 at the 7% cut-off boundary. The northern portion of the West Zone has higher grade values concentrated near the hanging wall and footwall contacts separated by a lower grade section which generally grades 3-4% zinc and minor lead. As a result, separate tonnages have been calculated for the footwall and hanging wall portions of the West Zone (Figures 10 and 11). The lower grade section has been included in the reserve when it would be impractical to leave it behind during mining.

### 2.1.3 TOM EAST ZONE

The Tom East Zone is a series of intensely contorted, fault bounded pods of high grade laminated barite, chert, sphalerite and galena. The East Zone is in the structurally complex core of the anticline where it is in fault contact with sand banded shale and chert pebble conglomerate (Figures 3, 4, and 6). The zone has a strike length of 325 metres and dips vertically. Drilling on the 1,450 level has cut off mineralization at depth. The East Zone has an average width of about 10 metres and has been tested by 32 diamond drill holes and about 140 metres of lateral development on the 1,450 level (Figures 6 and 12).

East Zone mineralization consists of laminae and bands of barite, sulphides and chert which are highly folded and contorted. The barite occurs as fine to medium, equant to




LEGEND

Proven Ore Outline

T 17 — Drill Hole Intercept and Number

38·40/11·20/12·21 / 9·0 — % Pb / % Zn / oz/t Ag; Horizontal Width in Metres

Drift

FIG. 12

VERTICAL LONGITUDINAL SECTION
EAST ZONE
TOM VALLEY PROJECT

| DATE | SCALE | NTS | DWG. NO. |
|---|---|---|---|
| FEB. 1986. | | | |



Figure 2.1-12

elongate grains either in monomineralic bands or with interstitial galena and sphalerite. Galena varies in size from 50 um interstitial grains in a baritic matrix to coarse recrystallized masses in monomineralic bands or remobilized into fractures. Sphalerite occurs as pale honey coloured to vermillion coloured fine grains (<100 um) in monomineralic bands and laminae, or as isolated anhedral grains in a baritic matrix. Pyrite occurs as variably sized (up to 500 um) euhedral grains or as small (<30 um) spheroidal clusters.

The same parameters were used to classify ore reserves as those used in the Tom West Zone resulting in the delineation of 2.6 million tons of high grade proven reserves (Table 2.1-1) with a zinc to lead ratio of about 0.7:1.

### 2.1.4 JASON SOUTH ZONE

The Jason South Zone consists of a series of up to three moderately folded tabular bodies with a maximum strike length of 400 metres and a down dip extension of 600 metres. It dips about 85° north near surface but flattens to about 60°N at depth (Figure 9). True thickness varies from less than 2 metres near surface to over 50 metres in multiple zones at depth. The South Zone has been intersected by 18 drill holes at a spacing of roughly 100 metres. It is open in all directions except near surface where it has been tested along strike. The South Zone consists of a high grade proximal massive sulphide facies and a lower grade chert-barite facies; both similar in many respects to the facies described above for the Tom West Zone. It is hosted by a series of slumped shales.

The massive sulphide facies occurs on the east side of the South Zone (Figure 13). It is texturally variable but in general is massive to banded in character and contains varying amounts of sulphides, iron-rich carbonates and quartz. Sulphide minerals are relatively coarse grained and include galena, iron-rich sphalerite, pyrite, pyrrhotite and minor chalcopyrite. The only silver-bearing mineral which has been positively identified is tetrahedrite. The massive sulphide facies is rich in lead and silver and contains the highest grade minerlization in the South Zone. The facies is underlain by a cross-cutting footwall alteration zone. Rocks within this alteration zone are silicified and carbonatized and are cut by a stockwork of quartz, siderite, ankerite, pyrite, sphalerite, galena, pyrrhotite and chalcopyrite.

The chert-barite facies, on the west side of the South Zone, is more extensive and thicker than the sulphide facies. The chert-barite facies is characterized by interbeds of chert and barite containing well laminated layers of disseminated, predominantly iron-poor sphalerite with minor galena, pyrite and pyrrhotite. These sulphide minerals are relatively fine grained. Thin argillite interbeds occur locally in this facies. The chert-barite facies is zinc-rich, poor in silver and generally lower in grade than the massive sulphide facies.

The three tabular lenses which comprise the South Zone are referred to as the upper, middle and lower lenses (Figure 9). Varying thicknesses of barren sedimentary rock separate the three lenses. The upper lens of the South Zone is the best developed lens in the drill tested area (Figure 13). The lower two lenses are developed at depth but are absent near surface (Figures 14 and 15).

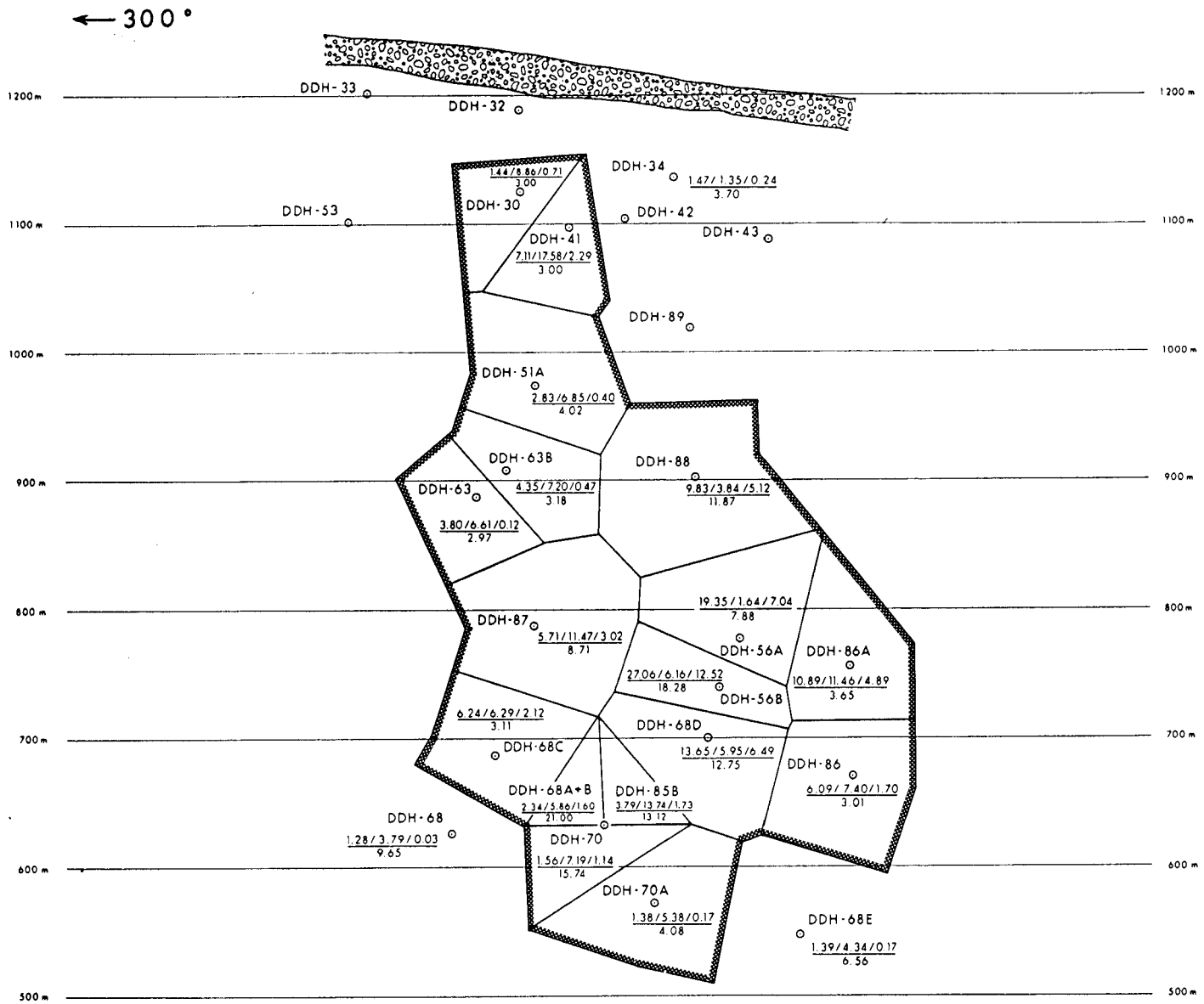



FIG. 13

ABERFORD RESOURCES LTD.

SOUTH ZONE
UPPER LENS

JASON PROJECT,

| DATE | SCALE | NTS | DWG. NO. |
|---|---|---|---|
| Sept. 1985 | | 105 O/1 | |



Figure 2.1-13

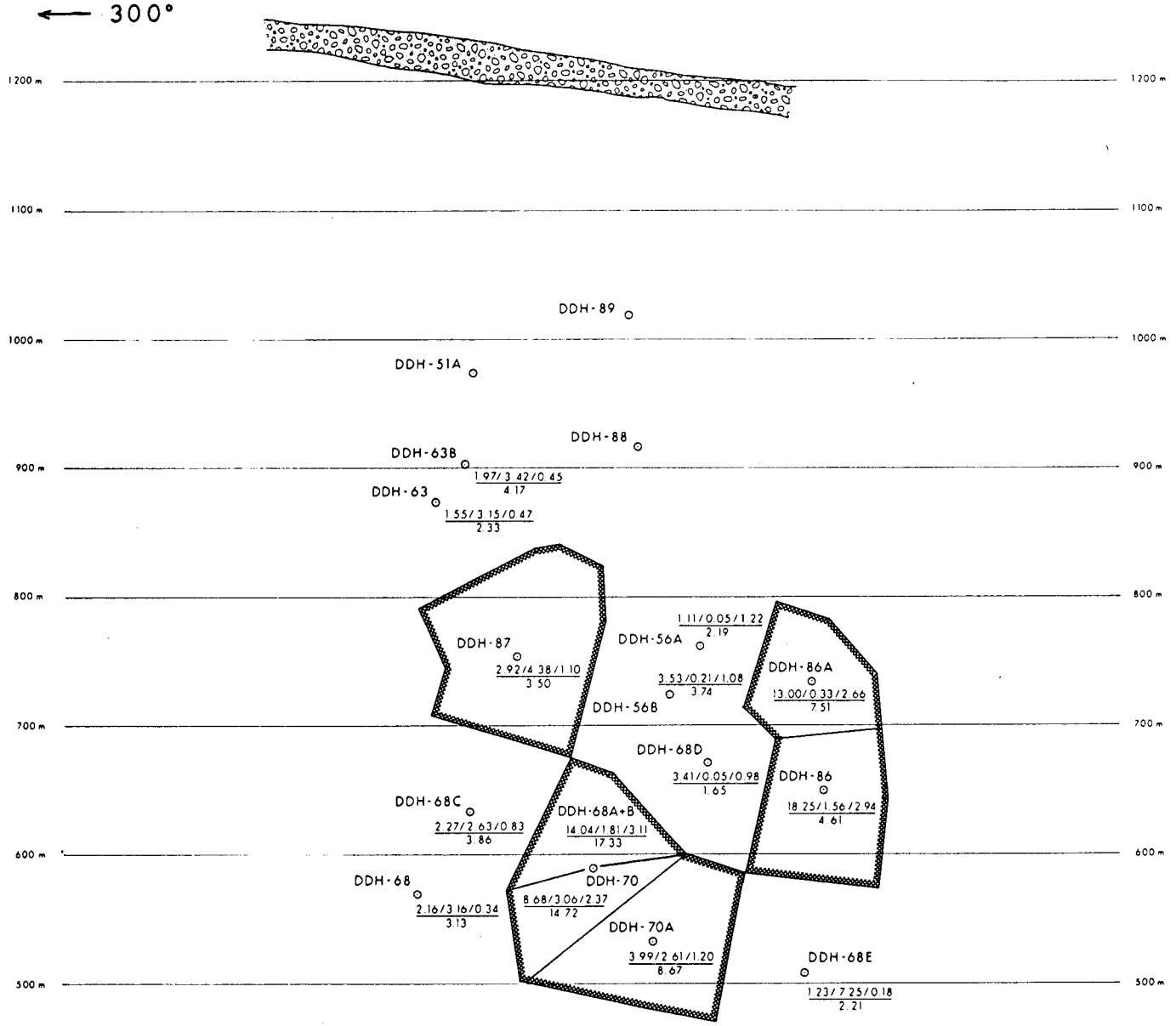



FIG. 14

ABERFORD RESOURCES LTD.

SOUTH ZONE
MIDDLE LENS

JASON PROJECT,

| DATE | SCALE | NTS | DWG. NO. |
|---|---|---|---|
| Sept. 1985 | | 105 O/1 | |



Figure 2.1-14

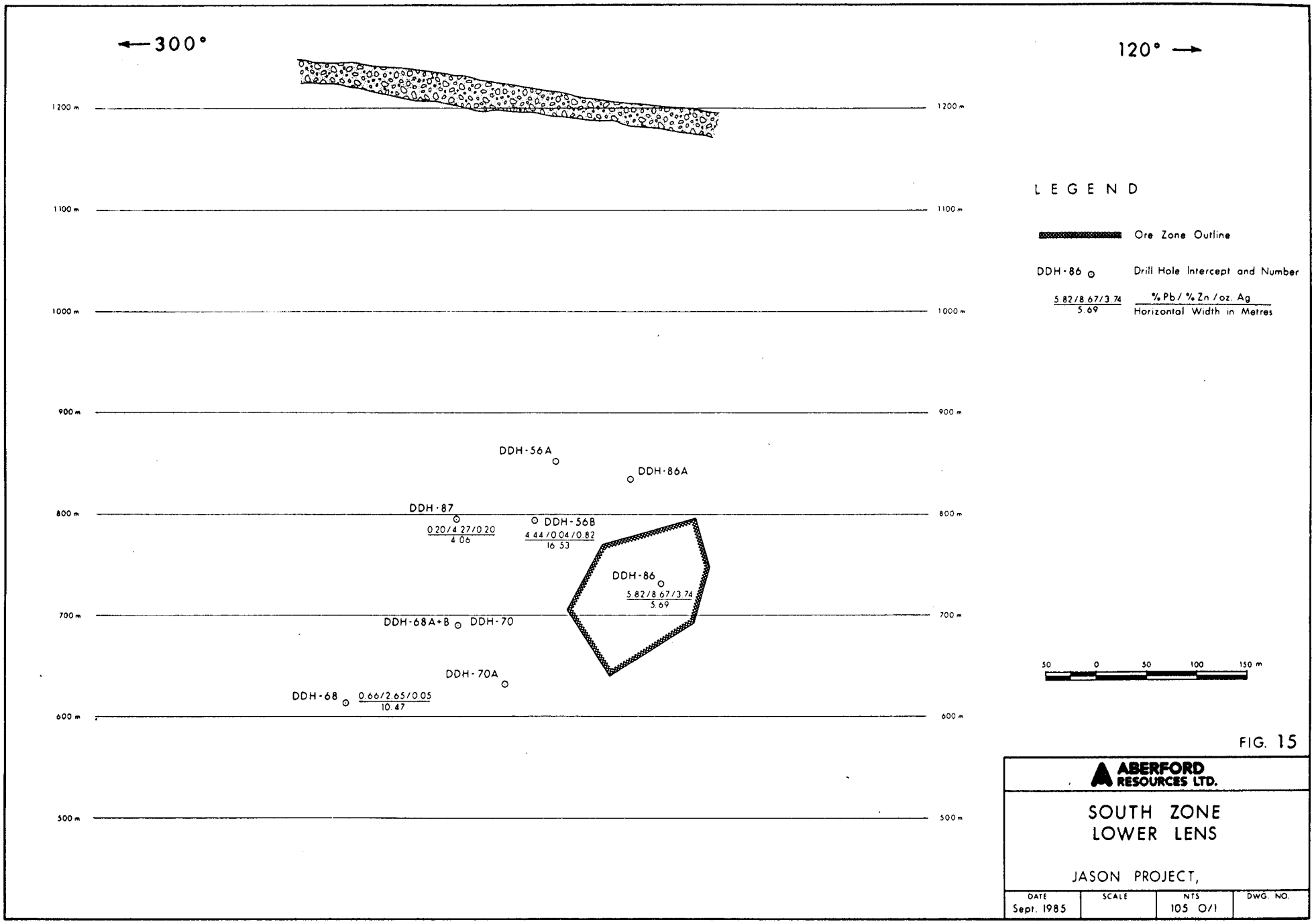



FIG. 15

ABERFORD RESOURCES LTD.

SOUTH ZONE
LOWER LENS

JASON PROJECT,

| DATE | SCALE | NTS | DWG. NO. |
|---|---|---|---|
| Sept. 1985 | | 105 O/1 | |



Figure 2.1-15

In the South Zone, a cut-off grade of 8% Pb + Zn equivalent over a true width of 3 metres was used, Holt (1979). Seventeen drill intercepts through the upper lens exceed the minimum grade requirements; six holes through the deeper, portion of the middle lens are ore grade; and one drill hole through the deepest, most easterly portion of the lower South Zone lens satisfies the grade requirements. Potential for additional ore grade material at depth in the middle and lower lenses is considered to be excellent. The breakdown in tonnage estimates for the South Zone is shown in Table 2.1-1.

The average distance between drill holes cutting the South Zone long section is 90 metres. The tonnage in the upper lens, which has good grade continuity and is well bedded, is classified as Probable. The middle and lower lenses are geologically continuous but have poorer grade continuity than the upper lens and the tonnage defined by them is therefore classified as Possible.

### 2.1.5 JASON MAIN ZONE

The Jason Main Zone is a tabular body which dips 85° south and is roughly 700 metres in strike length by 500 metres down dip. It varies in thickness from 3 to 18 metres, averaging about 8 metres and is thickest near the surface. It is hosted by sand banded shale within a fault bounded block. The Main Zone is comprised of chert-barite facies similar to that found in the Jason South Zone and the Tom West Zone and a chert facies which is slightly higher in grade and is unique to the Main Zone.

The chert facies which occurs at the east end of the Main Zone comprises most of the "ore grade" portion of this zone. It is texturally similar to the chert-barite facies but contains only minor barite. The chert facies is cut by numerous bedding plane faults and has a punky character. It grades about 5% higher in lead plus zinc than the Main Zone chert-barite facies.

The higher grade portion of the Main Zone is relatively uniform in metal values averaging between 10 and 13% lead plus zinc with a Zn:Pb ratio of about 5:1. A cut-off grade of 8% Pb+Zn over a true width of 3 metres was used for determining intervals to be included in the tonnage calculations. Fifteen drill intercepts through the higher grade chert facies of the Main Zone exceed the cut-off grade (Figure 16). The tonnage defined by this area of the Main Zone is summarized in Table 2.1-1.

The Main Zone has been tested by 30 diamond drill holes and is open along strike to the east and west (Figure 16). The average distance between adjacent drill holes in this area is 95 metres. Due to the continuous, uniform, well bedded nature of the Main Zone mineralization, the tonnage is classified as Probable.

### 2.1.6 JASON END ZONE

The Jason End Zone is a tabular galena-rich massive sulphide lens which dips at about 85° to the north and has been traced for 150 metres on surface by trenching and to a depth of 150 metres by diamond drilling. It varies in thickness from less than one metre to about 11 metres (Figure 17). Testing of this zone has been limited to 4 diamond drill

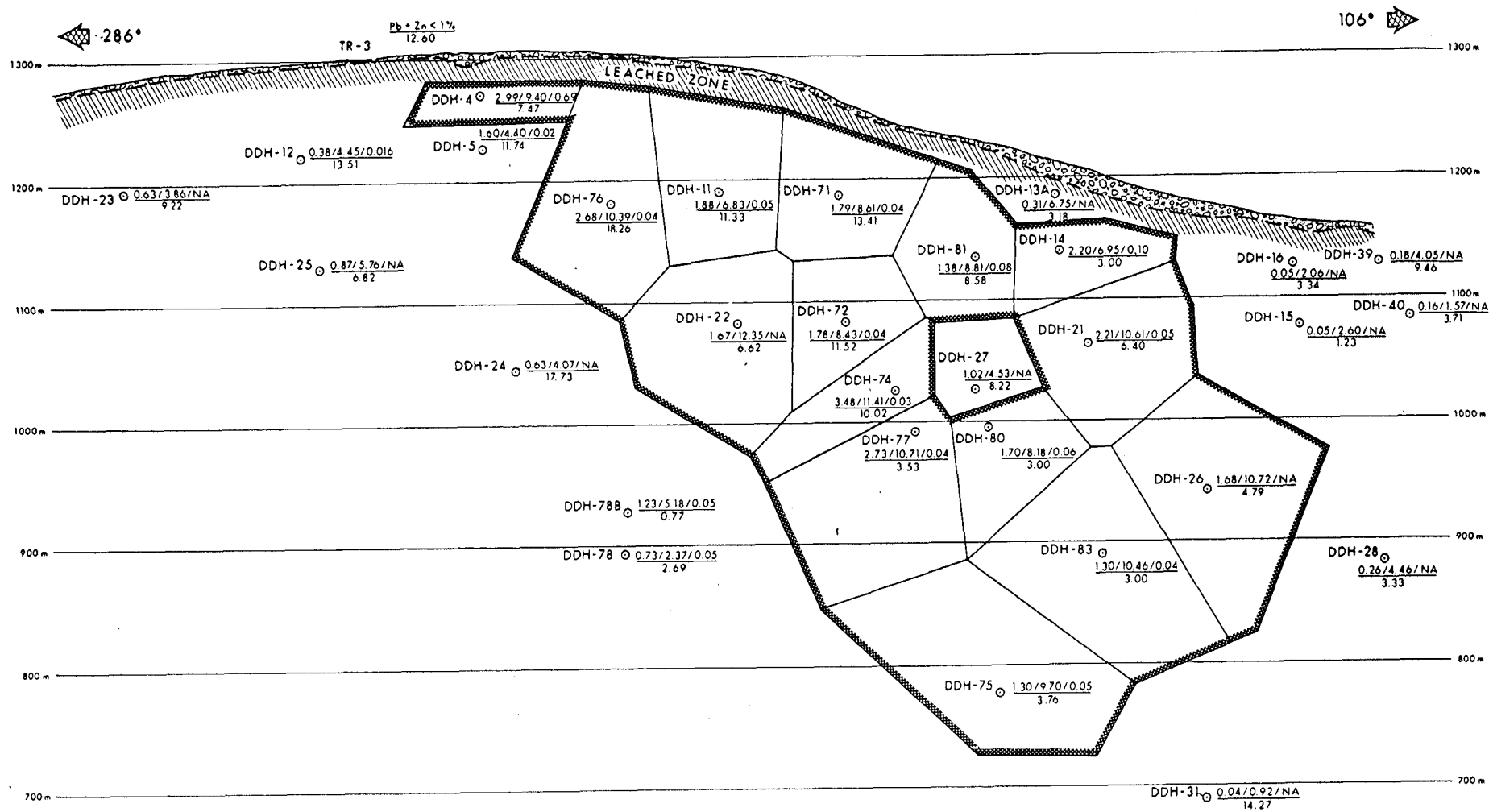



FIG. 16

Figure 2.1-16

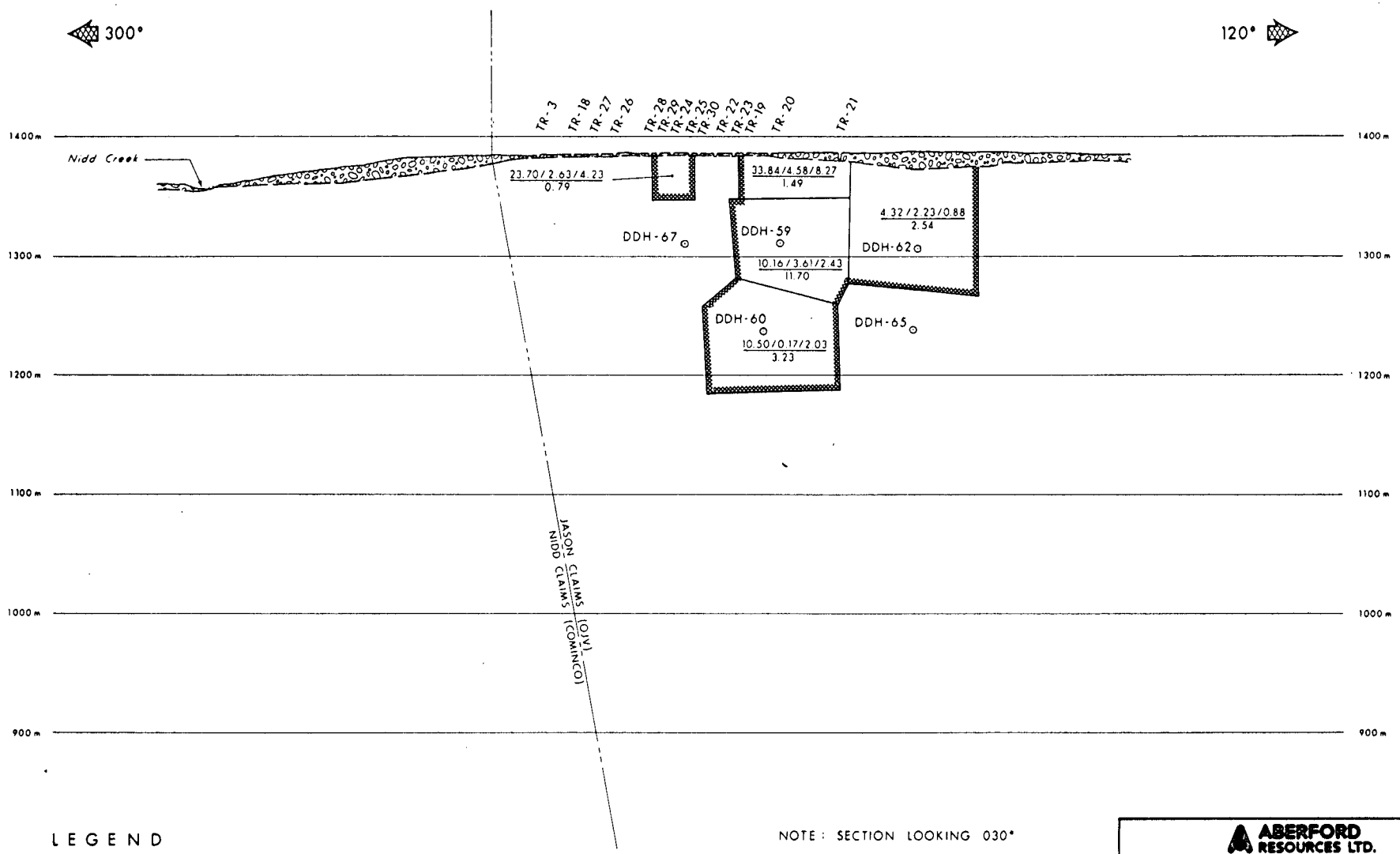



FIG. 17

LEGEND

Ore Zone Outline

DDH-62 ⊙ 4.32/2.23/0.88 / 2.54 — Drill Hole Intercept and Number; % Pb / % Zn / oz. Ag; Horizontal Width in Metres

NOTE: SECTION LOOKING 030°

50 0 50 100 150 m

ABERFORD RESOURCES LTD.

# LONGITUDINAL SECTION END ZONE

JASON PROJECT,

| DATE | SCALE | NTS | DWG. NO. |
|---|---|---|---|
| Sept. 1985 | | 105 O/1 | |



Figure 2.1-17

holes and as a consequence it is open in all directions. The End Zone occurs in Lower Earn Group sandy and silty shales near their contact with the Road River Group.

The End Zone has a massive, poorly laminated character and poor geological continuity, and therefore the tonnage is classified as Possible. The tonnage calculations are summarized in Table 2.1-1.

### 2.1.7 POTENTIAL FOR ADDITIONAL RESERVES

The potential for the delineation of additional reserves at Tom and Jason is excellent. Of the five zones discovered to date, only two, the Tom East and the Jason Main, have been extensively drill tested along strike; the other three are open in at least one direction. In addition, the prospective package is poorly exposed and less than 50 percent of its strike length has been tested by reconnaissance diamond drilling. Further exploratory drilling will very likely result in the discovery of new zones in areas covered by overburden. Numerous promising targets defined by geology, geochemistry and geophysics remain to be tested.

In the Tom West Zone, at the southern end, potential exists for an estimated four million tons of ore between the 900 and 1,200 metre levels in the main ore shoot (Figure 10). This area could be tested from underground drilling stations on the existing hangingwall development on the 1300 metre level. The Tom East Zone is cut off by faults and although the area to the north of the East Zone has been tested extensively, potential does exist for the discovery of additional fault bounded blocks, especially to the south (Figure 12).

At Jason, The South Zone has excellent potential to provide additional reserves. The South Zone has been tested along strike near surface without success (Figure 13) but it is open at depth in all directions. This potential should be investigated from underground drill stations rather than surface. The End Zone has only been tested by five diamond drill holes. Systematic drilling both along strike and at depth is warranted. The Main Zone is a less promising target for additional reserves because it is "cut off" in all directions by low grade intercepts. However, it is geologically open in all directions and could provide additional ore reserves if the grade increases again along strike.

## 2.2 MINING

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2.2.1 SUMMARY

2.2.2 MINING METHODS
- .1 Vertical Crater Retreat
- .2 Sublevel Retreat Mining

2.2.3 TOM MINE DESIGN
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- .2 Ventilation
- .3 Drainage
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2.2.4 JASON SOUTH ZONE MINE DESIGN
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2.2.5 JASON MAIN ZONE MINE DESIGN
- .1 Mine Layout
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- .3 Drainage
- .4 Facilities and Service
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2.2.6 PRODUCTION SCHEDULE

Table 2.2-1 Tom/Jason Mining Schedule

## 2.2 MINING

### 2.2.1 SUMMARY

All mining at Tom and Jason will utilize high productivity trackless underground mining methods. The Tom orebodies and the Jason South Zone orebody will be mined by the vertical crater retreat system without backfilling. Poorer ground conditions in the Jason Main Zone will require backfilling and sublevel retreat mining will be employed with fill provided from borrow pits.

All crushing will be done underground. Tom ore will be conveyed to the concentrator through an adit serving as the main mine access. The Jason South Zone will be serviced by a shaft and access to the Jason Main Zone will be by decline. All Jason ore will be truck hauled 5 km to the concentrator.

Major surface facilities will be centralized at the concentrator/power plant/service complex with services and facilities provided at the individual mine sites kept to a minimum. Care has been taken to ensure adequate provision for mine drainage and ventilation.

Production will commence from the Tom East orebody in Project Year 2 and full annual production of 1,575,000 tons will be attained in Year 3.

## 2.2.2 MINING METHODS

### .1 Vertical Crater Retreat Mining

The Tom and Jason South orebodies will be mined by the vertical crater retreat (VCR) mining method. Despite requiring a considerable amount of preproduction development, this mining system is very cost effective as the open stoping production mining is both low cost and safe. Avantages inherent in the VCR system are:

- Breaking can proceed well ahead of extraction so the production rate can easily be maintained.
- The stope can be kept full of broken ore thus minimizing wall sloughing and dilution.
- Good fragmentation is achieved thus reducing secondary blasting.
- No backfill is required.

The orebody is divided into 30 metre long stopes extending from footwall to hangingwall and separted by 15 metre pillars. A footwall drift driven 15 metres from the ore provides access to drawpoints at 10 metre intervals along the stope length. The stope is completely undercut at the drawpoint level and the back taken down to an 8 metre height.

Drill sublevels are driven at 40 metre vertical intervals and slashed out from footwall to hangingwall. From these sublevels a 3 metre x 3 metre pattern of 6 1/2" parallel subvertical blastholes are drilled to the opening below. Blasting is done with high density slurry explosive and each blast breaks off the bottom 2.5 metres of ore in the stope. Scooptraus load the ore at the stope bottom drawpoints and then transport it to a crushing station orepass.

.2 Sublevel Retreat Mining

Extensive faulting in the Jason Main Zone will necessitate a mining system employing fill to ensure adequate ground support. Sublevel retreat mining was selected as it is productive, well suited to the 10 metre average ore width and borrow pits to provide fill can be readily established nearby.

Drifts are driven the full length of the ore at 15 metre vertical intervals and slots cut at the extremities. The ground between drifts is drilled with 2 inch upholes and broken while retreating to the entry cross cut. As blasting and mucking proceeds, the void is filled with coarse waste which is passed down the fill raise and placed in the stope by scooptram.

Mining proceeds from the top down. The sequence, level by level, is development, drilling, blasting, mucking and filling. Several levels can be in production at the same time by keeping each upper level ahead of the one below.

Development and mining will be highly mechanized and very productive. Development will be predominantly with hydraulic jumbos, 3-1/2 or 5 $yd^3$ scooptrams, and 13 or 27 ton trucks. Production will depend on hydraulic drill wagons, 5 $yd^3$ scooptrams and 27 ton trucks. Auxiliary equipment includes Anfo trucks, roof bolter and grader.

## 2.2.3 TOM MINE DESIGN

### .1 Mine Layout

The Tom orebodies are located in a mountain east of the Macmillan River Valley. Access for mining will be via a 10' x 12' adit 2775 metres in length. The portal will be located in the valley near the mill at elevation 1225 metres. As well as safe entry free from avalanche danger, the adit will provide gravity mine drainage, an ore conveyorway and a good location for further exploration.

The steeply dipping configuration of the ore zones plus competent ground conditions permits the use of the highly productive vertical crater retreat (VCR) mining system described in Section 2.2.2. Scooptrams will transport the ore from the stopes to orepasses feeding 42" x 48" jaw crushers. There will be three crusher stations located so as to minimize haulage distances. The crushed ore (-10") will discharge into surge pockets and then onto conveyors which will transfer it to the main conveyor system in the adit. This system will employ 42" steel cord belts and the conveyor structure will be suspended from the adit back. The crushed ore will be discharged to the coarse ore storage pile outside the portal adjacent to the mill.

.2 Ventilation

Ventilation for initial development will be provided by surface fans and plastic ducting. For the main conveyorway this system will be employed for almost a year so a small individual heating plant will be required.

The permanent ventilation system will utilize the 1440 metre exploration adit to Tom Valley as the air intake. Each of the ore zones will be fed air by an 84" fan; that for the East Zone located on the 1440 cross-cut while the West Zone fan will be situated on the main decline exiting the 1440 level. The circuits will be completed with raises to surface and from the 1310 level to the 1440 level within the West Zone.

A building at the 1440 level adit will contain two direct-fired propane air heating units. Each heater will have a capacity of 20 million BTU/hr and be capable of heating incoming air from -40°C to +10°C.

.3 Drainage

While the exploration decline was being driven from the 1440 level, serious problems were created by water flows particularly in the conglomerate formation. It is not known how significant water flows will be during production but the 1% gradient on the main conveyorway provides a gravity drainage system with the capability of handling large volumes.

The existing decline to the West Zone is full of water. After this is pumped out with portable pumps a

permanent sump and pump station will be established on the 1310 level with 300 USGPM pumps discharging to the Tom Valley via the 1440 adit.

Pumping will be required in the East Zone during development but this will be replaced with gravity drainage once the conveyorways are completed.

Grouting will probably provide adequate water control during development but water problems during stoping could be more serious. Hydrological studies should be undertaken as soon as activity resumes in order to anticipate potential problems and plan remedial action.

.4 Facilities and Services

Changehouse and office facilities for 250 crew and 25 staff are provided in the main concentrator/power plant/service building. All machine shop, electrical and mobile equipment repair facilities are also located in this building.

Compressed air will be suppliled from a compressor room located on the 1440 metre level. Two 3500 CFM compressors will be installed. High pressure (250 PSI) air for the ITH stoping drills will be supplied by individual compressors near each drill.

Mine development will initially be done using portable diesel generators in the main conveyorway and the 1440 adit portal. Once the main power plant is operational, electricity will be supplied to underground substations at 13.8 kV before being transformed to 4.16 kV and 600 V for consumption.

All water for drilling and other operational uses will be provided by drill holes. Potable water will be supplied to underground from the surface plant.

.5 Mining Equipment

Development will be done using hydraulic jumbos, 5 $yd^3$ scooptrams and 27 ton trucks. Stope drilling will employ ITH drills and 8 $yd^3$ scooptrams will transport broken ore to the crushing stations.

## 2.2.4 JASON SOUTH ZONE MINE DESIGN

.1 Mine Layout

The Jason orebodies lie west of the Macmillan River on the opposite side of the North Canol Road from the Tom ore zones. Jason ore will be trucked to the concentrator via a new road 1.8 km long, across a Bailey bridge on the river and along a 3.0 km section of the North Canol Road.

Access to the Jason South orebody will be provided by a shaft consisting of three 6' x 6' compartments, two for hoisting and one for a manway, services and ventilation duct. One hoisting compartment will contain a skip only and the other a skip and cage in balance. The shaft will be serviced by an 1800 HP drum hoist which will be used for both the shaft sinking and development phase and for later production. Shaft construction will be with 6" x 8" and 8" x 8" B.C. fir.

The shaft collar will be at 1220 metres and the bottom at 490 metres. The crusher will be located at the 550

level and the loading pocket at the 520 level. The main mining levels are 500, 600, 700, 800, 900 and 966 metres. The 500 level will be accessed by a decline from the 600 level.

As the steeply dipping ore configuration is suitable and the ground conditions are expected to be similar to those at Tom, the Jason South orebody will also be mined by the vertical crater retreat method. Broken ore from the stopes will flow by gravity to the crushing station where it will be passed through a 42" x 48" jaw crusher. The crushed ore will be transferred by conveyor to the loading pocket, hoisted to surface and dumped into one of two 750 ton ore bins. The bins will discharge the ore into 35 ton rear dump trucks for the haul to the concentrator.

.2 Ventilation

The 200,000 CFM ventilation fan is located on surface and supplies air to the mine via a centrally-located ventilation raise. Distribution of air to the working areas is controlled by doors on each of the levels. Exhaust raises at the extremities of the orebody carry the air upward, eventually to the 966 level and from there through a single raise to surface.

Mine air heating is provided by 20 million BTU/hr propane heaters on surface. The system is identical to that for Tom and will be located in a small building adjacent to the shaft.

.3 Drainage

Underground water conditions at Jason South are not known, but in view of the problems experienced at Tom allowance has been made for substantial volumes. Sumps will be cut on the 550 and 900 levels and three pumps installed in each sump. Capacity of each pump will be 800 USGPM at 1500 ft of head and it is hoped that normally one pump will be able to handle the load.

.4 Facilities and Service

Jason personnel will use the changehouse and office facilities in the concentrator/power plant/service complex. All major maintenance facilities are also located in this complex. Underground equipment which cannot be readily taken to surface will be serviced and repaired in an underground maintenance shop.

As well as the hoist the headframe building will contain electrical distribution panels, the mine air compressors and a small shop area.

Electricity from the main power plant will be transmitted by overhead pole line to a substation near the shaft where it will be transformed down from 13.8 kV to 4.16 kV and 600V for distribution.

Water for both surface and underground will be provided by a pressure system operating from a small pumphouse on the Macmillan River.

.5 Mining Equipment

Development drilling will be done with pneumatic jumbos. Stope drilling will employ ITH drills with individual high pressure compressors. Mucking will be done with 3 1/2 $yd^3$ scooptrams or pneumatic mucking machines. Development raising will be done conventionally on timber and with Alimak raise timbers.

## 2.2.5 JASON MAIN ZONE MINE DESIGN

.1 Mine Layout

The Jason Main Zone which outcrops just under surface overburden will be accessed by a decline from surface. This will lead down to the crushing station at elevation 1125 metres. From this point both an incline and a decline will provide access to mining sublevels. Top of the incline will be the 1245 level which will be driven in both waste and ore. A fill raise will be carried through to surface from the waste drift.

Surface drilling indicates a considerable amount of faulting in the Main Zone and the ground is expected to be less competent than that in the other ore zones. This situation dictated a mining method employing fill and led to the selection of the sublevel retreat system described in Section 2.2.2.

.2 Ventilation

The 200,000 CFM ventilation fan is located in a building on surface and delivers fresh air to a ventilation

raise. After distribution to the working places the air is exhausted up raises at the ore extremities to the 900 level and from there up the decline to surface.

Air heating is by 20 million BTU/hr propane heaters identical to those at Tom and Jason South.

.3 Drainage

The Main Zone mine will have one permanent sump on the 720 level. Three pumps will be installed in the sump each capable of delivering 800 USGPM at 1500 ft of head.

.4 Facilities and Services

There will be a small service garage at the Main Zone mine. All other maintenance, changehouse and office facilities will be provided by the concentrator/power plant/service complex. Electricity at 4.16 kV will be provided from the substation at the Jason South mine and transformed locally to 600 V. Water will be provided from the Macmillan River pumphouse.

.5 Mining Equipment

Hydraulic jumbos, 3 1/2 or 5 $yd^3$ scooptrams and 13 or 27 ton trucks will be used for development. Production will employ hydraulic drill wagons, 5 $yd^3$ scooptrams and 27 ton trucks.

Equipment for quarrying fill will include a blasthole drill, front-end loader and dump trucks.

### 2.2.6 PRODUCTION SCHEDULE

The current project schedule assumes that ore production commences from the Tom East zone in Project Year 2, Month 6. Full annual production of 1,575,000 tons is achieved from Tom in Year 3. Production from the Jason South mine begins in Year 4 and that from the Jason Main Zone in Year 9. Project life is a minimum of 15 years.

## Tom/Jason Mining Schedule

Note: Jason SHW = Jason South Hangingwall
Jason SM - Jason South Middle Lens

| | | Ore Production | | | |
|---|---|---|---|---|---|
| | | Tonnage | Grade | | |
| | | ($10^3$ tons) | Pb % | Zn % | Ag opt |
| Year 2 - | Tom East | 513.0 | 14.35 | 8.01 | 4.65 |
| | Tom West | 143.0 | 6.55 | 7.91 | 1.68 |
| | Total | 656.0 | 12.65 | 7.99 | 4.00 |
| Year 3 - | Tom East | 848.7 | 9.35 | 8.31 | 3.75 |
| | Tom West | 726.3 | 6.55 | 7.91 | 1.68 |
| | Total | 1575.0 | 8.06 | 8.13 | 2.77 |
| Year 4 - | Tom East | 350.0 | 10.84 | 8.82 | 4.97 |
| | Tom West | 893.8 | 6.43 | 8.51 | 2.10 |
| | Jason SHW | 331.2 | 15.22 | 5.57 | 6.93 |
| | Total | 1575.0 | 9.26 | 8.00 | 3.75 |
| Year 5 - | Tom East | 350.0 | 8.36 | 8.14 | 3.38 |
| | Tom West | 700.0 | 5.44 | 6.87 | 2.14 |
| | Jason SHW | 525.0 | 14.41 | 5.94 | 6.48 |
| | Total | 1575.0 | 9.08 | 6.84 | 3.87 |
| Year 6 - | Tom East | 350.0 | 13.00 | 8.74 | 5.04 |
| | Tom West | 700.0 | 6.18 | 7.76 | 1.99 |
| | Jason SHW | 525.0 | 9.31 | 6.03 | 4.30 |
| | Total | 1575.0 | 8.74 | 7.40 | 3.44 |
| Year 7 - | Tom East | 255.0 | 11.11 | 7.56 | 3.20 |
| | Tom West | 795.0 | 6.15 | 7.40 | 1.97 |
| | Jason SHW | 525.0 | 6.88 | 5.97 | 3.26 |
| | Total | 1575.0 | 7.20 | 6.95 | 2.60 |
| Year 8 - | Tom West | 1050.0 | 3.49 | 6.26 | 0.67 |
| | Jason SHW | 525.0 | 4.15 | 7.00 | 2.08 |
| | Total | 1575.0 | 3.71 | 6.51 | 1.14 |
| Year 9 - | Tom West | 965.9 | 3.66 | 6.86 | 0.91 |
| | Jason SHW | 525.0 | 6.38 | 4.97 | 3.33 |
| | Jason Main | 83.1 | 1.70 | 10.52 | 2.19 |
| | Total | 1574.0 | 4.46 | 6.42 | 1.78 |

TABLE 2.2-1
Sheet 1

| | | Ore Production | | | |
|---|---|---|---|---|---|
| | | Tonnage ($10^3$ tons) | Grade Pb % | Zn % | Ag opt |
| Year 10 - | Jason SHW | 525.0 | 13.76 | 6.62 | 6.09 |
| | Jason SM | 283.0 | 1.70 | 10.52 | 2.19 |
| | Jason Main | 745.5 | 1.97 | 7.52 | 0.12 |
| | Total | 1553.0 | 5.91 | 7.76 | 2.51 |
| Year 11 - | Jason SHW | 525.0 | 10.74 | 5.05 | 5.03 |
| | Jason SM | 283.0 | 1.71 | 9.44 | 2.02 |
| | Jason Main | 765.0 | 1.72 | 7.77 | 0.03 |
| | Total | 1573.0 | 4.73 | 7.16 | 2.06 |
| Year 12 - | Jason SHW | 525.0 | 5.34 | 6.66 | 2.62 |
| | Jason SM | 283.0 | 2.03 | 7.01 | 1.67 |
| | Jason Main | 765.0 | 1.72 | 7.77 | 0.03 |
| | Total | 1573.0 | 2.98 | 7.26 | 1.19 |
| Year 13 - | Jason SHW | 90.4 | 1.77 | 7.63 | 1.04 |
| | Jason SM | 485.0 | 2.36 | 6.26 | 1.57 |
| | Jason Main | 1000.0 | 1.32 | 5.94 | 0.02 |
| | Total | 1575.0 | 1.67 | 6.14 | 0.56 |
| Year 14 - | Jason SM | 575.0 | 2.07 | 8.00 | 1.81 |
| | Jason Main | 1000.0 | 1.72 | 8.68 | 0.03 |
| | Total | 1575.0 | 1.85 | 8.43 | 0.68 |
| Year 15 - | Jason SM | 230.9 | 2.33 | 5.35 | 1.40 |
| | Jason Main | 485.5 | 1.19 | 8.27 | 0.03 |
| | Total | 716.4 | 1.56 | 7.33 | 0.47 |

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## 2.3 MILLING

### 2.3.1 SUMMARY

Mineralogical examinations of the Tom and Jason ores reveal that they are finely-grained massive sulphides with relatively simple intergrowth patterns within the mineral assemblage. This would indicate that they should be amenable to treatment by differential flotation. Individual flotation testwork on the two ores proved that this was the case and provided data for a preliminary commercial plant design. Testwork done on Tom ore only indicated that it was amenable to autogenous grinding and this was incorporated into the preliminary flowsheet. Further testwork on both flotation and grinding is necessary to provide information for detailed design and permit improved metallurgical results to be forecast.

As the design currently stands the concentrator is a 5000 tons/day plant with fully-autogenous primary grinding and secondary pebble milling. The grinding units could be converted to semi-autogenous and ball milling operating mode respectively if required. Coarse lead flotation is incorporated in the grinding circuit to prevent overgrinding of galena. The other flotation circuits and dewatering circuits are standard lead/zinc practice.

Average annual production at full operating rate is 119,000 tons of Pb concentrate (68% Pb, 23 opt Ag) and 160,000 tons Zn concentrate (56% Zn). Overall forecast recoveries are 91, 79 and 79 for Pb, Zn and Ag respectively.

## 2.3.2 MINERALOGICAL INVESTIGATIONS

Microscopic examinations of Tom ore samples were made by Michigan Tech while samples of Jason ore were studied by Hazen Research. Their findings were similar and the key results are summarized below.

- The predominant sulphide minerals are sphalerite, galena and pyrite. Tetrahedrite is also commonly present while chalcopyrite, marcasite and pyrrhotite are found less frequently.

- While quite coarse in some higher grade samples, the sulphides are generally fine grained. The sphalerite is typically in the 30-40 um particle size range while the galena varies widely from 5 to 300 um. Despite their fineness, the sulphide particles exhibit relatively simple intergrowth patterns.

- The major gangue minerals are quartz, barite and siderite.

- The gangue minerals are coarser than the sulphides with particle sizes generally in the range of 150 - 300 um.

- All of the major minerals except quartz have good cleavages, are brittle and relatively soft.

- Samples of Jason Main Zone ore contain carbonaceous material, usually as stringers in the gangue but occasionally intermingled with pyrite- sphalerite intergrowths.

- o There is also some evidence of oxidation in the Jason Main Zone samples.

In summary, the mineralogical investigations indicate an ore which will need to be finely ground in order to liberate the minerals but which should then be amenable to differential flotation. The presence of carbonaceous material and oxidation in the Jason Main Zone will likely make this ore the most difficult from which to obtain acceptable metallurgical results.

### 2.3.3 FLOTATION TESTWORK

#### .1 Tom Ore

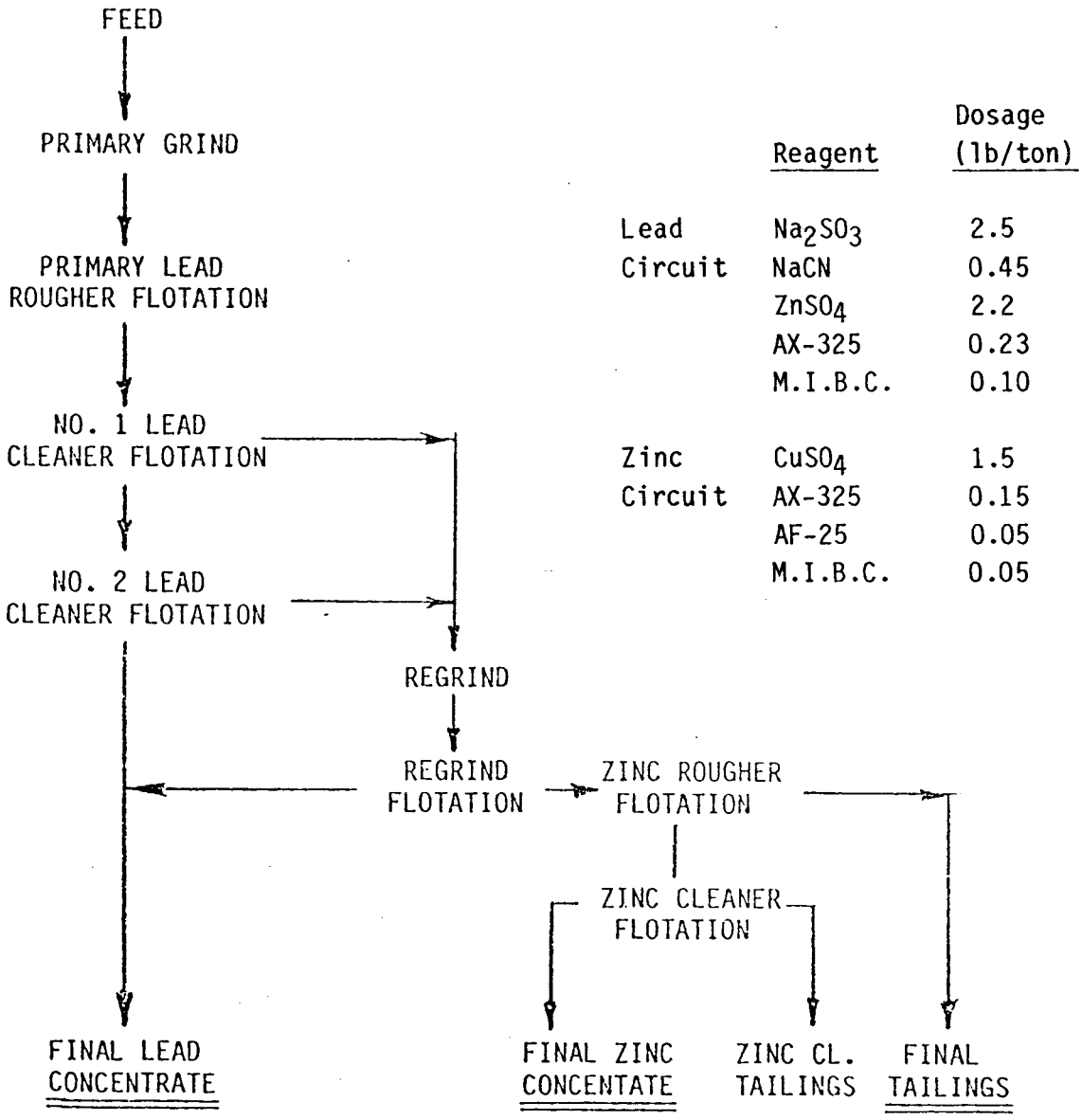
Initial flotation testing of Tom ore was done in 1979 by Hudson Bay Mining and Smelting at Flin Flon. The flowsheet developed utilized a lime -$SO_2$ treatment to depress zinc while floating lead. Metallurgical results were not acceptable with the principal problems being low concentrate grades and high losses of zinc to the lead concentrate.

In 1981 the Institute of Mineral Research at Michigan Tech was commissioned to do further flotation testing of Tom ore. A total of five samples, two from Tom West and three from Tom East, were submitted and tested to varying degrees.

The flowsheet developed by Michigan Tech is unusual for a lead/zinc circuit in that no lime or other pH modifier is used. Zinc depression during lead flotation is accomplished with high dosages of zinc sulphate (2.2 lb/ton) and sodium sulphite (2.5 lb/ton).

TOM ORE BENEFICIATION

(Developed By Michigan Tech. University)




| | Reagent | Dosage (lb/ton) |
|---|---|---|
| Lead Circuit | $Na_2SO_3$ | 2.5 |
| | NaCN | 0.45 |
| | $ZnSO_4$ | 2.2 |
| | AX-325 | 0.23 |
| | M.I.B.C. | 0.10 |
| Zinc Circuit | $CuSO_4$ | 1.5 |
| | AX-325 | 0.15 |
| | AF-25 | 0.05 |
| | M.I.B.C. | 0.05 |

Figure 2.3-1

The best results achieved by Michigan Tech were with the last two samples tested, identified as East #3 and West #2. Results of these tests are summarized below:

| Composite | Grind (% -325M) | Assays Pb % | Assays Zn % | Assays Ag opt | Distribution (%) Pb | Distribution (%) Zn | Distribution (%) Ag |
|---|---|---|---|---|---|---|---|
| East #3 | | | | | | | |
| Feed | 88 | 12.2 | 10.5 | 4.03 | 100 | 100 | 100 |
| Pb Conc. | | 65.5 | 10.8 | 18.1 | 92.5 | 17.6 | 77.8 |
| Zn Conc. | | 1.99 | 59.2 | | 2.21 | 76.2 | |
| West #2 | | | | | | | |
| Feed | 86 | 12.3 | 10.8 | 4.75 | 100 | 100 | 100 |
| Pb Conc. | | 68.6 | 8.35 | 24.5 | 91.1 | 13.8 | 80.8 |
| Zn Conc. | | 3.16 | 53.4 | | 3.12 | 64.6 | |

Mercury in the ore was found to be associated with the sphalerite. Cleaned zinc concentrates from the above tests contained 344 and 850 ppm Hg respectively

.2 Jason Ore

o Bulk Flotation

In 1981 and 1982 Bacon Donaldson & Associates of Vancouver performed initial flotation tests on Jason ore. The main focus of their work was on producing a bulk concentrate followed by depression of sphalerite into a separate concentrate. Although this method did yield good lead concentrate grades at fairly reasonable recoveries, the zinc metallurgy was unacceptable in terms of both concentrate grades and recoveries. This approach was not pursued further.

o Jason South Zone

In April 1982 two composite samples of Jason South Zone ore were submitted to Hazen Research of Golden Colorado. Following mineralogical examination they concluded that differential flotation was feasible and they devised a flowsheet which incorporates coarse lead flotation between two stages of grinding. The ore is initially ground to -200M and the coarse lead tailings are thickened and reground to -400M. The reagent balance for this flowsheet follows conventional lead/zinc practice and employs lime for pH control. Results of Hazen's testwork on the two Jason South composites are summarized below:

| | Grind | Assays | | | Distribution (%) | | |
|---|---|---|---|---|---|---|---|
| Composite | Mesh | Pb % | Zn % | Ag opt | Pb | Zn | Ag |
| 1-1 | | | | | | | |
| Feed | -200/-400 | 3.04 | 5.10 | 1.05 | | | |
| Pb Conc. | | 55.3 | | | 93.4 | | |
| Zn Conc. | | | 57.3 | | | 91.2 | |
| 1-2 | | | | | | | |
| Feed | -200/-400 | 13.10 | 2.67 | 3.77 | | | |
| Pb Conc. | | 76.4 | | | 94.4 | | |
| Zn Conc. | | | 52.0 | | | 84.3 | |
| 1-1 & 1-2 | | | | | | | |
| Feed | -200/-400 | 8.19 | 3.93 | 2.41 | | | |
| Pb Conc. | | 71.6 | | 18.5 | 95.8 | | 80.4 |
| Zn Conc. | | | 61.3 | 4.1 | | 87.9 | 9.6 |

Lead concentrate from the combined feed composite contained 300 ppm As and 600 ppm Sb. The zinc concentrate contained 900 ppm Hg.

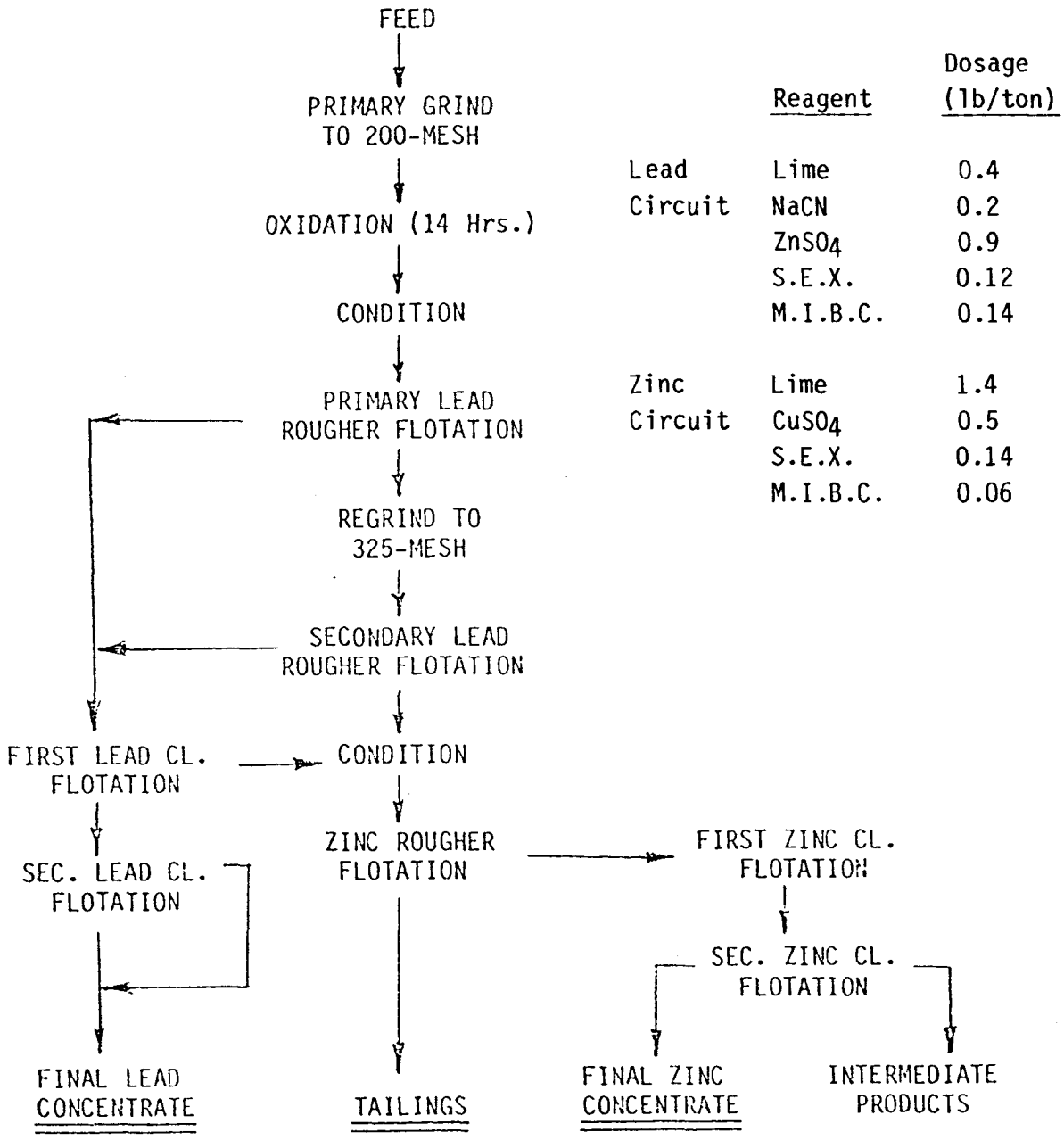
o Jason Main Zone

Initial tests using the South Zone flowsheet for Main Zone ore yielded satisfactory zinc metallurgy but the lead concentrate grade (19% Pb) and recovery (50%) were unacceptably low. In addition, the consumption of collector was unusually high. Further study identified the principal problem to be the presence of soluble ferrous sulphate formed by the partial ozidation of sulphides in the ore. Hazen showed that the ferrous sulphate could be precipitated and its effect negated by air oxidation of the ground pulp prior to lead flotation. However the zinc depressants also tended to precipitate during the air oxidation so the flotation procedure was modified to add these after grinding and oxidation rather than before grinding as previously done.

Organic carbon in the Main Zone ore was also identified as a problem. In order to reduce its effect a composite of two parts South Zone ore and one part Main Zone ore was blended. Using the modified flowsheet satisfactory flotation results were obtained from the composite sample.

JASON COMPOSITE BENEFICIATION

(Developed by Hazen Research (International), Inc., 1983)




| | Reagent | Dosage (lb/ton) |
|---|---|---|
| Lead Circuit | Lime | 0.4 |
| | NaCN | 0.2 |
| | $ZnSO_4$ | 0.9 |
| | S.E.X. | 0.12 |
| | M.I.B.C. | 0.14 |
| Zinc Circuit | Lime | 1.4 |
| | $CuSO_4$ | 0.5 |
| | S.E.X. | 0.14 |
| | M.I.B.C. | 0.06 |

Figure 2.3-2

| Composite | Grind Mesh | Assays Pb % | Zn % | Ag opt | Distribution (%) Pb | Zn | Ag |
|---|---|---|---|---|---|---|---|
| 2:1 Blend South Zone to Main Zone | | | | | | | |
| Feed | -200/-400 | 6.70 | 7.23 | 1.55 | 100 | 100 | 100 |
| Pb Conc. | | 61.0 | | 15.5 | 87.6 | | 80.5 |
| Zn Conc. | | | 56.8 | 1.15 | | 88.8 | 6.8 |

The zinc concentrate from the Main Zone/South Zone composite assayed 400 ppm Hg, indicating the Main Zone to be lower in mercury content than the South Zone.

### 2.3.4 GRINDING TESTWORK

#### .1 Fineness of Grind

The optimum grind for treating Tom and Jason ores has yet to be determined. In limited testing of Tom ore at various grinds Michigan Tech achieved their best results at 86-88% -325M. for the two stage grinding of Jason ore Hazen normally used a -200M initial grind followed by a -400M regrind (exact percentages passing not stated). However, tests run using a -325M regrind yielded results only slightly inferior to those run at -400M. Further testing will be required to determine with confidence the relationship between grind, concentrate grades and recoveries and hence establish the most economic grind.

.2 Autogenous Grinding

With significant capital and operating cost savings potentially available from fully or semi-autogenous grinding, tests were run to determine the viability of either approach. The tests were performed by Aerofall Mills (U.S.) Inc. under the direction of A.R. MacPherson Consultants Ltd. Three samples were tested; one each of Tom East ore, Tom West ore and conglomerate material from near the Tom deposit. Small scale continuous grinding tests were run on each sample and Autogenous Work Indices calculated. From comparison with historical commercial data Commercial Work Indices were derived. These compared favourably with Bond Work Indices obtained on the same samples:

| Sample | Autogenous Work Index | Commercial Work Index | Bond Work Index |
|---|---|---|---|
| | ----------kwh/ton---------- | | |
| Tom West | 10.44 | 10.4 | 12.53 |
| Tom East | 4.46 | 4.5 | 7.36 |
| Conglomerate | 27.15 | 18.2 | Not tested |

Experience has shown that an ore with an Autogenous Work Index of about 10 kwh/ton, such as Tom West, is ideally suited to fully autogenous grinding. The markedly low index for Tom East indicates that it is soft and easily ground and that if ground alone fully-autogenously, insufficient large pieces may survive long enough to break medium sized peices. Mixing it with a harder ore such as Tom West would eliminate this problem and fully-autogenous grinding would proceed unhindered.

Conglomerate is exceptionally hard and would not grind completely fully-autogenously. Although large chunks could be fed to the mill to aid in grinding the softer ore, this would introduce unwanted dilution and is therefore not recommended.

### 2.3.5 RECOMMENDATIONS FOR FUTURE TESTWORK

Testwork to date has successfully demonstrated the feasibility of treating Tom and Jason ores with conventional flotation techniques. Sufficient information has been generated to arrive at a preliminary plant design and permit the selection, sizing and costing of major equipment items. However, before a definitive plant design can be established further metallurgical testwork is required. The major points to be addressed by this testwork are summarized below:

#### .1 Blending of Tom and Jason Ore

To date Tom and Jason ores have been investigated with separate testwork programs and in most cases the individual ore zones have been treated separately. Future testwork should use composite samples as representative as possible of the ore mixtures and grades envisaged by the mining plan.

#### .2 Fineness of Grind

The optimum fineness of grind has yet to be established. All testwork to date indicates that Tom and Jason ore needs to be ground to at least 80% -325M. The benefits of grinding finer than this should be assessed and weighed against the costs. The number of stages in which the final grind is achieved also requires further study.

.3 Grinding Type and Configuration

The autogenous grinding tests done by Aerofall in their 18 inch laboratory mill were successful and gave an indication of the overall power requirements for grinding Tom ores either fully or semi-autogenously. However, before the commercial plant design is finalized it is essential that further grinding tests be done, preferably in a continuous pilot plant. As well as determining the type, size and configuration of the primary and secondary grinding units, this testwork must investigate the grinding characteristics of the various ore mixtures to be treated.

.4 Reagent Balance

The separate testwork programs developed different reagent balances for Tom and Jason ores. A single basic system sill have to be established for the commercial plant with provisions for any modifications required by the various ore blends. It is recommended that future flotation testing focus on a conventional lead/zinc reagent balance similar to that employed by Hazen. The scheme devised by Michigan Tech for Tom appears to be both expensive and one which makes the flotation control difficult.

.5 Dewatering

As yet no thickening or filtering tests have been done on Tom or Jason flotation products. These will be required to provide plant design data.

## 2.3.6 PREDICTED METALLURGICAL PERFORMANCE

The head grades of samples on which the laboratory flotation testing was done deviated significantly from ore reserve grades in some cases. In order to use the laboratory results to predict the metallurgical performance for each ore zone at its projected mining grade, the following relationship was used:

$$\text{Predicted \% Recovery} = \text{Lab Test \% Recovery} \times \frac{\left(1 - \frac{A}{PF^B}\right)}{\left(1 - \frac{A}{TF^B}\right)}$$

where PF = Projected mining feed grade
TF = Lab test feed grade

and A and B are constants as follows:

| | A | B |
|---|---|---|
| Pb % Recovery in Pb/Zn Ore | 0.18 | 0.8 |
| Zn % Recovery in Pb/Zn Ore | 0.32 | 0.6 |
| Ag % Recovery in Pb/Zn Ore | 0.40 | 0.6 |

The above formula is a modification of that published by T.A. O'Hara in "Quick Guide to the Evaluation of Orebodies" in the CIM Bulletin.

It is not suggested that this procedure is considered a suitable substitute for testing representative samples but it was considered to be within the accuracy of this study.

The predicted metallurgical performance derived in this manner for the average reserve grade of each ore zone is shown in Table 2.3-1.

## PREDICTED METALLURGICAL PERFORMANCE

(For Average Reserve Grade of Each Zone)

| Ore Zone | Assays | | | Distribution (%) | | |
|---|---|---|---|---|---|---|
| | Pb % | Zn % | Ag opt | Pb | Zn | Ag |
| Lead Concentrate | | | | | | |
| Tom West - Hangingwall | 68.0 | | tr. | 80.0 | | 0 |
| Tom West - Footwall | 68.0 | | 14.7 | 89.0 | | 65.0 |
| Tom East | 65.0 | | 21.0 | 92.0 | | 78.0 |
| Jason South Zone | 72.0 | | 30.0 | 93.0 | | 83.3 |
| Jason Main Zone (blended with South zone) | 61.0 | | tr. | 81.3 | | 0 |
| Zinc Concentrate | | | | | | |
| Tom West - Hangingwall | | 53.0 | | | 63.0 | |
| Tom West - Footwall | | 53.0 | | | 63.0 | |
| Tom East | | 58.0 | | | 75.0 | |
| Jason South Zone | | 60.0 | | | 90.0 | |
| Jason Main Zone (blended with South Zone) | | 56.8 | | | 87.8 | |

Table 2.3-1

## 2.3.7 CONCENTRATOR DESIGN

### .1 Basis of Design

The Tom/Jason concentrator has a design capacity of 5000 tons/day with throughput limited by the grinding circuit. The design is conservative inasmuch as the grinding equipment is sized for the hardest ore while the design of the flotation and dewatering circuits makes allowance for the highest grade of ore. As it currently stands the preliminary process design is based largely on the Tom metallurgical testwork. However. changes necessitated by information gained from the Jason testwork and future testing of ore mixtures can be readily incorporated.

### .2 Crushed Ore Storage

Crushed ore, delivered from Tom by conveyor and from Jason by truck, is stored in a 10,000 ton underground pocket excavated in the hill behind the concentrator. This system minimizes the requirement for protection against ore freezing.

### .3 Grinding

Following screening to separate minus 3 1/2" plus 1 1/2" pebbles for secondary grinding, the crushed ore is fed to a 24' dia. x 11' fully-autogenous mill for primary grinding. If necessary this mill can be operated semi-autogenously with a ball charge of up to 8%. The primary mill power draw is 2400 HP. The primary mill operates in closed circuit with cyclones which make a split

at 80% -100 mesh. At this fineness a considerable proportion of the galena is liberated so a coarse lead flotation stage has been incorporated in the flowsheet in order to prevent overgrinding of the galena.

The primary cyclone overflow and the secondary mill discharge is combined and fed to the coarse lead rougher flotation cells. The rougher concentrate is cleaned in a single unit cell and the cleaned concentrate sent to either the lead third cleaners or final product, depending upon grade.

Tailings from the coarse lead flotation are pumped to the secondary cyclones from which the overflow at 80% -325 mesh passes to the lead flotation circuit. Cyclone underflow is fed to two 14' x 22' secondary pebble mills each with a 1500 HP drive. Feed to the mills is 6-10% pebbles and any pebble chips are removed by discharge trommel screens.

.4 Flotation

The secondary cyclone overflow is conditioned with reagents and then fed to three 1350 $ft^3$ flotation cells for lead roughing and two such cells for scavenging. Lead rougher concentrate is upgraded in three cleaning stages of four 600 $ft^3$ cells each. First and second cleaner tailings are reground in a 9' dia. x 12' overflow ball mill in closed circuit with cyclones. The cyclone overflow is sent to a separate rougher/cleaner flotation circuit with the concentrate produced directed to the lead scavenger feed.

Lead scavenger tailings are conditioned and then a zinc rougher concentrate is floated in three 1350 $ft^3$ cells. The concentrate is upgraded in four 350 $ft^3$ second cleaners and three 300 $ft^3$ third cleaners. The tailings from the zinc scavengers are the final tailings from the process and are pumped to the disposal area.

.5 Reagent Balance

The reagent balance assumed for the preliminary plant design is that developed during the testwork on Tom ore. It is somewhat unusual for a lead/zinc circuit in that lime is not used for pH control in the differential flotation. This reagent scheme with the quantities allowed for in the operating cost estimate is shown in Table 2.3.2. There is no allowance for lime mixing and distribution in the current design but this could readily be incorporated at a later date. It is likely that future flotation testwork on Tom and Jason ore mixtures will indicate that lime is required. Reduction in the consumption of other reagents, particularly cyanide and zinc sulphate, should offset the additional costs.

.6 Dewatering, Storage and Loadout

Concentrates are thickened using conventional thickeners located within the concentrator building. The diameters are 70 ft and 60 ft for lead and zinc respectively. The thickened concentrates are filtered using pressure filters which offer the advantage of producing cake moisture low enough that further drying is not required. There are two 990 $ft^3$ filters for each concentrate which will provide ample capacity for even the highest grade of ore anticipated.

After filtering the concentrates are conveyed to separate domed storage buildings 100 ft in diameter. Each

## REAGENTS

| Reagent | Use | Amount lb/ton | Strength, % wt. | Addition Points |
|---|---|---|---|---|
| $ZnSO_4$ | Zn depressant | 1.65 | 10 | Pb conditioner /flotation/ regrind circuit |
| $Na_2SO_3$ | Zn depressant | 1.88 | 5 | Pb conditioner /regrind circuit |
| $Na_2SiO_2$ | Slimes dispersant | 0.28 | 7.5 | Pb conditioner |
| NaCN | Zn & Pyrite depressant | 0.34 | 10 | Pb conditioner /flotation/ regrind circuit |
| AX-325 | Pb promotor | 0.29 | 10 | Pb conditioner /regrind |
| MIBC | frother | 0.11 | 100 | Pb & Zn flotation |
| AF-99E | frother | 0.30 | 100 | Pb & Zn flotation |
| $CuSO_4$ | Zn activator | 1.13 | 5 | Zn conditioner |
| Xanthate | Zn promotor | 0.15 | 10 | Zn conditioner |
| AF-25 | frother | 0.04 | 100 | Zn flotation |

Table 2.3-2

building is equipped with a reclaim system and scale for weighing the highway transport trucks as they are loaded. Total capacity of each concentrate storage building is at least 14 days production although only a small portion of this is live storage as it is assumed shipments are made daily.

## .7 Tailings Disposal

A five stage centrifugal pumping system pumps tailings from the concentrator to the tailings impoundment area at Rat Lake on the western portion of the Jason property. Here a natural basin sealed off by two relatively small dams can provide a storage area more than adequate for the tailings volume from the known ore reserves. The initial dam height will provide sufficient capacity for 10 years of operation. Prior to deposition tailings are thickened in a 200 ft diameter thickener with the excess water recycled to the concentrator.

## .8 Facilities and Services

All major maintenance facilities, offices and the power plant are located in the same building complex as the concentrator.

Electricity is generated by five diesel generators of 3.8 MW with one unit normally on standby. The generation voltage and distribution voltage within the concentrator is 4.16 KV.

Water supply, both for process make-up and potable water, is from the South Macmillan River. From a pumphouse at a pond near the river two 500 USGPM pumps supply water to a 1,000,000 USGPM storage tank near the Tom mine portal.

## 2.3.8 PLANT PERFORMANCE AND PRODUCTION SCHEDULE

For this study the concentrators overall metallurgical performance with Tom and Jason ore blends was assumed to be the equivalent of treating the ore from each zone separately and summing the results. The predicted metallurgical results for each zone were adjusted on a year-by-year basis according to the zone's projected mining grade and the grade/recovery relationship derived in Section 2.3.6. Applying these results to the Mining Schedule in Table 2.2-1, the overall metallurgical performance is predicted as follows in Table 2.3-3 and 2.3-4.

## MILL FEED GRADES AND RECOVERIES

| Project Year | Mill Feed Grades | | | Recoveries | | |
|---|---|---|---|---|---|---|
| | Pb % | Zn % | Ag opt | Pb | Zn | Ag |
| 2 | 12.65 | 7.99 | 4.00 | 92.0 | 72.3 | 77.4 |
| 3 | 8.06 | 8.13 | 2.77 | 90.8 | 69.8 | 73.9 |
| 4 | 9.26 | 8.00 | 3.75 | 91.8 | 70.4 | 81.0 |
| 5 | 9.08 | 6.84 | 3.87 | 92.3 | 73.8 | 82.6 |
| 6 | 8.74 | 7.40 | 3.44 | 91.8 | 73.6 | 79.9 |
| 7 | 7.20 | 6.95 | 2.60 | 90.9 | 72.9 | 76.4 |
| 8 | 3.71 | 6.51 | 1.14 | 88.5 | 72.7 | 65.3 |
| 9 | 4.46 | 6.42 | 1.78 | 89.8 | 72.2 | 74.7 |
| 10 | 5.91 | 7.76 | 2.51 | 92.2 | 89.6 | 86.2 |
| 11 | 4.73 | 7.16 | 2.06 | 91.2 | 89.0 | 85.7 |
| 12 | 2.98 | 7.26 | 1.19 | 88.5 | 89.0 | 77.9 |
| 13 | 1.67 | 6.14 | 0.56 | 83.0 | 87.6 | 69.3 |
| 14 | 1.85 | 8.43 | 0.68 | 83.5 | 89.3 | 72.9 |
| 15 | 1.56 | 7.33 | 0.47 | 82.3 | 88.1 | 67.5 |

Table 2.3-3

## CONCENTRATE PRODUCTION

| Project Year | Lead Concentrate Tonnage (tons) | Lead Concentrate Grades Pb % | Lead Concentrate Grades Ag opt | Zinc Concentrate Tonnage (tons) | Zinc Concentrate Grades Zn % |
|---|---|---|---|---|---|
| 2 | 116,900 | 65.3 | 17.4 | 66,500 | 57.0 |
| 3 | 174,200 | 66.1 | 18.5 | 159,900 | 55.9 |
| 4 | 197,200 | 67.9 | 24.3 | 160,900 | 55.2 |
| 5 | 193,000 | 68.4 | 26.1 | 142,100 | 56.0 |
| 6 | 186,700 | 67.7 | 23.2 | 153,700 | 55.9 |
| 7 | 152,100 | 67.8 | 20.6 | 143,500 | 55.6 |
| 8 | 75,100 | 68.8 | 15.6 | 135,100 | 55.1 |
| 9 | 91,300 | 69.0 | 22.9 | 132,500 | 55.0 |
| 10 | 123,300 | 68.6 | 27.3 | 188,200 | 57.5 |
| 11 | 99,200 | 68.4 | 28.0 | 174,700 | 57.4 |
| 12 | 61,600 | 67.4 | 23.7 | 177,200 | 57.4 |
| 13 | 33,400 | 65.4 | 18.3 | 147,900 | 57.3 |
| 14 | 37.700 | 64.5 | 20.7 | 207,200 | 57.2 |
| 15 | 14,100 | 65.3 | 16.1 | 81,000 | 57.1 |

Table 2.3-4

## 2.4 ENVIRONMENTAL IMPACT

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## 2.4 ENVIRONMENTAL IMPACT

### 2.4.1 INTRODUCTION

This section provides a description and summary of environmental programs related to the Jason and Tom properties. The focus is on how environmental issues could affect the process of developing a mine in Macmillan Pass. First is a description of the evolution and current status of the regulatory framework, then follows a brief summary of the history of environmental studies in the area, the main results of the studies completed to date and a discussion of the main issues likely to be raised in the future.

Enough work has now been done in Macmillan Pass to show that environmental concerns by themselves are not likely to be significant enough to prevent or significantly delay the development of a mine. However, environmental issues could involve considerable public and governmental participation. Such involvements can be time consuming and, with poor planning or bad luck, significantly delay development. Given the major financial consequences of unexpected delays and changes in schedule, the major result of environmental issues may not be field surveys or abatement technology, but meetings, politics and public relations. This section will give insight into both the scientific and political issues involved.

### 2.4.2 REGULATIONS AND GOVERNMENT POLICY

Primary responsibility for ensuring that the environmental impact of the pre-operational, operational, and abandonment phases of any northern mine development are

adequately assessed, is vested in the Federal Government through the Department of Indian and Northern Affairs (DINA), by means of the Environmental Assessment and Review Process (EARP). This legislation applies not only to potential impact upon biological systems, but also addresses the physical/chemical environment, aesthetics, and socio-economic aspects of the projects. Although the Federal Government has retained its lead role in assessments, DINA has delegated responsibility for socio-economic matters to the Yukon Territorial Government (YTG). The first formal step in initiating EARP is the formation of an Environmental Review Committee (ERC). There was no ERC in place in Yukon in the early 1980's. Proponents were expected to undertake studies, on their own initiative, to document the physical and biological baseline conditions on their properties. Both Abermin (as Pan Ocean Oil Ltd.) and HBM&S commenced and continued such studies while the regulatory mechanisms were being developed.

In January of 1981 a meeting of representatives from industry, the Federal Government and the Territorial Governments (NWT was involved because the Mactung and Howard's Pass areas were also being considered) was convened in Whitehorse. This was the first of five meetings of the Macmillan Pass Development Task Force held during 1980. The Task Force's purpose, stated in a letter from the Honourable Dan Lang, Minister of Tourism and Economic Development for YTG, to Pan Ocean on December 17, 1980, was to "provide a forum for senior executives and officials to continue the process of industry-government discussion and cooperation". An Environmental Sub-committee was also proposed at that time to "establish a mechanism for developing a single comprehensive environmental plan for the entire Macmillan/

Howard's Pass area". However, the Environmental Sub-committee never met. Its responsibilities were assumed by the Task Force representatives.

The meetings were almost exclusively devoted to discussion and debate concerning development options, proposals to industry from YTG to contribute funds towards socio-economic studies and cost sharing arrangements for regional biological work. These issues were never fully resolved. Nonetheless, regional wildlife work was initiated under the direction of the Renewable Resources Division of YTG. Eash of the four industrial members of the task force-Abermin, HBM&S, Amax and Placer Development-contributed $2,000 each towards a literature review of socio-economic implications of Macmillan Pass development, prepared by Stanley and Associates.

The federally constituted Environmental Review Committee, mentioned previously, was appointed in December 1981 and began to assume the lead role in environmental assessment. A set of draft requirements for the expected Initial Environmental Evaluation (IEE) was distributed in spring of 1982 with a request for response. The declining economy of the time resulted in no further action by Abermin or HBM&S. However, the Amax property has continued along the assessment pathway, with work now being reviewed by government officials in Yellowknife.

As of 1986, the ERC in Whitehorse is chaired by Bob Friesen of DINA. Socio-economic issues, the perview of Tony Hodge of DINA, are really administered by the Yukon Government. The person now in charge there is Bruce Demchuk,

Director of Major Projects. The probable sequence of events for a revived MacPass development project, according to Mr. Friesen, follows.

The first step would be to notify the committee of the project and to request a formal review. They would ask for a project description and time frame, sufficient to identify issues and permit requirements. They may follow this with a request for an IEE, if more information was needed on specific issues. The ERC now tends to focus on specific issues rather than on the general approach of former years. Given the amount of information available, the initial submission and even an IEE could probably be prepared from existing data, without additional field work. Mr. Friesen could not say that a MacPass development would not proceed to the further evaluations possible under EARP (ie. a full Environmental Impact Statement (EIS) via the complex process run by the Federal Environmental Assessment and Review Office (FEARO), but noted that recent projects have not gone beyond the IEE stage. He suggested that the pattern established by the Amax Project has been very satisfactory and that a Macmillan Pass project that followed their example would likely be well received. Amax has accumulated and provided a great amount of environmental information and has invited much public participation, almost certainly more than the minimum required by regulations.

Socio-economic issues still remain the responsibility of the YTG. The formal guidelines for project proponents that were being developed in 1981 were never accepted by territorial cabinet. There is at present no defined method for evaluating project consequences. There is the Yukon Benefits Committee, a federal/territorial group formed in mid

1984 mainly for Beaufort Sea projects, which sits on the ERC Committee. They are concerned with socio-ecnomic issues, but Mr. Demchuk suggests that should a major project be proposed before formal guidelines are developed, an ad-hoc review would be arranged, with all Yukon departments being asked to review the project using their own criteria as appropriate to their responsibilities. Further, a new federal/territorial process is about to begin. The Northern Land Use Planning process is now being developed which will almost certainly play a role in future development proposals.

The focus of part of the review process will be the likelihood that the project will meet existing legal requirements. However, actually addressing those requirements is a separate process. Aquatic issues come under the federal Northern Inland Waters Act and Fisheries Act. An application for water use licence must be made under the Northern Inland Waters Act. This is an important task. The process may require data, a public hearing and the establishment of site specific terms. This process can take over a year. Requirements under the Fisheries Act are generally included in the licence terms. Air emissions are dealt with under the Clean Air Act. No permit is required but submission and approval of air emissions plans will be necessary.

### 2.4.3 HISTORY

The first environmental work in the Macmillan Pass was the irregular collection of water samples by Cordilleran Engineering and Hudson Bay Mining and Smelting personnel between 1976 and 1980. A variety of government water studies were also completed. In 1980 Beak Consultants prepared an overview environmental review for Abermin, based upon existing

literature and a brief field trip. The same year Art Pearson and Associates prepared a literature review of the environmental characteristics of the Macmillan Pass area for HBM&S.

In early 1981 the Yukon Territorial Government formed a Task Force to help coordinate environmental requirements in the area, since early development was anticipated. Based upon Beak's recommendations, in-house evaluations and the decisions of the Task Force, Abermin initiated several projects in 1981. Monenco Consultants conducted a survey of aquatic biology of the Macmillan Pass area and the water sampling program was consolidated and expanded by company staff. A series of in-house reclamation studies began along with a study of the vegetation and flora of both Jason and Tom Properties (the latter in return for HBM&S support of other water studies). HBM&S commissioned Ken Weagle to study the waters of Macmillan Pass in 1981, and both companies contributed money to government agencies to support regional bird, mammal and socio-economic studies.

In 1982, plans for expanded studies were cancelled as were the larger parts of the reclamation studies, although funding for government projects and onsite work continued. In 1983 and subsequent years the initial revegetation studies, vegetation maps and regional flora were completed as well as a brief study of two rare plants identified during the botanical survey. Aquatic studies have continued but on a very reduced basis. These later studies have been funded by Abermin and the Federal Government. The territorial government has completed its regional wildlife work.

## 2.4.4 RESULTS OF WORK

The Macmillan Pass area has three mineral properties which have, at various times, seemed likely prospects for development: Amax's MacTung Property, about 8 kilometres to the northwest on the Yukon-N.W.T. border as well as Jason and Tom. Each has sponsored environmental studies. In addition, biological studies were undertaken at Cirque Lake, near MacTung, by the International Biological Program, and a variety of regional studies have been completed by Yukon and Northwest Territories Government biologists. DINA has completed hydrology, water chemistry and snow surveys which include the Macmillan Pass area. (It should be noted that the work that has been sponsored has examined those subjects that government agencies and the public tend to feel are important. While those studies are relevant there are subjects which some scientists may feel are significant, such as ecosystem processes or soil mychorhiza, that have not been studied. It is unlikely that the focus of applied studies will change in the near future, and thus the limitations placed on this work are probably appropriate). The principal results from the MacPass studies, excluding Amax's, which are not available, are assembled below.

## 2.4.5 BIOLOGICAL STUDIES

No wildlife studies have been conducted specific to just the Tom or Jason properties, although some casual observations have been recorded. Environmental overviews of the Jason and Tom properties by Beak Consultants and Art Pearson and Associates and onsite observations support the view that the sites support wildlife typical of a wilderness, mountain area.

Of the larger mammals, caribou, moose, grizzly bear, black bear, wolf and wolverine are all known on site. Several observations suggest that there may be separate, small caribou herds in the mountains to the west and east of the Macmillan Valley, around Enigma and Sekie Mountains, respectively. No sheep have been reported from either the Jason or Tom sites, but there are sheep known from studies in the MacTung area and geologists have seen sheep in mountains west of Nidd Creek.

The regional mammal studies completed by YTG have augmented the data base for the area, although they do not add much detail about the project sites. They do indicate some of the potential significance of development to the large animal populations of the North Canol/Macmilland Pass area.

The bird populations of the MacPass area itself have received little special attention to date, although two of the YTG regional surveys examined the North Canol/Macmillan Pass area. They noted relatively little waterfowl use of the Macmillan Pass area itself and noted a recently abandoned golden eagle nest near the MacPass airfield. That study concluded that exploration activity was probably responsible for the displacement of one gyrfalcon pair and possibly two golden eagle pairs from the Macmillan Pass area.

Site-specific aquatic/fisheries studies have been done on the Jason Property by Monenco Consultants and on the Tom Property by Ken Weagle. Monenco found a few small Arctic grayling on site in July in the more downstream parts of the Macmillan River within the property, but none in June. They felt that the MacPass area of the river offered limited fisheries potential. Weagle's results are similar. Monenco found no salmon during the helicopter survey of the upper

regions of the Hess River drainage to the west of the Jason Property, but noted the potential significance of such populations. Regional fisheries work by the Yukon Government provides support for those concerns.

Monenco's studies of stream insects found populations similar to other Yukon locales. There was little biological activity noted in several streams of very high natural acidity.

A regional vegetation survey of the east central Yukon, including the Macmillan Pass area, was completed by the Ecological Land Survey (ELS). Site specific vegetation maps have been completed and a survey of local plants species was completed. The forest and alpine communities seem typical for the region. Two rare plant species were identified, but a follow-up study showed moderately large local populations and good chances that other populations exist in the area. Revegetation studies show that fertilizer is essential for the area. The tests also resulted in development of two species mixes that may be useful and revealed a native grass that shows excellent potential for local reclamation use.

### 2.4.6 CLIMATE, GEOMORPHOLOGY AND SOILS

Amax maintained a weather station at the Tsichu River airstrip for a number of years and for some time reported their readings in Environment Canada's publication Monthly Record fo Meteorological Observations. Hudson Bay had some weather instruments at their base camp, although the current location of the records is not known. Temperature and rainfall were recorded at Jason during the summer of 1982.

The regional ELS study has some discussion of the geomorphology and soils of the area, but no limited field work was done at Jason and Tom. Some features of note, discovered during vegetation studies, are patches of permafrost in the forested part of the north-facing slope of the Tom Property, above the Canol Road, and the permafrost-cored palsas, in the wetlands of the valley.

### 2.4.7 HYDROLOGY AND WATER CHEMISTRY

Data accumulated by DINA's water survey branch show the streams of Macmillan Pass and Jason to have typical mountain hydrographs, with peak flows due to spring runoff and autumn rainfall. Snow survey results are also available from DINA.

There has been more study of the water chemistry of the Jason and Tom areas than of any other feature. Studies have been undertaken by HBM&S, Abermin and the Inland Waters Branch and Environmental Protection Service of the federal government. These studies show stream chemistry to be normal for these areas. There are occasional high concentrations of some elements, but this is not unusual in mineralized areas. The naturally acid nature of several streams is well documented.

### 2.4.8 ARCHAEOLOGICAL, SOCIAL AND ECONOMIC ISSUES

A regional archaeological study was completed in association with the ELS study. There was regular but infrequent human use of the area in prehistoric times. Apparently the Macmillan Pass was used mostly as a travel route and there were no regular residents. No major archaeological sites were discovered.

The only formal study of a social issue has been the Stanley overview of housing options for Macmillan Pass: fly-in versus permanent settlement. The YTG study of furbearers in the region also has a socio-economic context.

### 2.4.9 CONCLUSION

The major biological, chemical and historical issues have all been addressed. While more work on all of them is possible and even probable, it is unlikely that these areas will offer suprises. These subjects do not appear likely to offer prospects of serious, unexpected delay to development of a mine if the appropriate studies are undertaken and appropriate environmental protection measures are adopted. These things do take time and cannot be added on at the end, but if addressed continuosly and simultaneously with the evolution of development plans, environmental issues can be successfully incorporated into plans with little disruption of schedules. In principle this is also true for socio-economic matters, but two special problems exist in this area. Not only is there little accumulated data from the first round of interest in MacPass development, but there is still no organized governmental mechanisms for dealing with such issues. These two circumstances offer potential for significant confusion and delay, and appropriate early attention should be paid to coordination of socio-economic projects should development be considered.

The matters that are likely to be discussed in a contemporary review of issues and IEE are those that have already been raised and studies in the earlier discussions: they are still important. The main issues will probably be large mammals, particularly caribou and grizzly bear; water

quality in general with special concern to salmon in particular; social issues with regional economic impact and local social impact being the main points (note that local issues will include native issues); and land reclamation and post mining site management. It is impossible to say what will happen, but the best guess is that the existing data base will be sufficient to make general policy (with the exception of socio-economic issues).

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# HUDSON BAY MINING AND SMELTING CO., LIMITED

AND

# ABERFORD RESOURCES LIMITED

## TOM / JASON PROJECT

YUKON TERRITORY

# CAPITAL COST STUDY

OFFICE OF THE REGIONAL MANAGER
MINERAL RIGHTS
FEB 17 1986
WHITEHORSE
YUKON TERRITORY

PREPARED BY

BECHTEL CANADA ENGINEERS LIMITED

APRIL 1985

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CANADA

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FEB 1986
MINING RECORDER
WATSON LAKE, Y.T.
I.A. & N.D.

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HUDSON BAY MINING AND SMELTING CO. LIMITED

AND

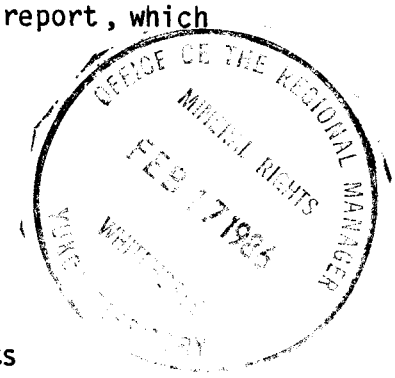
ABERFORD RESOURCES LIMITED

TOM/JASON PROJECT

CAPITAL COST STUDY

Hudson Bay Mining and Smelting Co. Limited and Aberford Resources Limited are preparing a Feasibility Study for the joint development of two adjacent lead-zinc (silver) properties located near the Macmillan Pass, Yukon Territory. The two properties, Tom and Jason, are principally owned by Hudson Bay and Aberford respectively.

This Capital Cost Study has been prepared by Bechtel Canada Engineers Limited and will form Section 3 of the overall Feasibility Study. The other sections of the study are being prepared by Hudson Bay and Aberford, who will incorporate Section 3 into the whole report, which will comprise:




| | | |
|---|---|---|
| Section One | - | Summary Report |
| Section Two | - | Technical Reports |
| Section Three | - | Capital Cost Study |
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TOM/JASON PROJECT

SECTION 3 CAPITAL COST STUDY

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# 3.1 CAPITAL COST ESTIMATE

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## 3.1 CAPITAL COST ESTIMATE

### 3.1.1 INTRODUCTION

The following estimate of capital cost covers the scope and quality of those facilities described in Sections 3.5 through 3.12 hereafter, required for the complete grass-roots mine, processing plant and ancillaries to process 4500 tons per day of ore from the Tom and Jason mines. The facilities and systems described represent a "Base Case" workable project, developed from limited data and assumptions, applying best judgement and preliminary engineering. It is recognized that prior to proceeding with implementation of the project, the assumptions must be verified and additional data obtained. Locations of the various facilities, equipment selections, etc., may be optimized from this Base Case as further information is developed, with the objective of reducing the capital cost.

The report has been prepared generally using English units or measurement. In some instances metric units have been used, primarily for distance and elevation, for consistency and ease of reference to available topographic maps which had been prepared in that system.

Estimated project cost are tabulated in Section 3.2, which contains an overall summary, a schedule of capital expenditures from Notice to Proceed through Year 5, cost sheets for each facility at the direct level, construction distributable summaries, and contingency analyses. Also included are all-in estimates of cost for the Haines Terminal and, for possible future application, a conveyor haulage option for ore from Jason mine to the concentrator.

Major quantities have been provided for the following commodities and/or categories of work:

- o Equipment
- o Earthwork
- o Concrete
- o Steel
- o Siding & Roofing
- o Architectural & Building Finish
- o Wire and Cable
- o Raceway
- o Piping

The definition of various direct and indirect (distributable) cost categories is provided later in this section.

### 3.1.2 METHODOLOGY

This estimate has been prepared using procedures, techniques and data sources normally employed by Bechtel. In brief this involves:

- o Site visit to evaluate location conditions - site access and topography, sources of power and water, material and labour, etc.

- o Defining work content (scope).

- Estimating the direct cost applicable to each facility by work category:

  a) Developing material and equipment quantities to be purchased and installed.

  b) Developing current pricing for materials and equipment by soliciting quotations from suppliers and/or Bechtel's in-house data.

  c) Establishing manual labour cost per hour for materials and equipment installation, using current union wage rate agreements for applicable crafts as guidelines, and appropriate crew mix required to perform the work.

  d) Evaluating manual labour manhours to install materials and equipment.

- Estimating the indirect (or distributable) cost such as:

  a) Temporary construction facilities, power, water, fuel, etc.; construction equipment and tools; material handling, warehousing, general clean-up, safety, medical and security, etc.

  b) Construction office non-manual staff payroll, taxes, insurances and fringe benefits and cost of operating the office.

  c) Engineering and project services cost.

At least three methods are normally used, independently or in combination, in preparation of a cost estimate. The choice depends on estimate objectives and the nature of the facility to be evaluated. The three methods are direct pricing, unit cost, and indexing.

An appropriate method from the aforementioned was selected depending upon the quality of the information and data available, and uniqueness of the item being evaluated.

### 3.1.3 DEFINITION OF COST CATEGORIES

#### .1 Direct Costs

Direct cost comprise all permanent equipment, materials, installation, labour and services:

- Blasting agents, concrete forming and curing materials, material handling from storage to point of installation, directly related cleanup and surveying, vendor's erection supervision, sales taxes and duty.

- Clearing the property of bush, trees, debris, and obstruction; surface and road drainage; slope protection; stripping and rough grading; finish grading; landscaping; fencing and gates for permanent plant and substations; roads; parking; road signs and guardrails; power distribution

including substations outside buildings; water lines; construction gate guardhouse; communications network; etc.

- Mass and detail excavation and disposal for building, equipment and tank foundations; backfilling and compacting; shoring and dewatering; concrete including formwork, rebar and embeds for footings, piers, grade, basement or pit walls; walls and floor slab special finishings.

- Structural steel for columns, girts, purlins, sag rods, trusses, crane beams, etc., and miscellaneous steel for platforms, walkways, landings, stairs, floor decking, and support framework; elevated floor concrete; siding and roofing; exterior block walls; built-up roofing and roof support decking.

- Exterior doors and windows, louvres, interior walls/partitions, doors, false ceiling, built-in cabinets and cupboards, finishes and coverings for walls, floors, and ceilings.

- Lighting - panels, transformer, fixtures, wire and cable and conduit; HVAC - heaters, fans, boilers, compressors, roof exhausters/ventilators, air conditioners and ductwork; plumbing/sewer/service water - fixtures, instruments, support and insulation; fire protection, etc.

- Mechanical equipment such as grinding mills, tanks, cranes, air compressors, sewage and water treatment plant, river water pumps, etc.

.2 Construction Distributables

Construction distributables include those cost which cannot be directly or conveniently identified with specific permanent facility or structure, but are incurred in constructing the facility or structure:

- Temporary construction facilities such as work areas and bays, roads and parking, temporary offices, fabrication shops; construction plants - batch plant, aggregate plant, etc.; temporary power, light, communication, water, air, steam and sanitary; weather protection, general scaffolding.

- General and final clean-up, material handling and warehousing, craft training and testing, security, first aid, soil investigations, site surveys, operation and maintenance of construction facilities, pre-op testing, manual labour allowances.

- Construction equipment, tools and consumables and their maintenance, freight and transportation.

- Construction camp, camp maintenance and catering.

.3 Engineering and Project Services

Engineering and project services include:

- Cost of project office staff and services such as project management, engineering, cost and scheduling, procurement, construction support, finance and accounting, legal and insurance, labour relations and safety.

- Costs related to construction non-manual staff and operating cost of the construction office.

.4 Contingency

All estimates involve the application of pricing for equipment, materials and labour to a given scope which is described in terms of quantity and quality. This scope description generally includes three levels of definition:

- Explicit definition which includes quotations, drawings, etc.

- Implicit definition which includes items normally encountered on a project but not explicitly defined.

- No definition, which includes special project developments which cannot logically be defined or foreseen.

Contingency is the amount of money included in an estimate or forecast based on historical experience to cover the following:

- Errors or omissions in the evaluation of explicit definition.

- Errors or omissions in the evaluation of implicit definition.

- Special project developments which may be encountered but are difficult or impossible to quantify at the time the estimate is prepared. Typical items include:

    Labour strikes/walkoffs
    Schedule delays
    Labour availability
    Poor soil conditions
    Equipment and material deliveries
    (Sub)contract claims.

The contingency allowance is added to the estimated cost to yield anticipated total project cost. It is an amount which is expected to be used.

It is to be noted that contingency is not an allowance for changes in the defined scope of a project or an allowance for circumstances beyond normal experience and/or control. Contingency does not cover cost associated with: actions taken by regulatory agencies; force majeures such as wars, crimes, sabotage,

catastrophies, political influences, and major fires or accidents; commercial changes such as changes in federal or state, or local taxes, interest rates, etc.; extraordinary monetary fluctuations such as major changes in escalation and foreign currency exchange rates.

### 3.1.4 ESTIMATE PREPARATION

#### .1 Quantity Development

Quantity take-offs were made from the drawings prepared for the study for earthwork, major buildings, siding and roofing, tanks and bins, power cable and yard piping.

The balance of bulk material quantities were developed by applying appropriate historical factors to unique sizes and specifications established for this project.

#### .2 Pricing

The estimate is expressed in Canadian dollars and reflects 1st Quarter 1985 pricing level and market conditions. Since project execution is not scheduled, escalation does not form part of this estimate.

Quotations were received on the major mechanical and mobile equipment comprising 60% of the total equipment dollars. All other mechanical equipment was priced using current in-house data. Electrical equipment was priced from catalog data with appropriate discounts considered.

Quotations were received on selected civil bulk materials, i.e. cement, rebar, concrete batching. All other bulk material pricing is from current in-house sources.

Cost of the accommodation complex was estimated based on historical and current data. (Refer to Section 3.11)

Manual labour rates are based on a seventy (7 x 10) hour work week, non union equivalent wage rate, time and one half for overtime after forty hours.

Where applicable, taxes and duties have been included in the body of the estimate.

.3 Construction Distributables

Temporary construction facility requirements were established based on previous Arctic projects.

Construction support services were calculated based on a nominal 21 month construction program.

A 350 bed construction camp is included, with credit for existing facilities considered in pricing.

Construction equipment requirements were evaluated and durations established to develop pricing.

Quotations were received on catering, fuel and communications services.

Quotations were received for road freight cost from various southern points to Ross River. Costs for a staging area to consolidate freight at Ross River and transportation from Ross River to jobsite are included.

Personnel movement cost were based on commercial airfare to Whitehorse and charter air services between Whitehorse and Macmillan Pass. A rotation schedule of 45 days was used for calculating number of trips.

Costs for contractor supervision have been included as a percent of total direct and distributable cost using historical experience.

.4 Engineering and Project Services

Project services, comprising design engineering, procurement, cost and schedule control and project management, have been included as a percent of total field cost.

.5 Contingency

The contingency analysis is shown on page 3-31.

## .6 Estimating Responsiblities

The capital cost of estimates which follow in Section 3.2 were prepared by Bechtel. They include a portion of the total cost estimates for the Tom mine and for the Jason mine. The balance of the estimates for the mines were prepared by Hudson Bay Mining and Smelting's Mining department. The division of responsibilities in this respect is shown in the tabulation below:

### Tom Mine

| | |
|---|---|
| Underground mine development including tunnel | HBM&S |
| Concrete for tunnel portal | HBM&S |
| Crusher station excavation | HBM&S |
| Crusher & conveying - mechanical | Bechtel |
| Crusher station foundations and steel | Bechtel |
| Power distribution and lighting | HBM&S |
| Water, air, dewatering piping | HBM&S |
| Mine air compressors | Bechtel |
| Mine air heater | Bechtel |
| Mine ventilation fans | HBM&S |
| Temporary power generation | HBM&S |
| Mining equipment | HBM&S |
| Camp catering, mine development personnel | HBM&S |

### Jason Mine

| | |
|---|---|
| Headframe and hoisting facilities | Bechtel |
| Shaft sinking and collar | HBM&S |
| Underground mine development | HBM&S |
| Crusher & conveying - mechanical | HBM&S |

Jason Mine (Cont'd)

| | |
|---|---|
| Crusher station civil | HBM&S |
| Power distribution and lighting | HBM&S |
| Water, air, dewatering piping | HBM&S |
| Mine air compressors | Bechtel |
| Mine ventilation fan & heater | Bechtel |
| Power generation equipment - from permanent plant | Bechtel |
| Mining equipment | HBM&S |

### 3.1.5 ESTIMATE QUALIFICATIONS

- Ore haul trucks are included in the base estimate. Conveyor system from Jason headframe to concentrator is shown as an option.

- Mobile equipment required for permanent plant operation will be purchased early and utilized for construction purposes.

- Existing camp facilities have been considered in pricing total construction needs.

- Due to limited geotechnical data available competent rock was assumed for foundation design.

- North Canol Road ongoing upgrading program to enable normal highway (44,000 lbs) payloads will be completed prior to construction start.

- Manual labour estimate is based on non-union rates. Should project be executed by unionized labour, there will be an additional cost of $14.0 million to the project.

- Tailings impoundment dams are sufficient for 10 years of operation.

- Estimate reflects first quarter 1985 economic and market conditions.

- Estimate reflects programme shown in 3.3 Project Schedule.

- Haines Terminal arrangement and estimate are derived from a study performed by others for another Yukon minerals project, and presented to the City of Haines.

### 3.1.6 ESTIMATE EXCLUSIONS

- Upgrading cost for North Canol Road (Government).
- Maintenance of the North Canol Road during construction (Government).
- Concentrate haul trucks.
- Propane tanks (by vendor).
- Working capital.
- Financing cost.
- Project insurance, permits, licenses, approvals.
- Cost of preparing this or any other studies.
- Items identified as HBM&S responsiblity on page 3-13 of this presentation.
- Escalation.
- Property acquisitions.

### 3.1.7 ESTIMATE ACCURACY

This estimate is considered to have an overall accuracy of plus 15%, minus 10% at the 90% probability level. Stated differently, there is a 90% probability that the cost will fall within the range extending 15 percent more, and 10 percent less than the total estimated cost shown on the project cost summary, for the described scope of work.

## 3.2 ESTIMATE SUMMARIES

### CONTENTS


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## PROJECT COST SUMMARY

| | Manhours x 1000 | $ x 1000 Labour | $ x 1000 Material & Equip. | $ x 1000 Total |
|---|---|---|---|---|
| **Facilities** | | | | |
| Tom Mine | 89 | 2,186 | 8,044 | 10,230 |
| Jason Mine | 41 | 1,007 | 4,383 | 5,390 |
| Coarse Ore Storage | 34 | 821 | 1,729 | 2,550 |
| Concentrator | 331 | 8,186 | 23,854 | 32,040 |
| Power Plant & Service Bldg. | 150 | 3,701 | 16,659 | 20,360 |
| Yard Facilities | 195 | 4,851 | 13,279 | 18,130 |
| Airstrip | 13 | 314 | 1,276 | 1,590 |
| Subtotal Facilities - Direct Costs | 853 | 21,066 | 69,224 | 90,290 |
| **Construction Distributables** | | | | |
| Construction Facilities | 57 | 1,348 | 4,052 | 5,400 |
| Construction Support | 220 | 6,427 | 13,673 | 20,100 |
| Construction Camp | 137 | 6,160 | 240 | 6,400 |
| Construction Equipment | 61 | 1,440 | 9,160 | 10,600 |
| Subtotal Construction Distributables | 475 | 15,375 | 27,125 | 42,500 |
| **Accommodation Complex** | | | | 9,900 |
| **General Allocations** | | | | |
| Mobile Equipment | | | | 2,340 |
| Initial Fill of Lubricants & Glycol | | | | 100 |
| Geotechnical Investigations | | | | 500 |
| Plant Start Up Assistance | | | | 1,000 |
| Capital Spares | | | | 1,000 |
| Subtotal General Allocations | | | | 4,940 |
| **Engineering and Project Services** | | | | 17,500 |
| **Contingency** | | | | 19,670 |
| **Total Estimated Cost - Site Facilities** | | | | 184,800 |
| **Estimated Cost - Haines Terminal** | | | | 10,000 |

TABLE 3.2-1

## EXPENDITURE BY YEAR

| | Total | Year A Apr-Mar | Year 1 Apr-Mar | Year 2 Apr-Mar | Year 3 Apr-Mar | Year 4 Apr-Mar | Year 5 Apr-Mar |
|---|---|---|---|---|---|---|---|
| Tom Mine | 10,230 | | - | 8,530 | 940 | - | 760 |
| Jason Mine | 5,390 | | 200 | 5,190 | | | |
| Coarse Ore | 2,550 | | 2,550 | - | | | |
| Concentrator | 32,040 | | 16,500 | 15,540 | | | |
| Power Plant & Service Bldg | 20,360 | | 13,820 | 6,540 | | | |
| Yard Facilities | 18,130 | | 7,760 | 10,370 | | | |
| Airstrip | 1,590 | | 1,590 | - | | | |
| Construction Facilities | 5,400 | | 4,500 | 900 | | | |
| Construction Support | 20,100 | | 11,780 | 8,320 | | | |
| Construction Camp | 6,400 | | 4,680 | 1,720 | | | |
| Construction Equipment | 10,600 | | 6,580 | 4,020 | | | |
| Accommodation Complex | 9,900 | | 1,000 | 8,900 | | | |
| Mobile Equipment | 2,340 | | 2,340 | - | | | |
| Initial Fills | 100 | | | 100 | | | |
| Geotechnical Inv. | 500 | 500 | - | - | | | |
| Plant Start Up Assist. | 1,000 | | - | 900 | 100 | | |
| Capital Spares | 1,000 | | - | 750 | 250 | | |
| Eng. & Proj. Services | 17,500 | 5,000 | 7,500 | 5,000 | | | |
| Contingency | 19,670 | 500 | 9,200 | 9,820 | 110 | - | 40 |
| Total - Site Facilities | 184,800 | 6,000 | 90,000 | 86,600 | 1,400 | - | 800 |
| Haines Terminal | 10,000 | | 3,000 | 6,000 | 1,000 | | |

TABLE 3.2-2

## FACILITY COST SUMMARY
## AT DIRECT LEVEL

| | Quantity | Unit | $ x 1000 Labour | Material & Equip. | Total |
|---|---|---|---|---|---|
| **TOM MINE** | | | | | |
| Crusher Station (3 ea) | | | | | |
| - Concrete | 90 | CY | 22 | 14 | 36 |
| - Steel | 195 | Ton | 187 | 390 | 577 |
| - Electrical Room | 1 | Lot | 22 | 60 | 82 |
| Conveyor Supports | 1,600 | Ea | 38 | 80 | 118 |
| Feeder Supports | 8 | Ton | 7 | 16 | 23 |
| Conveyor Gallery | 240 | LF | 55 | 147 | 202 |
| Heater Housing | 1 | Lot | 12 | 15 | 27 |
| Belt Conveyor (6 ea) | 12,050 | LF | 1,582 | 5,212 | 6,794 |
| Air Compressor | 2 | Ea | 94 | 550 | 644 |
| Mine Air Heater System | 1 | Lot | 10 | 100 | 110 |
| Jaw Crusher | 3 | Ea | 37 | 850 | 887 |
| Water Treatment System | 1 | Lot | 2 | 10 | 12 |
| Tramp Iron Magnet | 3 | Ea | 11 | 45 | 56 |
| Dust Collector | 3 | Ea | 7 | 33 | 40 |
| Vibrating Feeder | 7 | Ea | 17 | 140 | 157 |
| Service Crane | 3 | Ea | 15 | 120 | 135 |
| Chutework | 66 | Ton | 68 | 232 | 300 |
| Explosives Magazine | 1 | Ea | | 30 | 30 |
| Subtotal Tom Mine | | | 2,186 | 8,044 | 10,230 |

TABLE 3.2-3

## FACILITY COST SUMMARY
## AT DIRECT LEVEL

| | Quantity | Unit | $ x 1000 Labour | Material & Equip. | Total |
|---|---|---|---|---|---|
| **JASON MINE** | | | | | |
| Headframe/Hoist House Civil | 1 | Lot | 389 | 836 | 1,225 |
| Fan/Heater Foundations | 50 | CY | 10 | 7 | 17 |
| Mine Hoist | 1 | Ea | 168 | 2,000 | 2,168 |
| Mine Air Compressor | 2 | Ea | 94 | 550 | 644 |
| Mine Ventilation Fan & Heater | 1 | Lot | 37 | 300 | 337 |
| Bin Gates | 2 | Ea | 2 | 20 | 22 |
| Water Treatment Systems | 1 | Lot | 2 | 10 | 12 |
| Repair Shop Equipment | 1 | Lot | | 50 | 50 |
| Electrical Equipment | 1 | Lot | 51 | 296 | 347 |
| Raceway | 1,100 | LF | 26 | 11 | 37 |
| Wire & Cable | 26,800 | LF | 64 | 90 | 154 |
| Grounding | 1,000 | LF | 8 | 4 | 12 |
| Lighting | 1 | Lot | 57 | 50 | 107 |
| HVAC | 1 | Lot | 22 | 75 | 97 |
| Piping | 2,000 | LF | 67 | 53 | 120 |
| Fire Protection | 1 | Lot | 10 | 31 | 41 |
| Subtotal Jason Mine | | | 1,007 | 4,383 | 5,390 |

TABLE 3.2-4

## FACILITY COST SUMMARY
## AT DIRECT LEVEL

| | Quantity | Unit | $ x 1000 Labour | Material & Equip. | Total |
|---|---|---|---|---|---|
| **COARSE ORE STORAGE** | | | | | |
| Excavation, Rock | 13,500 | CY | 259 | 405 | 664 |
| Concrete | 600 | CY | 101 | 90 | 191 |
| Steel | 237 | Ton | 156 | 522 | 678 |
| Siding/Roofing | 19,000 | SF | 41 | 96 | 137 |
| Shuttle Conveyor | 50 | LF | 17 | 60 | 77 |
| Reclaim Conveyor | 450 | LF | 67 | 225 | 292 |
| Hoist | 1 | Ea | 2 | 15 | 17 |
| Vibrating Feeder | 3 | Ea | 6 | 50 | 56 |
| Chutework | 20 | Ton | 20 | 70 | 90 |
| Misc. Mechanical | 1 | Lot | 2 | 7 | 9 |
| Electrical | 1 | Lot | 75 | 76 | 151 |
| Lighting | 1 | Lot | 34 | 22 | 56 |
| Piping | 1,500 | LF | 31 | 29 | 60 |
| Instrumentation | 1 | Lot | 5 | 45 | 50 |
| Fire Protection | 1 | Lot | 5 | 17 | 22 |
| Subtotal Coarse Ore Storage | | | 821 | 1,729 | 2,550 |

TABLE 3.2-5

FACILITY COST SUMMARY
AT DIRECT LEVEL

| | Quantity | Unit | $ x 1000 Labour | Material & Equip. | Total |
|---|---|---|---|---|---|
| CONCENTRATOR | | | | | |
| Excavation, Rock | 16,400 | CY | 235 | 410 | 645 |
| Backfill | 7,900 | CY | 31 | 89 | 120 |
| Concrete | 10,400 | CY | 1,620 | 1,560 | 3,180 |
| Steel | 2,055 | Ton | 1,009 | 3,960 | 4,969 |
| Siding & Roofing | 194,000 | SF | 368 | 900 | 1,268 |
| Architectural Finishes | 1 | Lot | 50 | 37 | 87 |
| Storage Dome | 2 | Ea | 58 | 242 | 300 |
| Mill, Primary | 1 | Ea | 247 | 1,950 | 2,197 |
| Mill, Pebble | 2 | Ea | 247 | 1,630 | 1,877 |
| Mill, Regrind | 1 | Ea | 49 | 550 | 599 |
| Pressure Filter | 4 | Ea | 60 | 2,093 | 2,153 |
| Flotation Cell | 39 | Ea | 189 | 1,571 | 1,760 |
| Thickener & Mechanism | 2 | Ea | 190 | 508 | 698 |
| Cyclone | 3 | Ea | 15 | 206 | 221 |
| Onstream Analyzer | 1 | Lot | 7 | 164 | 171 |
| Reagent Systems | 11 | Lot | 32 | 120 | 152 |
| Pump | 71 | Ea | 153 | 965 | 1,118 |
| Air Blower | 4 | Ea | 19 | 117 | 136 |
| Air Compressor | 5 | Ea | 17 | 205 | 222 |
| Belt Conveyor (13 Ea) | 920 | LF | 118 | 456 | 574 |
| Belt Feeder | 4 | Ea | 30 | 260 | 290 |
| Tanks & Bins | 12 | Ea | 49 | 175 | 224 |
| Chute & Platework | 76 | Ton | 74 | 280 | 354 |
| Crane | 2 | Ea | 25 | 200 | 225 |
| Sampler | 6 | Ea | 7 | 60 | 67 |
| Agitator | 6 | Ea | 14 | 50 | 64 |
| Pebble Screen | 1 | Ea | 5 | 25 | 30 |
| Belt Scale | 1 | Ea | 2 | 15 | 17 |
| Vendor Rep's | 700 | Days | | 350 | 350 |
| Misc. Mechanical | 1 | Lot | 2 | 9 | 11 |
| HVAC | 1 | Lot | 181 | 555 | 736 |
| Piping | 45,500 | LF | 1,637 | 1,323 | 2,960 |

TABLE 3.2-6
Sheet 1

FACILITY COST SUMMARY
AT DIRECT LEVEL

| | Quantity | Unit | $ x 1000 Labour | Material & Equip. | Total |
|---|---|---|---|---|---|
| CONCENTRATOR (cont'd) | | | | | |
| Fire Protection/Detection | 1 | Lot | 70 | 155 | 225 |
| Switchgear & Transformer | 1 | Lot | 24 | 268 | 292 |
| Motor Control Centre | 8 | Ea | 46 | 232 | 278 |
| H.V. Starter | 9 | Ea | 14 | 181 | 195 |
| Other Electrical Equip. | 1 | Lot | 106 | 100 | 206 |
| Raceway | 9,400 | LF | 216 | 90 | 306 |
| Wire & Cable | 234,000 | LF | 502 | 642 | 1,144 |
| Grounding | 3,500 | LF | 12 | 13 | 25 |
| Lighting | 1 | Lot | 306 | 299 | 605 |
| Communications | 1 | Lot | 25 | 14 | 39 |
| Instrumentation | 1 | Lot | 125 | 825 | 950 |
| Subtotal Concentrator | | | 8,186 | 23,854 | 32,040 |

TABLE 3.2-6
Sheet 2

## FACILITY COST SUMMARY
## AT DIRECT LEVEL

| | Quantity | Unit | $ x 1000 Labour | Material & Equip. | Total |
|---|---|---|---|---|---|
| **POWER PLANT & SERVICE BUILDING** | | | | | |
| Excavation, Rock | 7,000 | CY | 101 | 175 | 276 |
| Backfill | 5,200 | CY | 19 | 63 | 82 |
| Concrete | 4,100 | CY | 638 | 615 | 1,253 |
| Steel | 1,000 | Ton | 456 | 1,848 | 2,304 |
| Siding & Roofing | 135,000 | SF | 254 | 618 | 872 |
| Fireproofing | 1 | Lot | 36 | 64 | 100 |
| Interior Finish | 50,000 | SF | 240 | 250 | 490 |
| Office Furnishings | 1 | Lot | | 200 | 200 |
| Warehouse Shelving | 1 | Lot | | 50 | 50 |
| Diesel Generator | 5 | Ea | 124 | 8,500 | 8,624 |
| Vendor Rep. | 300 | Days | | 150 | 150 |
| Crane | 3 | Ea | 20 | 295 | 315 |
| Air Compressor | 2 | Ea | 7 | 70 | 77 |
| Water Treatment, Filter, Chlor. | 1 | Lot | 5 | 40 | 45 |
| Shop Equipment | 1 | Lot | | 630 | 630 |
| Lab Equipment | 1 | Lot | | 300 | 300 |
| Pump | 10 | Ea | 13 | 60 | 73 |
| Service Elevator | 1 | Ea | 37 | 150 | 187 |
| Hot Water System | 1 | Lot | 5 | 33 | 38 |
| Exhaust Stacks | 1 | Lot | 10 | 50 | 60 |
| Misc. Mechanical Equip. | 1 | Lot | 2 | 28 | 30 |
| HVAC | 1 | Lot | 242 | 825 | 1,067 |
| Piping | 16,000 | LF | 450 | 310 | 760 |
| Fire Protection/Detection | 1 | Lot | 105 | 207 | 312 |
| Communications | 1 | Lot | 30 | 31 | 61 |
| Switchgear & Transformer | 1 | Lot | 33 | 267 | 300 |
| Motor Control Centre | 4 | Ea | 25 | 114 | 139 |
| Other Electrical Equip. | 1 | Lot | 76 | 74 | 150 |
| Raceway | 6,300 | LF | 136 | 57 | 193 |
| Wire & Cable | 157,000 | LF | 329 | 372 | 701 |
| Grounding | 3,000 | LF | 8 | 11 | 19 |
| Lighting | 1 | Lot | 300 | 202 | 502 |
| Subtotal Power Plant & Service Building | | | 3,701 | 16,659 | 20,360 |

TABLE 3.2-7

## FACILITY COST SUMMARY
## AT DIRECT LEVEL

| | Quantity | Unit | $ x 1000 Labour | Material & Equip. | Total |
|---|---|---|---|---|---|
| **YARD FACILITIES** | | | | | |
| Clear & Grub | 85 | Ac | 60 | 119 | 179 |
| Site Earthworks | | | | | |
| - Jason Headframe Area | 102,000 | CY | 156 | 344 | 500 |
| - Concentrator/Power Plant | 300,000 | CY | 411 | 925 | 1,336 |
| - Roads & Pipelines | 116,000 | CY | 254 | 689 | 943 |
| - Water Supply Pond | 22,000 | CY | 31 | 65 | 96 |
| * - Tailings Thickener/Reclaim | 71,000 | CY | 128 | 293 | 421 |
| * - Tailings Containment | 430,000 | CY | 1,138 | 2,370 | 3,508 |
| *Impervious Liner | 240,000 | SF | 54 | 179 | 233 |
| *Reclaim Pumphouse/Intake | 1 | Ea | 77 | 80 | 157 |
| *Surge Tank Enclosure | 1 | Ea | 24 | 25 | 49 |
| *Dump Valve Enclosure | 1 | Ea | 5 | 3 | 8 |
| *Tailings Overflow Structure | 1 | Ea | 5 | 20 | 25 |
| *Tailings Pumphouse | 1 | Ea | 3 | 7 | 10 |
| *Thickener Weather Cover | 1 | Ea | 24 | 126 | 150 |
| *Thickener Tank & Mechanism | 1 | Ea | 96 | 520 | 616 |
| *Tailings Overflow Treatment | 1 | Ea | 5 | 25 | 30 |
| Bridge Crossing | 50 | LF | 9 | 35 | 44 |
| Drainage Control | 1 | Lot | 24 | 76 | 100 |
| Fencing | 2,600 | LF | 24 | 38 | 62 |
| Concrete | 520 | CY | 86 | 78 | 164 |
| Water Pumphouse/Intake | 1 | Ea | 72 | 50 | 122 |
| Fuel Oil Pumphouse | 1 | Ea | 10 | 10 | 20 |
| Fire/Ambulance/Security | 1 | Ea | 29 | 96 | 125 |
| Diesel Fuel Tank | 2 | Ea | 99 | 250 | 349 |
| Water Storage Tank | 2 | Ea | 154 | 512 | 666 |
| Other Tanks | 3 | Ea | 12 | 32 | 44 |
| Pump | 10 | Ea | 25 | 127 | 152 |
| Truck Scale | 3 | Ea | 37 | 75 | 112 |
| Sewage Treatment Plant | 1 | Ea | 12 | 150 | 162 |
| Emergency Diesel Generator | 1 | Ea | 10 | 175 | 185 |
| Heat Tracing Load Centre | 36 | Ea | 28 | 360 | 388 |
| Other Electrical Equip. | 1 | Lot | 11 | 28 | 39 |
| Raceway | 2,300 | LF | 51 | 23 | 74 |

*Denotes Tailings System

TABLE 3.2-8
Sheet 1

FACILITY COST SUMMARY
AT DIRECT LEVEL

| | Quantity | Unit | $ x 1000 Labour | Material & Equip. | Total |
|---|---|---|---|---|---|
| YARD FACILITIES (cont'd) | | | | | |
| Wire & Cable | 115,000 | LF | 322 | 682 | 1,004 |
| Grounding | 7,000 | LF | 30 | 24 | 54 |
| Pole Line | 5 | Mi | 165 | 140 | 305 |
| Pipelines - Tailings | 21,000 | LF | 440 | 2,100 | 2,540 |
| - Reclaim | 19,000 | LF | 295 | 1,235 | 1,530 |
| - Water | 27,200 | LF | 395 | 1,110 | 1,505 |
| - Other | 2,800 | LF | 40 | 83 | 123 |
| Subtotal Yard Facilities | | | 4,851 | 13,279 | 18,130 |

TABLE 3.2-8
Sheet 2

FACILITY COST SUMMARY
AT DIRECT LEVEL

| | Quantity | Unit | $ x 1000 Labour | Material & Equip. | Total |
|---|---|---|---|---|---|
| AIRSTRIP | | | | | |
| Clear & Grub | 15 | Ac | 12 | 21 | 33 |
| Earthworks | 100,000 | CY | 204 | 720 | 924 |
| Surface Treatment | 35,000 | SF | 24 | 35 | 59 |
| Building | 800 | SF | 24 | 50 | 74 |
| Lighting & Navigation | 1 | Lot | 50 | 450 | 500 |
| Subtotal Airstrip | | | 314 | 1,276 | 1,590 |

TABLE 3.2-9

## CONSTRUCTION DISTRIBUTABLE COST SUMMARY

| CONSTRUCTION FACILITIES | Manhours X1000 | $X1000 Labour | Material | Sub Contract | Total |
|---|---|---|---|---|---|
| Temporary Roads & Laydown | 3.2 | 77 | 132 | | 209 |
| Temporary Buildings | 10.1 | 240 | 969 | | 1,209 |
| Temporary Power | 6.5 | 153 | 685 | | 838 |
| Temporary Mechanical | 8.0 | 189 | 350 | | 539 |
| Concrete Batch Plant | 19.2 | 453 | 800 | | 1,253 |
| Communications | 1.0 | 23 | 902 | | 925 |
| Temporary Heating/Hoarding | 9.0 | 213 | 160 | | 373 |
| Scaffolding | | | 54 | | 54 |
| Sub-Total Construction Facilities | 57.0 | 1,348 | 4,052 | | 5,400 |

TABLE 3.2-10

| CONSTRUCTION SUPPORT | | | | | |
|---|---|---|---|---|---|
| General & Final Clean-up | 16.5 | 389 | | | 389 |
| Material Handling & Warehousing | 37.6 | 887 | 100 | | 987 |
| Craft Training/Testing | 5.5 | 130 | 35 | | 165 |
| Fuel Distribution | 12.0 | 283 | | | 283 |
| Operate/Maintain Facilities | 24.3 | 574 | 180 | | 754 |
| Road/Airstrip Maintenance | 18.0 | 425 | 40 | | 465 |
| Surveying | 21.6 | 510 | 35 | | 545 |
| Pre-Operation Testing (Manual) | 5.4 | 127 | 120 | | 247 |
| Manual Labour Allowances | 4.1 | 102 | 546 | | 648 |
| Commercial Air Transport | | | 1,202 | | 1,202 |
| Air Charter Whitehorse/Site | | | 1,207 | | 1,207 |
| Freight | | | 9,284 | | 9,284 |
| Staging/Freight Consolidation | | | 924 | | 924 |
| Contractor Supervision | 75.0 | 3000 | | | 3,000 |
| Sub-Total Construction Support | 220.0 | 6,427 | 13,673 | | 20,100 |

TABLE 3.2-11

## CONSTRUCTION DISTRIBUTABLE COST SUMMARY

| | Manhours X1000 | $X1000 Labour | Material | Sub Contract | Total |
|---|---|---|---|---|---|
| **CONSTRUCTION CAMP** | | | | | |
| Temporary Camp | 9.0 | | | 3,175 | 3,175 |
| Camp Maintenance | 18.0 | 425 | 100 | | 525 |
| Catering | 110.0 | | 140 | 2,560 | 2,700 |
| Sub-Total Construction Camp | 137.0 | 425 | 240 | 5,735 | 6,400 |

TABLE 3.2-12

| | | | | | |
|---|---|---|---|---|---|
| **CONSTRUCTION EQUIPMENT** | | | | | |
| Construction Equipment | - Purchase | 1.0 | 24 | 1,390 | 1,414 |
| | - Rental | | | 613 | 613 |
| Tools/Consumables | | | | 1,710 | 1,710 |
| Equipment Maintenance | | 60.0 | 1,416 | 1,120 | 2,536 |
| Fuel & Lubricants | | | | 4,327 | 4,327 |
| Sub-Total Construction Equipment | | 61.0 | 1,440 | 9,160 | 10,600 |

TABLE 3.2-13

## CONTINGENCY ANALYSIS

| | Estimated Cost x 1000 | Average % Contingency | Contingency Amount x 1000 |
|---|---|---|---|
| Facilities | | | |
| Tom Mine | 10,230 | 14 | 1,432 |
| Jason Mine | 5,390 | 11 | 593 |
| Coarse Ore Storage | 2,550 | 14 | 357 |
| Concentrator | 32,040 | 12 | 3,845 |
| Power Plant & Service Bldg. | 20,360 | 11 | 2,240 |
| Yard Area | 18,130 | 14 | 2,538 |
| Airstrip | 1,590 | 15 | 238 |
| Subtotal Facilities | 90,290 | 12.5 | 11,243 |
| Construction Distributables | | | |
| Construction Facilities | 5,400 | 11 | 594 |
| Construction Support | 20,100 | 11 | 2,211 |
| Construction Camp | 6,400 | 9 | 576 |
| Construction Equipment | 10,600 | 11 | 1,168 |
| | 42,500 | 10.7 | 4,549 |
| Accommodation Complex | 9,900 | 12 | 1,188 |
| General Allocations | | | |
| Mobile Equipment | 2,340 | 10 | 234 |
| Initial Fill | 100 | 15 | 15 |
| Geotechnical Investigations | 500 | 15 | 75 |
| Plant Start Up | 1,000 | 15 | 150 |
| Capital Spares | 1,000 | 15 | 150 |
| Subtotal Allocations | 4,940 | 12.6 | 624 |
| Engineering, Procurement & Construction Services | 17,500 | 11.8 | 2,066 |
| Total | 165,130 | 11.9 | 19,670 |

TABLE 3.2-14

## OPTION TO CONVEY ORE FROM JASON

| DESCRIPTION | Manhours x 1000 | $ x 1000 Labour | $ x 1000 Material & Equip. | $ x 1000 Total |
|---|---|---|---|---|
| Civil | 11.8 | 280 | 380 | 660 |
| Mechanical | 79.5 | 1,960 | 11,110 | 13,070 |
| Electrical | 21.5 | 560 | 460 | 1,020 |
| Lighting | 7.2 | 180 | 130 | 310 |
| Instrumentation | 1.0 | 30 | 370 | 400 |
| Subtotal Direct Costs | 121.0 | 3,010 | 12,450 | 15,460 |
| Construction Distributables | | | | 1,840 |
| Engineering, Procurement, Construction Services | | | | 1,400 |
| Contingency | | | | 1,500 |
| Total Estimated Cost | | | | 20,200 |

TABLE 3.2-15

## HAINES TERMINAL

| DESCRIPTION | $ x 1000 |
|---|---|
| Concentrate Storage Building | 780 |
| Services Building | 220 |
| Ship Loader | 4,200 |
| Truck Unloader | 540 |
| Conveyors, Samplers, Feeders | 630 |
| Shiploader, Belt Scale | 50 |
| Mechanical and Electrical Installations | 550 |
| Mobile Equipment | 700 |
| Ship Fender Extension | 350 |
| Total Field Cost | 8,020 |
| Engineering and Contingency @ 25% | 1,980 |
| Total Estimated Cost | 10,000 |

TABLE 3.2-16

## 3.3 PROJECT SCHEDULE

CONTENTS

3.3.1 INTRODUCTION

3.3.2 BASIS OF SCHEDULE

Fig. 3.3-1 Preliminary Project Schedule

Fig. 3.3-2 Construction Schedule

## 3.3 PROJECT SCHEDULE

### 3.3.1 INTRODUCTION

The project schedule which is covered by the capital cost estimate is depicted on the Preliminary Project Schedule, and the Construction Schedule included in this section. For this presentation, the time scale is given as years A, 1, 2, 3. The overall 32 month schedule, from "Decision to Proceed" in May of Year A through January 2 of Year 3 when the plant is ready to receive feed, is an achievable schedule with some potential for reduction. Time has been allowed at the front end of the schedule for engineering to progress sufficiently prior to commencement of field construction to obtain good quality construction contract bids. It is intended to maximize construction progress during the favorable summer seasons. In addition it is considered advantageous to be able to commit procurement of major items such as the grinding mills and the power generators in time to have them installed prior to final closing in of the buildings for winter of Year 1.

### 3.3.2 BASIS OF SCHEDULE

- Field construction work to be done within a 21 month period, assuming start of field work April 1.

- A 70 manhour work week (7 x 10 hour shift) has been assumed, with 45 days turn around for manual workers.

- Personnel transportation to the jobsite will be by commercial flights from Vancouver/Edmonton to Whitehorse and from Whitehorse to site by charter. Because the unreliable weather conditions at the existing airstrip will make it impossible to adequately schedule personnel rotation flights, a new airstrip will be constructed as an initial activity in Year 1.

- The North Canol Road will have been improved at least through the phase 1 plan of the Government.

- Construction and plant materials and equipment will be transported by land from Vancouver/Edmonton via highway to a staging area at Ross River.

  At Ross River, materials and equipment will be shipped across the Pelly River by ferry from May to October, and by the ice bridge from December to March. There are no scheduled shipments across the Pelly River in April and November, which are considered the ice thawing and ice freeze-up periods respectively.

- Tom mine underground development will start in Spring of Year 1 and will take place concurrently with surface plant construction so that there is an adequate ore supply available at time of start-up.

- Jason mine permanent surface facilities will be constructed concurrently with other surface plant construction, with shaft sinking to commence when the process plant starts up.

- Geotechnical studies to be completed in the year or years prior to Year A, so that field survey for construction may be done in the summer of Year A and engineering may start effective design work.

- The detailed early construction plan should be done in Year A so that construction equipment and materials and camp may be purchased and shipped across the ice bridge in the winter of Year A.

- The construction camp and facilities will be erected in the spring of Year 1. Mass earthwork and new airstrip development will commence. Rock excavation for the ore storage will also be started.

- Major construction activities such as mass earthwork, dam construction, yard facilities installation and concrete pouring are to be concentrated during the summer months. Steel erection will follow immediately to permit the closure of the concentrator and power plant by mid December of Year 1. Architectural work will continue into the winter and spring season. It is planned to order the generating sets and mills early, to set them in place before building closure.

  Major mechanical installation will commence in early Year 2, followed by electrical and piping.

- Pre-operational testing of systems will be done in the last three months of the construction period. Training of plant operational personnel is expected to take place prior to and during this period.

- Plant will be mechanically complete and ready to accept feed on Jan. 2 of Year 3.

**LEGEND:**

- ENGINEERING
- PROCUREMENT
- CONSTRUCTION
- BY OTHERS
- ICE BREAK-UP / ICE FREEZE-UP (PELLY RIVER)
- ☆ KEY DATES
- △ BID OUT
- ◇ AWARD
- ▽ EQUIP. ON SITE

# TOM/JASON PROJECT

HUDSON BAY MINING AND SMELTING CO., LIMITED
AND
ABERFORD RESOURCES LTD.

## PRELIMINARY PROJECT SCHEDULE

BECHTEL CANADA

JOB NO. 16988

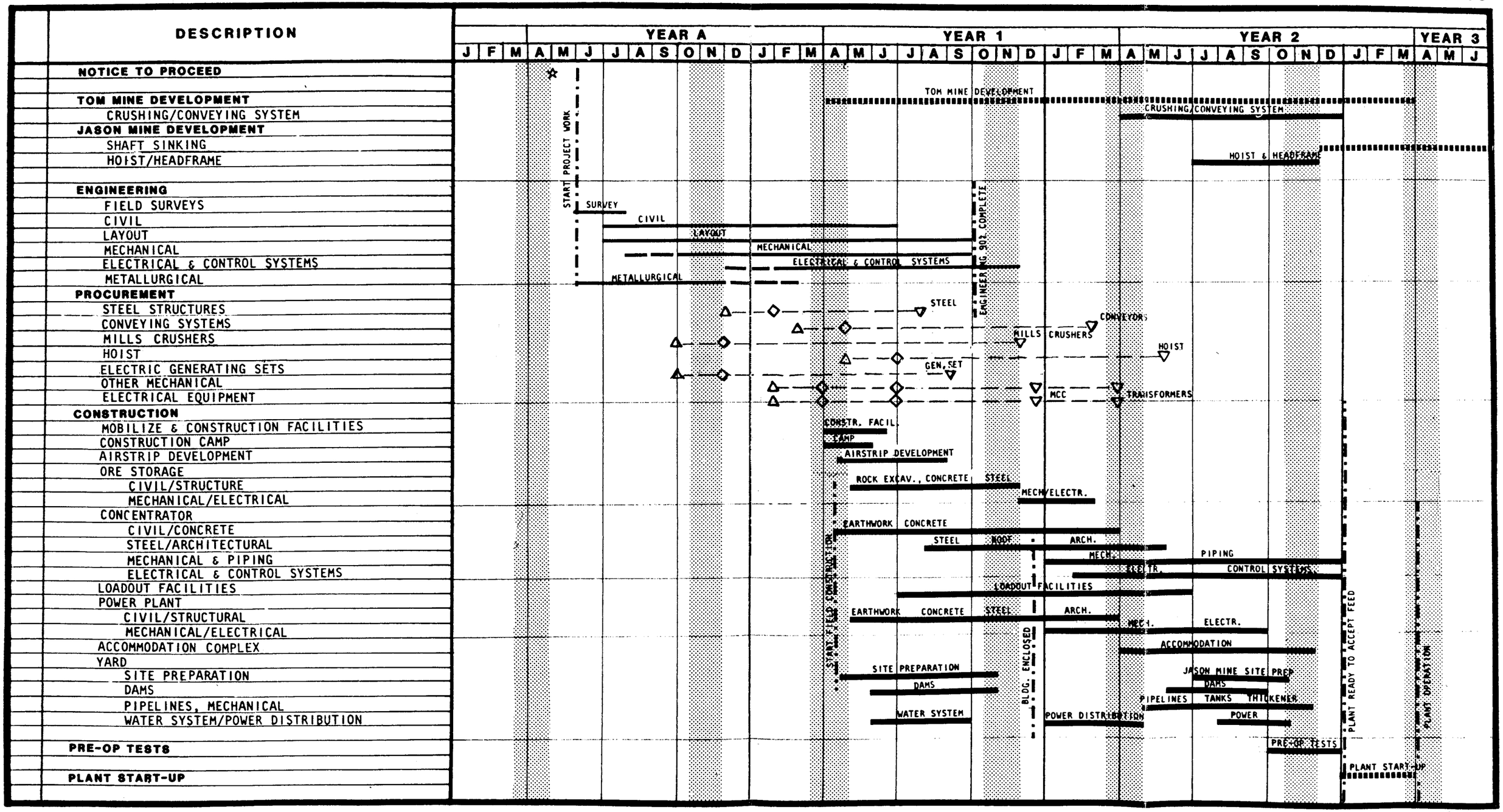


FIG. 3.3-1

08APR85

LEGEND:

- CONSTRUCTION
- WORK BY OTHERS
- ICE BREAK-UP/ICE FREEZE-UP (PELLY RIVER)

# TOM/JASON PROJECT

HUDSON BAY MINING AND SMELTING CO., LIMITED
AND
ABERFORD RESOURCES LTD.

## CONSTRUCTION SCHEDULE

JOB NO. 16988

BECHTEL CANADA

| FAC. NO. | DESCRIPTION |
|---|---|
| | MOBILIZATION |
| | CONSTRUCTION CAMP |
| | CONSTRUCTION FACILITIES |
| 100 | **TOM MINE** |
| | CRUSHERS/CONVEYING SYSTEM |
| 200 | **JASON MINE** |
| | SITE PREPARATION/ROAD |
| | HOIST/HEADFRAME |
| 300 | **ORE STORAGE** |
| | EARTHWORK |
| | CONCRETE |
| | STEEL, ROOF, SUPERSTRUCTURE |
| | MECHANICAL |
| | ELECTRICAL |
| | **CONCENTRATOR & LOADOUT** |
| | EARTHWORK |
| | CONCRETE |
| | STEEL, ROOF, SUPERSTRUCTURE |
| | LIGHTING |
| | MECHANICAL |
| | PIPING |
| | ELECTRICAL |
| | INSTRUMENTATION |
| 500 | **POWER PLANT & SERVICES** |
| | EARTHWORK & CONCRETE |
| | STEEL. ROOF, ARCHITECTURAL |
| | LIGHTING |
| | MECHANICAL & PIPING |
| | ELECTRICAL |
| 600 | **ACCOMMODATION COMPLEX** |
| | SERVICES |
| | STRUCTURE |
| 700 | **YARD & GENERAL SERVICES** |
| | AIRSTRIP DEVELOPMENT |
| | SITE PREPARATION |
| | TAILINGS DAMS |
| | OTHER EARTHWORK & CONCRETE |
| | WATER SUPPLY SYSTEM |
| | PIPELINES |
| | TANKS & THICKENER |
| | ELECTRICAL POWER DISTRIBUTION |
| | POLE LINE |
| | **PRE-OP TESTS** |
| | **PLANT START-UP** |

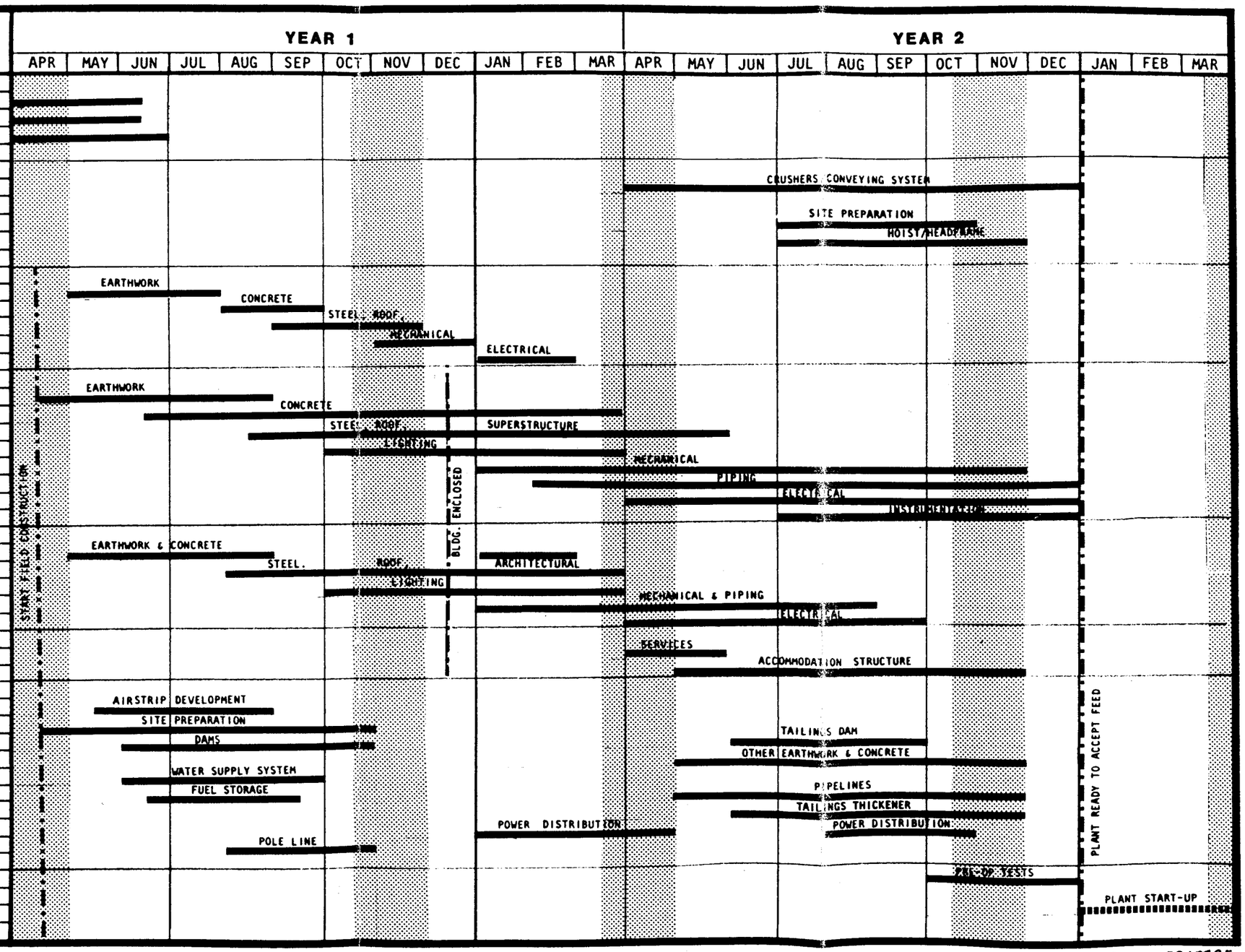


FIG. 3.3-2 08APR85

## 3.4 PRODUCTION STATISTICS

CONTENTS


Table 3.4-1 Production Schedule

Table 3.4-2 Summaries

## PRODUCTION SCHEDULE - TOM CLAIMS AND JASON

(By HBM&S Mining Department)

| | TONS X 1000 | GRADE | | | PRODUCTION (X 1000) | | |
|---|---|---|---|---|---|---|---|
| | | Zn, % | Pb, % | Ag, oz/t | Zn, t | Pb, t | Ag, oz |
| **Year 2** | | | | | | | |
| Tom East | 513.0 | 8.01 | 14.35 | 4.65 | 41.1 | 73.6 | 2,387.4 |
| Tom West | 143.0 | 7.91 | 6.55 | 1.68 | 11.3 | 9.4 | 239.6 |
| Jason SHW | | | | | | | |
| Total | 656.0 | 7.98 | 12.65 | 4.00 | 52.4 | 83.0 | 2,627.0 |
| **Year 3** | | | | | | | |
| Tom East | 848.7 | 8.31 | 9.35 | 3.75 | 70.5 | 79.3 | 3,151.6 |
| Tom West | 726.3 | 7.91 | 6.55 | 1.68 | 57.4 | 47.6 | 1,126.7 |
| Jason SHW | | | | | | | |
| Total | 1,575.0 | 8.12 | 8.06 | 2.77 | 127.9 | 126.9 | 4,386.3 |
| **Year 4** | | | | | | | |
| Tom East | 350.0 | 8.82 | 10.84 | 4.97 | 30.9 | 38.0 | 1,737.8 |
| Tom West | 893.8 | 8.51 | 6.43 | 2.10 | 76.1 | 57.4 | 1,879.2 |
| Jason SHW | 331.2 | 5.57 | 15.22 | 6.93 | 19.0 | 50.4 | 2,294.1 |
| Total | 1,575.0 | 8.00 | 9.26 | 3.75 | 126.0 | 145.8 | 5,911.1 |
| **Year 5** | | | | | | | |
| Tom East | 350.0 | 8.14 | 8.36 | 3.38 | 28.5 | 29.3 | 1,183.5 |
| Tom West | 700.0 | 6.87 | 5.44 | 2.14 | 48.1 | 38.1 | 1,494.6 |
| Jason SHW | 525.0 | 5.94 | 14.41 | 6.48 | 31.2 | 75.6 | 3,401.8 |
| Total | 1,575.0 | 6.84 | 9.08 | 3.86 | 107.8 | 143.0 | 6,079.9 |
| **Year 6** | | | | | | | |
| Tom East | 350.0 | 8.74 | 13.00 | 5.04 | 30.6 | 45.5 | 1,764.8 |
| Tom West | 700.0 | 7.76 | 6.18 | 1.99 | 54.3 | 43.2 | 1,389.9 |
| Jason SHW | 525.0 | 6.03 | 9.31 | 4.30 | 31.7 | 48.9 | 2,258.9 |
| Total | 1,575.0 | 7.40 | 8.74 | 3.44 | 116.6 | 137.6 | 5,413.6 |

Table 3.4-1
Sheet 1

| | TONS X 1000 | GRADE Zn, % | Pb, % | Ag, oz/t | PRODUCTION (X 1000) Zn, t | Pb, t | Ag, oz |
|---|---|---|---|---|---|---|---|
| Year 7 | | | | | | | |
| Tom East | 255.0 | 7.56 | 11.11 | 3.20 | 19.3 | 28.3 | 815.8 |
| Tom West | 795.0 | 7.40 | 6.15 | 1.97 | 58.8 | 48.9 | 1,568.7 |
| Jason SHW | 525.0 | 5.97 | 6.88 | 3.26 | 31.3 | 36.1 | 1,713.8 |
| Total | 1,575.0 | 6.95 | 7.19 | 2.60 | 109.4 | 113.3 | 4,098.3 |
| Year 8 | | | | | | | |
| Tom East | | | | | | | |
| Tom West | 1,050.0 | 6.26 | 3.49 | 0.67 | 65.7 | 36.6 | 701.2 |
| Jason SHW | 525.0 | 7.00 | 4.15 | 2.08 | 36.8 | 21.8 | 1,093.3 |
| Total | 1,575.0 | 6.51 | 3.71 | 1.14 | 102.5 | 58.4 | 1,794.5 |
| Year 9 | | | | | | | |
| Tom East | | | | | | | |
| Tom West | 965.9 | 6.86 | 3.66 | 0.91 | 66.2 | 35.3 | 880.1 |
| Jason SHW | 525.0 | 4.97 | 6.38 | 3.33 | 26.1 | 33.5 | 1,746.8 |
| Jason SM | 83.1 | 10.52 | 1.70 | 2.19 | 8.7 | 1.4 | 182.1 |
| Total | 1,574.0 | 6.42 | 4.46 | 1.78 | 101.0 | 70.2 | 2,808.9 |
| Year 10 | | | | | | | |
| Tom East | | | | | | | |
| Tom West | | | | | | | |
| Jason SHW | 525.0 | 6.62 | 13.76 | 6.09 | 34.8 | 72.2 | 3,194.9 |
| Jason SM | 283.0 | 10.52 | 1.70 | 2.19 | 29.8 | 4.8 | 619.8 |
| Jason Mn | 745.5 | 7.52 | 1.97 | 0.12 | 56.0 | 14.7 | 92.0 |
| Total | 1,553.0 | 7.76 | 5.91 | 2.51 | 120.6 | 91.7 | 3,906.7 |
| Year 11 | | | | | | | |
| Tom East | | | | | | | |
| Tom West | | | | | | | |
| Jason SHW | 525.0 | 5.05 | 10.74 | 5.03 | 26.5 | 56.4 | 2,642.4 |
| Jason SM | 283.0 | 9.44 | 1.71 | 2.02 | 26.7 | 4.8 | 572.6 |
| Jason Mn | 765.0 | 7.77 | 1.72 | 0.03 | 59.4 | 13.2 | 22.9 |
| Total | 1573.0 | 7.16 | 4.73 | 2.06 | 112.6 | 74.4 | 3,237.9 |

Table 3.4-1
Sheet 2

| | TONS X 1000 | GRADE Zn, % | Pb, % | Ag, oz/t | PRODUCTION (X 1000) Zn, t | Pb, t | Ag, oz |
|---|---|---|---|---|---|---|---|
| **Year 12** | | | | | | | |
| Tom East | | | | | | | |
| Tom West | | | | | | | |
| Jason SHW | 525.0 | 6.66 | 5.34 | 2.62 | 35.0 | 28.0 | 1,375.8 |
| Jason SM | 283.0 | 7.01 | 2.03 | 1.67 | 19.8 | 5.8 | 471.7 |
| Jason Mn | 765.0 | 7.77 | 1.72 | 0.03 | 59.4 | 13.1 | 22.9 |
| Total | 1,573.0 | 7.26 | 2.98 | 1.19 | 114.2 | 46.9 | 1,870.4 |
| **Year 13** | | | | | | | |
| Tom East | | | | | | | |
| Tom West | | | | | | | |
| Jason SHW | 90.4 | 7.63 | 1.77 | 1.04 | 6.9 | 16.0 | 94.0 |
| Jason SM | 485.0 | 6.26 | 2.36 | 1.57 | 30.3 | 11.4 | 761.5 |
| Jason Mn | 1,000.0 | 5.94 | 1.32 | 0.02 | 59.4 | 13.2 | 21.7 |
| Total | 1,575.0 | 6.14 | 1.66 | 0.57 | 96.7 | 26.2 | 877.2 |
| **Year 14** | | | | | | | |
| Tom East | | | | | | | |
| Tom West | | | | | | | |
| Jason SHW | | | | | | | |
| Jason SM | 575.0 | 8.00 | 2.07 | 1.81 | 46.0 | 11.9 | 1,043.0 |
| Jason Mn | 1,000.0 | 8.68 | 1.72 | 0.03 | 86.8 | 17.2 | 27.8 |
| Total | 1,575.0 | 8.43 | 1.85 | 0.68 | 132.8 | 29.1 | 1,070.8 |
| **Year 15** | | | | | | | |
| Tom East | | | | | | | |
| Tom West | | | | | | | |
| Jason SHW | | | | | | | |
| Jason SM | 230.9 | 5.35 | 2.33 | 1.40 | 12.4 | 5.4 | 322.6 |
| Jason Mn | 485.5 | 8.27 | 1.19 | 0.03 | 40.1 | 5.8 | 14.6 |
| Total | 716.4 | 7.33 | 1.56 | 0.47 | 52.5 | 11.2 | 337.2 |

Table 3.4-1
Sheet 3

## SUMMARIES

| | TONS X 1000 | GRADE Zn, % | Pb, % | Ag, oz/t | PRODUCTION (X 1000) Zn, t | Pb, t | Ag, oz |
|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | | | | | | |
| Tom East | 2,666.7 | 8.28 | 11.03 | 4.14 | 220.8 | 294.0 | 11,040.9 |
| Tom West | 5,974.0 | 7.33 | 5.30 | 1.57 | 438.0 | 316.5 | 9,369.9 |
| Jason SHW | 4,621.6 | 6.04 | 9.19 | 4.29 | 279.3 | 424.6 | 19,815.8 |
| Jason SM | 2,223.0 | 2.05 | 7.82 | 1.79 | 45.6 | 173.8 | 3,973.2 |
| Jason Mn | 4,761.0 | 8.17 | 1.71 | 0.04 | 389.1 | 81.4 | 201.9 |
| Total Tom | 8,470.7 | 7.62 | 7.07 | 2.36 | 658.8 | 610.5 | 20,410.8 |
| Total Jason | 11,605.6 | 6.15 | 5.86 | 2.07 | 713.9 | 679.8 | 23,990.9 |
| Total | 20,246.3 | 6.78 | 6.37 | 2.19 | 1,372.7 | 1,290.3 | 44,401.7 |
| **TOTAL RESERVES** | | | | | | | |
| Tom East | 2,963.0 | 8.42 | 11.13 | 4.24 | 249.5 | 329.8 | 12,563.1 |
| Tom West | 6,638.0 | 7.26 | 5.27 | 1.56 | 481.9 | 349.8 | 10,355.3 |
| Jason SHW | 5,135.0 | 6.12 | 9.18 | 4.27 | 314.3 | 471.4 | 21,926.4 |
| Jason SM | 2,470.0 | 2.04 | 7.82 | 1.79 | 50.3 | 193.2 | 4,421.3 |
| Jason Mn | 6,013.0 | 8.13 | 1.73 | 0.05 | 488.9 | 104.0 | 300.7 |
| Total Tom | 9,601.0 | 7.62 | 7.08 | 2.39 | 731.4 | 679.6 | 22,918.4 |
| Total Jason | 13,618.0 | 6.27 | 5.64 | 1.96 | 853.5 | 768.6 | 26,648.4 |
| Total | 23,219.0 | 6.83 | 6.24 | 2.13 | 1,584.9 | 1,448.2 | 49,566.8 |
| **MINING RECOVERIES** | | | | | | | |
| Tom East | 90.00 | - | - | - | 88.50 | 89.16 | 87.88 |
| Tom West | 90.00 | - | - | - | 90.89 | 90.48 | 90.48 |
| Jason SHW | 90.00 | - | - | - | 88.87 | 90.07 | 90.37 |
| Jason SM | 90.00 | - | - | - | 90.40 | 89.97 | 89.87 |
| Jason Mn | 79.18 | - | - | - | 79.60 | 78.27 | 67.16 |
| Total Tom | 90.00 | - | - | - | 90.08 | 89.84 | 89.06 |
| Total Jason | 85.22 | - | - | - | 83.65 | 88.45 | 90.03 |
| Total | 87.20 | - | - | - | 86.62 | 89.10 | 89.58 |

Table 3.4-2

## 3.5 SITE INVESTIGATIONS AND SITE PREPARATION

CONTENTS


3.5.1 SITE INVESTIGATIONS

3.5.2 SITE VISIT

- .1 Plant Location
- .2 Tailings Disposal
- .3 Water Supply
- .4 Site Access
- .5 Observations

3.5.3 SITE PREPARATION AND DEVELOPMENT

## 3.5 SITE INVESTIGATIONS AND SITE PREPARATION

### 3.5.1 SITE INVESTIGATIONS

In the course of previous investigations by Hudson Bay Mining and Smelting into the Tom claims, preliminary geotechnical surveys were performed by Thompson Geotechnical Consultants of Vancouver in the areas on both sides of Sekie Creek No. 2 (Tom Creek) at the mouth of the Tom Valley, to identify areas suitable for construction of a minerals processing facility. Another survey was carried out in the area on the north side of the South Macmillan River valley, north east of the existing airstrip, to determine its suitablity as a townsite. Summary data from these surveys is contained in Thompson reports dated January, 1981 and December 1984.

Both investigations indicated that there are sites in these areas which appear suitable for the stated purposes. The investigations were fairly general in scope, though did include digging of test pits. Equipment constraints prevented excavation to a depth which would confirm bedrock, so the findings must be considered preliminary and must be confirmed by in-depth investigations prior to making final decisions as to the siting of facilities, or commencing detailed civil/structural designs for construction purposes.

It is understood that similar investigations have not been carried out on the Jason property.

Topographic maps, prepared by McElhanney Survey and Engineering Ltd. and Thompson Geotechnical Consultants Ltd. from aerial photographs, were made available for the study and form the basis of the plot and site plans. It is understood that survey and mapping discrepancies exist, as reported by Thompson in his report of March 1983. However, these are not considered to be sufficiently significant to influence the accuracy of this study.

### 3.5.2 SITE VISIT

For preparation of this study, both the Tom and the Jason properties were visited by an engineering team. The team was accompanied by Mr. Brian Thompson of Thompson Geotechnical Consultants to obtain the benefit of his earlier work, since no comprehensive report of the earlier work had been completed. Summary geotechnical data, compiled from field data obtained during a 1980-81 program was later supplied by Mr. Thompson covering the site selected for the process plant and service facility. This report is entitled "Geotechnical Conditions, Proposed Millsite Area" dated December 1984. Mr. Thompson also provided a printed map identifying several sites considered suitable for a camp development to the north of the existing airstrip.

The team also included the following:

Mr. M. J. Smith, HBM&S, Study Coordinator, Metallurgist
Mr. A. L. Weishar, Bechtel, Study Manager
Mr. J. Fliehmann, Bechtel, Chief Civil Engineer
Mr. W. Somerville, Bechtel, Project Cost Specialist
Mr. R. J. Bailes, Aberford Resources, Geologist

They also met Mr. Glenn Brown, Biological Research Services, at the site.

The objective of the visit, in addition to familiarization with site conditions, was to make preliminary decisions as to the:

- o Locations of process, services, and accommodations facilities.
- o Location of tailings disposal site.
- o Source of water for the project.

and to assess the condition of the North Canol Road to support the project development and the shipment of products.

Various discussions were held concerning project concepts. The team was guided extensively by the knowledge of Messrs. Thompson and Bailes concerning area soil conditions, snow, permafrost, water and overburden.

The following are observations and conclusions from the trip:

.1 Plant Location

Permafrost exists in the area. It is erratic but generally prevalent on the north-facing slopes and in valley areas which do not get sufficient sun exposure. Major facilities should be located on rock or in permafrost-free areas.

Avalanches or snow slides occur on some slopes. The existing Tom exploration camp and adit area is exposed to this hazard.

The South Macmillan River (a minor stream at this point) is reported to glaciate during winter and wander all over the valley such that ice build-ups occur. It was reported that the existing airstrip located in the valley at the mouth of the Tom Valley has been covered on occasion with several feet of ice. (This phenomenon may also have been due to glaciating from the Tom Creek).

Because of the above limitations and in view of the relative positions of the ore bodies and other topographical considerations, it was judged that the most suitable location for the concentrator facilities is at the mouth of the Tom Valley just south of Tom Creek and east of the Canol Road on a generally barren, gently sloping rock area. It is also within reasonable distance for conveyor haul of the Tom ore from the mine to the mill.

An area across the South Macmillan valley and the area north of Tom Creek offer suitable alternative sites for the accommodations complex and possibly other support facilities.

.2 Tailings Disposal

The reconnaissance of the area showed that there is no "ideal" tailings disposal site. Neither is there adequate soils or foundation data to fully support

any site selected at this time. The apparently most reasonable sites are the Rat Lake area on the Jason property and another area immediately to the west of Rat Lake. The Rat Lake area is attractive from the point of view of minimizing the earthwork required for the impoundment dam. This site is approximately 100 metres higher elevation than the proposed plant site and at the height of land between two valley systems so is traversed by fewer water courses and has minimum run-off considerations. Areas of the South Macmillan River valley, although at a lower elevation, have the disadvantage of being less attractive environmentally.

For the above reasons, it was concluded that the study proceed on the basis of using the Rat Lake area for tailings disposal. (See Section 3.8 for further discussions re Tailings Disposal.)

.3 Water Supply

The properties are located in the head waters area of the South Macmillan River. At this point, it is little more than a creek and there is no extended knowledge of the reliability of stream flow. It is joined by various creeks flowing from the mountains, with Sekie Creek No. 1 joining the river at the site of the Jason exploration camp. This creek adds considerably to the total flow. There are no substantial lakes in the area so water supply for the plant will have to come from the river at some point. It is believed that the river downstream of

Sekie Creek No. 1 may have sufficient flow to support the operation. Should there not be adequate flow at this point, it may be necessary to go several miles downstream and build an impoundment there. It has been assumed that an artificial lake can be dug adjacent to the stream path to a depth of 20 feet to maintain water depth which will not freeze over during winter. This can be constructed just downstream of the Sekie Creek No. 1 junction.

It was noted that waters from the Tom Valley area have a very low pH, in the 4 to 4-1/2 range, and water encountered in the mine ranged from very low to nearly neutral.

See Section 3.9 for further discussion re water supply.

.4 Site Access

Access to the site is via the North Canol Road from Ross River, or by air.

Currently, the North Canol Road is 15 to 18 feet wide, single lane. Although Public Works Canada has been doing some upgrading work at the southern end, the majority of the road is inadequate to handle the heavy traffic which will be experienced with the mine development. This includes the future trucking of concentrates to market, as well as haulage of construction materials. The government has plans for upgrading this road to serve mineral developments in the area.

There is an existing gravel airstrip on the Tom property located in the river valley. It is suitable for Twin Otters or similar short take-off aircraft.

See Section 3.13 for further discussion re Transportation.

.5 Observations

In the general site area may be found ferricrete and calcrete, both of which are crust-type deposits overlying soil and other overburden materials. Caution should be taken in any drill program to avoid mistaking either ferricrete or calcrete for bedrock. Calcrete in particular may be 2 to 3 feet thick.

The area is subject to heavy snow in the hills so designs must allow for high snow load on roofs and for considerable drifting in protected areas.

## 3.5.3 SITE PREPARATION AND DEVELOPMENT

The overall development of the project is shown on the Site Plan C-1, and in larger scale, on the Plot Plan C-3. The major elements of site preparation and development include:

- Clearing of vegetation from the process plant area, the tailings disposal area and the Jason shaft area.

- Mass excavation (and fill where required) to develop firm rock foundation conditions in the process plant area, plant yard area, concentrate storage area, Tom Mine yard area, Jason Mine yard area and the accommodations area. The amount of excavation and fill may be optimized at the detail design stage, when better knowledge of soil and rock conditions is available.
- Construction of a two lane road from the Canol Road over to the Jason shaft location, including provision of a single lane Bailey type bridge across the South Macmillan River.
- Construction of a two lane road from the Canol Road to the accommodations site.
- Construction of a single lane access road from the Jason shaft area to the tailings disposal area.
- Excavation of the water supply pond.
- Construction of a creek control channel in the plant area to contain the flow of the Tom Creek past the plant, and to prevent glaciation.
- Construction of minor access roads around the process plant area, and at the water supply pond.

The design basis for site development work is as follows:

| | | |
|---|---|---|
| o Roads: | Width, shoulder to shoulder | 20 ft |
| | , (truck haulage, plant site) | 20 ft with 3 ft shoulders on each side |
| | , (along pipelines) | 12 ft |
| | Surfaces | gravel |
| | Maximum grade, access | 10% |
| | , haulage | 8% |

| | | | |
|---|---|---|---|
| o | Yard: | Surfaces | gravel |
| | | Drainage | open ditching |
| | | Piping, above ground | steel and ABS traced, and insulated |
| | | , buried | N/A |

## 3.6 MINING

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## 3.6 MINING

### 3.6.1 INTRODUCTION

The following data and descriptions are intended to supplement Section 2 of the report, and describe the "permanent plant" of the two mines.

### 3.6.2 DESIGN CRITERIA

.1 Operating Parameters

| | |
|---|---|
| Design Capacity, dstpd | 5,000 |
| Nominal Capacity, dstpd | 4,500 |
| Operating - hours per shift | 8 |
| - shifts per day | 2 |
| - hours per day (effective) | 14 |
| - days per week | 7 |
| - days per year | 350 |
| Design Capacity, dstph | 357 |
| Nominal Capacity, dstph | 321 |
| Annual Capacity, dst | 1,575,000 |

.2 Ore Reserves

| | |
|---|---|
| Tom East, dst | 2,963,000 |
| Tom West, dst | 6,638,000 |
| Jason South HW, dst | 5,135,000 |
| Jason South M, dst | 2,470,000 |
| Jason Main, dst | 6,013,000 |
| Combined Total Reserves, dst | 23,219,000 |
| Combined Total Production, dst | 20,246,300 |
| Operating Years | 14 + |

.3 Run-of-Mine Ore Characteristics

| | |
|---|---|
| Feed Size, 80% passing, inches | 30 |
| Moisture Content, nominal, % | 3.0 |
| , range, % | 2.0 - 8.0 |
| Ore Specific Gravity, (design) | 3.36 |
| Bulk Density, average, pcf (volume) | 135 |

.4 Primary Crushing and Ore Conveying

Primary Crushing (Per Crusher)

| | |
|---|---|
| Design Capacity, dstpd | 5000 |
| Operating Hours per Day (effective) | 14 |
| Availability, % | 90 |
| Design Capacity, dstph | 397 |
| Crusher Type | Jaw |
| Crusher Size, inches | 42 x 48 |
| Discharge Setting, inches | 6 - 10 |
| Crusher Capacity, | |
| dstph @ 6" setting, 160 pcf | 550 |
| dstph @ 8" setting, 160 pcf | 700 |
| Product bulk density, pcf (volume) | 135 |

Crushed Ore Conveying (Tom)

| | |
|---|---|
| Capacity, nominal, dstph | 321 |
| , design, dstph | 357 |
| Max. Lump Size, inches | 10 |
| , shape | angular |

.5 Explosives Storage

| | |
|---|---|
| Capacity, ANFO, lbs | 50,000 |
| , detonators | 100,000 |

### 3.6.3 TOM MINE

#### .1 Access

The main access to the Tom mine will be via a new adit, the portal of which will be located immediately south of and at an elevation higher than the concentrator, at the mouth of the Tom Valley. A roadway will connect the concentrator yard area to a mine yard area at the portal.

The new adit will be approximately 2775 metres long, and have a cross section of 20 ft x 12 ft, sufficient for a vehicle roadway, conveyorway, electrical cables, ventilation ducting, service air lines and drainage ditch, and sloped at 1% towards the concentrator to facilitate mine drainage.

Mine development access will be via the existing exploration adit located near the head of Tom Valley, and via the new adit. Road access to the exploration adit will be maintained, to supply propane to the mine air heaters located at the portal.

The determination to use the long adit entry to the Tom mine was based on the following factors:

- Weather protected, secure from heavy snow accumulation and avalanche hazard in Tom Valley.
- Ore haulage to concentrator by single flight of belt conveyor within a combined roadway/conveyorway.
- Gravity drainage of mine water.

## .2 Ore Crushing and Transportation

Run-of-mine ore will be hauled by scooptrams to the nearest of three underground crushing stations, each capable of handling the total required mine output of 5000 tpd, thence by a conveyor system to the coarse ore storage pocket at the concentrator. Three stations have been provided in order to minimize ore haulage by the mobile equipment from the widespread workings and to take advantage of lower operating cost of belt conveyor haulage.

Each crushing station includes a chain gate vibrating feeder, jaw crusher, feeder conveyor with tramp iron magnet and cyclone dust collector. An overhead crane is included for servicing the equipment. This arrangement is shown on Drawing M-110.

Surge pockets between the crushers and the haulage conveyors permit crusher operation independent of the conveyor system operation.

The conveyor haulage system comprises three 42" conveyors, fitted with catenary idler loading stations and steel cord belts, with the main outhaul conveyor being fed directly from one crusher, and from the other crushers via tributary conveyors. Conveyors are suspended from the adit back.

The main outhaul conveyor will transport the ore to a coarse ore storage facility located just beyond the adit portal, and adjacent to the concentrator. The ore conveyors have been sized at 42" to accommodate ore chunks resulting from a 10" crusher discharge setting, rather than to accommodate the 357 TPH flow rate. This 10" maximum setting has been allowed

for to maximize the potential to utilize autogenous grinding in the mill. Should it be determined later that the crusher discharge setting will range from 6" to 8", 36" wide haulage conveyors may be used, with resulting lower capital costs.

.3 Heating and Ventilation

Ventilation air will be brought into the mine through the existing exploration adit at 1440 m elevation, located near the upper end of Tom Valley. Two main fan installations are provided underground, each consisting of one operating and one standby unit.

Heating will be provided by two 20,000,000 BTU/hr direct fired propane heating units, each capable of heating incoming air from $-40^{o}C$ to $+10^{o}C$. These units are located in a building at the adit portal. It has been assumed that propane storage tanks and auxiliaries will be provided by the gas vendor, and located within 100 ft of the portal.

When detail design is being carried out for construction purposes, the economic feasibility of mine heating utilizing waste heat from the generators in excess of that required for plant purposes should be investigated.

.4 Compressed Air

The mine compressed air plant will be also located underground on the 1440 m level, not far from the adit portal. Two 3500 CFM units have been provided. The location selected is convenient to both East and West zones, resulting in minimum pipeline lengths to active headings.

The major production drilling will be accomplished with high pressure drills served by 250 psi compressors located near each drill.

.5 Drainage

For the most part, mine drainage will be achieved by gravity flow in a ditch down the mine access adit. For the lowest areas of the mine (below 1320 level), pumps are provided which will pump to the upper end of the ditch. The drainage water will be captured in a sump near the tunnel portal, from which it will piped to a tank in the concentrator where any oil will be skimmed off.

The mine water will be joined with the tailings, so that the higher pH tailings will neutralize the mine water. In addition, disposition in this manner has the advantage that contained heavy metals, if any, will be precipitated and remain with the tailings at the disposal area.

During the water monitoring program conducted at Tom Mine from August 1981 - March 1982, total mine discharge flows ranged from 180 GPM up to 539 GPM. It was considered that the water was of surface origin. The pH varied, ranging from 4.1 to 7.1. Apparently, the exploration group had some success, though with great difficulty, in restricting water inflow by grouting.

It has been assumed that the flow can be restricted to 100-150 GPM. Should this not be possible, the concept of joining the mine drainage water with the tailings will have to be re-evaluated, and a cost/benefit comparison carried out between enlarging the tailings system, and a separate mine discharge treatment facility.

## .6 Electric Power

Power for both production and on-going mine development will be supplied by the permanent generators located in the main power plant. Mine development prior to commissioning of the main power plant will require the use of temporary generators. Permanent power generation will be at 4.16 kV, stepped up to 13.8 kV for transmission to underground substations, then stepped down to 4.16 kV and 600 V for usage.

## .7 Service Facilities

A small service shop is provided underground on the 1320 m level. This shop will be equipped with a 15 ton capacity service crane. Daily routine maintenance only will be performed there. All major maintenance of mine equipment and vehicles will be performed in the shops of the main service building.

The mine changehouse and offices are also located in the main service building portion of the plant complex. These will serve the Jason mine as well.

## .8 Explosives Storage

An explosive storage magazine, to contain 50,000 lbs of ANFO, is provided. It will be located remote from the concentrator and the portal, to prevent damage to those facilities in case of accident. A separate storage for 100,000 detonators is also provided.

## 3.6.4 JASON MINE

### .1 Access

The Jason mine will be reached from the concentrator via a new road approximately 1.8 km long, crossing the South Macmillan valley from a point on the North Canol Road approximately 3 km south west of the plant. This new road will be a two lane private road, with a single lane 50 ft long Bailey type bridge crossing the river.

The mine will be served by a vertical shaft. Shaft sinking and mine development will be handled by an 1800 HP drum hoist, which will also serve as the production and service hoist during the operating phase.

The Jason Main zone will be accessed by a decline, to be collared at elevation 1170 m.

### .2 Ore Crushing and Transportation

Ore will be crushed underground in a 42 x 48 inch jaw crusher. The installation is a duplicate of those at the Tom mine. The feeder conveyor will transfer the ore to a 42" wide 165 metre long transfer conveyor which will discharge directly into the skip loading ore pass.

When hoisted, ore will be discharged into either of two 750 ton ore bins, from which it will be fed directly into rear dump ore trucks for haulage to the ore storage facility at the concentrator. Highway trucks of 35 ton capacity are provided, to suit load limits of the North Canol Road, since about 3 km of the haulage distance is over that road.

Truck haulage was selected for the study in view of the relatively low extraction rate (1666 TPD design, 1500 TPD net) established for Jason. Should the extraction schedule be revised to the 5000 TPD design rate earlier proposed, an overland belt conveyor system may be economical. This concept has been included in this study as a "future option". (Refer to Drawings C-2 and M-112.) It comprises a short feeder conveyor and a 42" wide, three flight overland conveyor system, carried on concrete or timber sleepers on a road bed parallel to the Jason access road and the North Canol Road. The system would discharge onto the shuttle conveyor over the coarse ore storage pocket. As with the Tom Mine ore haulage conveyors, these conveyors could also be reduced to 36" width if the muck size will permit, thus reducing capital costs.

.3 Heating and Ventilating

A heating system identical to that for the Tom Mine, is provided for the Jason Mine. The propane fired heater, and the main mine ventilation fan are located at the top of the ventilation raise, not far from the shaft.

.4 Compressed Air

Compressed air for Jason will be supplied from two main compressors (one operating and one standby) located in the hoist house. Air will be piped down the shaft to the underground users. Separate 250 psi compressors are provided to serve each high pressure drill.

## .5 Drainage

It is not known at this time what water conditions will be encountered in the Jason mine. However, in view of the substantial water quantities encountered at Tom, it is reasonable to expect similar quantities at Jason. Therefore, two sumps with two sets of three pumps each have been provided; one set at the 550 m level and the other at 900 m level. Each pump will be capable of delivering 800 GPM against a head of 1500 ft. Assuming one pair of pumps capable of handling the normal load, the other two sets will serve as standby. It has been assumed that the water quality will be such that it need only be passed through an oil skimmer prior to release to the natural drainage system.

## .6 Electric Power

Electric power will be supplied from the permanent generators located in the main power plant. Power will be transmitted at 13.8 kV via an overhead pole line to a substation located near the Jason shaft, where it will be stepped down to 4.16 kV and 600 V for distribution to the surface installation and to underground.

## .7 Service Facilities

There are no major service facilities provided on surface at the Jason Mine although a small "convenience" repair shed will be located adjacent to the hoist house. All surface related maintenance or other services will be carried out from the main service building.

There is, however, an underground maintenance shop, adequately outfitted to service and maintain the underground equipment which cannot be readily taken to surface. A hoistman's comfort station is provided in the hoisthouse.

## 3.7 MILLING

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## 3.7 MILLING

### 3.7.1 DESIGN CRITERIA

.1 Operating Parameters

| | |
|---|---|
| Design Capacity, dstpd | 5,000 |
| Nominal Capacity, dstpd | 4,500 |
| Operating - hours per shift | 12 |
| - shifts per day | 2 |
| - hours per day | 24 |
| - days per week | 7 |
| - days per year | 350 |
| Design Capacity, dstph | 208 |
| Availability,% | 90 |
| Nominal Capacity, dstph | 231 |
| Annual Capacity, dst | 1,575,000 |

.2 Crushed Ore Storage

| | |
|---|---|
| Ore Size, 85% minus, | 10 inches |
| Angle of Repose, degrees | 37 |
| Drawdown Angle, degrees | 60 |
| Ore Shape | angular |
| Coarse Ore Storage, dst (live) | 2 days, 10,000 |

.3 Ore Reclaim, Pebble Screening

Ore Reclaim

| | |
|---|---|
| Operating Rate, design, dstph | 208.3 |
| , minimum, dstph | 185.0 |
| , maximum, dstph | 230.0 |

Mill Feed Conveyor

| | |
|---|---|
| Capacity, design, dstph | 208.3 |
| , maximum, dstph | 230 |

Pebble Recovery

| | |
|---|---|
| Pebble Screen, type | vibrating |
| , decks, number | 2 |
| , , upper, opening, in. | 3.5 |
| , , lower, opening, in. | 1.5 |
| , feed rate, dstph (design) | 208.3 |
| Pebble Recovery, rate, dstph, (6 in. ROM) | 62.5 |
| , rate, dstph, (8 in. ROM) | 43.7 |
| Pebble Consumption, rate, dstph, nominal | 17.7 |
| , rate, dstph, range | 14 - 20 |
| Pebble Storage, capacity, dst | 100 |
| , bulk density, pcf | 130 |
| Ore Storage, capacity, dst | 200 |
| , bulk density, pcf | 130 |

## .4 Grinding, Classification & Coarse Lead Flotation

Ore Feeding

| | |
|---|---|
| Operating rate, design, dstph | 208.3 |
| , minimum, dstph | 185.0 |
| , maximum, dstph | 230.0 |

## Primary Grinding Mill

| | |
|---|---|
| Mill, type | autogenous, suitable for semi-autogenous operation |
| Speed, % critical | 73 |
| Loading, autogenous, % by volume, ore | 30-35 |
| Loading, SAG, % by volume, ore | 24 |
| , , , balls | 6 |
| , , , total | 30 |
| Charge, % solids | 70 |
| Bond Work Index, kWh/dst, Tom East | N/A |
| , Tom West | 12.53 |
| Autogenous Work Index, kWh/dst, Tom East | N/A |
| , Tom West | 10.44 |
| Design Work Index, kWh/dst | 10.44 |
| 80% Passing Size, microns, feed | 150,000 |
| , product | 150 |
| Net Power Req'd., kWh/dst | 8.25 |
| , kW | 1718 |
| , HP | 2300 |
| , % losses | 6 |
| Circulating Load, nominal, % | 100 |
| , minimum, % | 50 |
| , maximum, % | 150 |
| Mill Discharge, type | grate |
| Trommel, type | reverse spiral |
| , opening, inches | 0.25 |
| Liners, material | Cr-Mo |
| Balls, size, inches | 4 |

| | |
|---|---|
| Mill Product, design, dstph (solids) | 383.3 |
| , minimum, dstph (solids) | 300.0 |
| , maximum, dstph (solids) | 450.0 |
| , % solids | 70 |

Primary Classification

| | |
|---|---|
| Classifier, type | cyclone |
| , size, diameter, inches | 30 |
| , inlet pressure, psig | 6 |
| , feed, design, dstph (solids) | 383 |
| , range, dstph (solids) | 300-450 |
| , circulating load, nominal % | 100 |
| , minimum % | 50 |
| , maximum % | 150 |
| Cyclone Feed Pump | |
| , flow, USGPM, design | 1337 |
| , , , range | 1200-1400 |
| , % solids, nominal | 63.5 |
| , pulp density, nominal | 1.80 |
| , type | hard metal lined |
| , drive, type | direct, fixed-speed |

Secondary Grinding

| | |
|---|---|
| Feed Rate, solids, design, dstph (total) | 629.9 |
| , minimum, dstph (total) | 360 |
| , maximum, dstph (total) | 760 |
| Mill, type | pebble, suitable for ball milling |

| | |
|---|---|
| , speed, % of critical | 72 |
| , loading, % by volume, total | 40 |
| , liners, material | rubber |
| , discharge, type | overflow |
| , trommel | no |
| Bond Work Index, kWh/dst, design | 12.5 |
| 80% passing size, microns, feed | 149 |
| , product | 37 |
| Net Power Required, kWh/dst | 10.0 |
| , kW | 1042 |
| , HP | 1400 |
| , % Losses | 7 |

Pebble Feeding

| | |
|---|---|
| Pebble consumption, design, % of plant feed | 8 |
| , dstph | 16.7 |
| , minimum, % of plant feed | 6 |
| , dstph | 14.0 |
| , maximum, % of plant feed | 12 |
| , dstph | 20.0 |

Secondary Classification

| | |
|---|---|
| Classifier, type | cyclones |
| , inlet pressure, psig | 14 |
| , feed, design, dstph (solids) | 817.6 |
| , range, dstph (solids) | 560-920 |
| , circulating load, design, % | 300 |
| , minimum, % | 150 |
| , maximum, % | 400 |

| | |
|---|---|
| Cyclone Feed Pump, flow, USGPM, design | 3545 |
| , USGPM, range | 3000-3900 |
| , % solids, nominal | 56.0 |
| , pulp density, nominal | 1.65 |
| , type | hard metal lined |
| , drive, speed | variable |

.5 Lead Flotation

Coarse Lead Flotation

Roughers:

| | |
|---|---|
| Feed, | |
| primary cyclone O/F, dstph, design (solids) | 191.7 |
| secondary mill disc., dstph, design(solids) | 629.9 |
| total, dstph, design(solids) | 821.6 |
| , USGPM, design (pulp) | 3358 |
| , USGPM, range (pulp) | 2300-3800 |
| , pulp density | 1.68 |
| , % solids | 58.0 |
| Coarse Pb Ro Cells, retention time, minutes | 1 |
| , launder spray, USGPM, nominal | 60.0 |

Cleaners:

| | |
|---|---|
| Feed, Ro conc., dstph, design (solids) | 11.8 |
| , USGPM, design (pulp) | 121 |
| , range (pulp) | 80-350 |
| , pulp density | 1.30 |
| , % solids | 30.0 |
| Coarse Pb Clnr. Cells, retention time, minutes | 15 |
| , launder spray, USGPM, nom | 40.0 |

## Lead Rougher and Scavenger Flotation

### Conditioning

| | |
|---|---|
| Conditioner, arrangement | 2 in series |
| , retention time, minutes, each tank | 5 |

### Roughers

| | |
|---|---|
| Ro Feed, secondary cyclone O/F, dstph, nom.(solids) | 2 [illegible].4 |
| , Pb scav. conc , dstph, design (solids) | 1[illegible]3 |
| , total , dstph, design (solids) | 21[illegible] |
| , range (solids) | 190-2[illegible] |
| Ro Cells, retention time, minutes | [illegible]2 |
| , launder spray, USGPM, nominal | 15[illegible] |

### Scavengers:

| | |
|---|---|
| Ro Scav. Cells, retention time , minutes | 8 |
| , launder spray, USGPM, nominal | 30.0 |

### Lead Cleaner Flotation

| | |
|---|---|
| 1st Pb Clnr. Cells, retention time, minutes | 27 |
| , launder spray, USGPM, nominal | 75.0 |
| 2nd Pb Clnr. Cells, retention time, minutes | 21 |
| , launder spray, USGPM, nominal | 75.0 |
| 3rd Pb Clnr. Cells, retention time, minutes | 24 |
| ,launder spray, USGPM, nominal | 75.0 |

## Lead Regrind Flotation Circuit

### Regrinding

| | |
|---|---|
| Regrind Mill Feed, dstph, design (solids) | 111.5 |
| , dstph, range, (solids) | 75-170 |
| , feed, % solids, nominal | 45.0 |
| Feed Size, 80% passing, microns | 37 |
| Product Size, 80% passing, microns | 30 |
| Power Required, kWh/dst, design | 2.86 |
| , kW, design | 350 |
| , HP, design | 470 |
| , % losses | 6.4 |
| Mill, type | ball |
| , speed, % of critical | 75 |
| , loading, % by volume | 40 |
| , liners, material | rubber |
| , discharge, type | overflow no trommel |

### Classification

| | |
|---|---|
| Classifier, type | cyclones |
| , inlet pressure, psig | 10 |
| , feed, design, dstph (solids) | 139.4 |
| , range, dstph (solids) | 90-220 |
| , circulating load, nominal % | 400 |
| , minimum, % | 200 |
| , maximum, % | 500 |
| Cyclone Feed Pump, flow, USGPM, design | 1156.5 |
| , range | 750-1800 |
| , % solids | 36.0 |
| , pulp density | 1.34 |
| , drive, type | direct, fixed-speed |

| | |
|---|---|
| Cyclone O/F, design, dstph (solids) | 27.9 |
| , % solids | 20.0 |
| , % passing 325 mesh | 95 |

Lead Regrind Rougher Flotation:

| | |
|---|---|
| Pb Regrind Ro Cells, retention time, minutes | 7 |
| , launder spray, USGPM, nominal | 15.0 |

Lead Regrind Cleaner Flotation:

| | |
|---|---|
| Pb Regrind Clnr Cells, retention time, minutes | 15 |
| , launder spray, USGPM, nominal | 5.0 |

.6 Zinc Flotation

Zinc Rougher and Scavenger Flotation

Conditioning

| | |
|---|---|
| Conditioner, arrangement | 2 in series |
| , retention time, minutes, each tank | 5 |

Roughers

| | |
|---|---|
| Ro Cells, retention time, minutes | 11 |
| , launder spray, USGPM, nominal | 50.0 |

Scavengers

| | |
|---|---|
| Ro Scav. Cells, retention time, minutes | 8 |
| , launder spray, USGPM, nominal | 50.0 |

Zinc Cleaner Flotation

| | |
|---|---|
| 1st Zn Clnr. cells, retention time, minutes | 15 |
| , launder spray, USGPM, nominal | 40.0 |
| 2nd Zn Clnr. Cells, retention time, minutes | 15 |
| , launder spray, USGPM, nominal | 40.0 |
| 3rd Zn Clnr. cells, retention time, minutes | 15 |
| , launder spray, USGPM, nominal | 40.0 |

.7 Concentrate Thickening, Filtration & Loadout

Lead Concentrate

Thickening:

| | |
|---|---|
| Thickener, type | conventional |
| , mechanism | bridge-mounted |
| , area, $ft^2$/dstpd, design | 5.0 |
| Flocculant addition, lb/dst, design | none |
| Thickener U/F, dstph, design | 31.5 |
| , % solids | 50.0 |
| Thickener O/F, USGPM, design | 251.6 |

Filtration

| | |
|---|---|
| Feed tank, retention time, minutes | 120 |
| Filter, type | pressure |
| , filter area, $ft^2$, each | 300 |
| , filter rate, lb/$ft^2$/hour | 123 |
| , availability, % | 85 |

| | |
|---|---|
| Filter Cycle (Provisional) | |
| , feed, minutes, design | 1.5 |
| , range | 1.0-1.5 |
| , close, minutes, design | 0.5 |
| , range | 0.5 |
| , blow, minutes, design | 3.0 |
| , range | 2.5-4.0 |
| , disc & misc., minutes, design | 4.0 |
| , range | 4.0 |
| , total, minutes, design | 9.0 |
| , range | 7.5-10.0 |
| Air Required, cfm, blow cycle, avg. | 1480 |
| , psig, initial | 100 |
| Filter Cake, dstph (rate), each filter | 18.5 |
| , % moisture | 8.0 |
| , bulk density | 4.1 |
| , specific gravity | 5.7 |

Loadout:

| | |
|---|---|
| Concentrate Storage, capacity, live | 12 hours |
| , capacity, total | 2 weeks |

Zinc Concentrate

Thickening:

| | |
|---|---|
| Thickener, type | conventional |
| , mechanism | bridge-mounted |
| , area, $ft^2$/dstpd | 5.0 |
| Flocculant Addition, lb/dst | none |
| Thickener U/F, dstph, design | 23.0 |
| , % solids | 50.0 |
| Thickener O/F, USGPM, design | 122.6 |

Filtration:

| | |
|---|---|
| Feed Tank, retention time, minutes | 150 |
| Filter, type | pressure |
| , filter area, $ft^2$, each | 300 |
| , filter rate, $lb/ft^2$/hour | 92 |
| , availability, % | 85 |
| Filter Cycle (Provisional) | |
| , feed, minutes, design | 1.5 |
| , range | 1.0-1.5 |
| , close, minutes, design | 0.5 |
| , range | 0.5 |
| , blow, minutes, design | 3.0 |
| , range | 2.5-4.0 |
| , disc & misc., minutes, design | 4.0 |
| , range | 4.0 |
| , total, minutes, design | 9.0 |
| , range | 7.5-10.0 |
| Air Required, cfm, blow cycle, avg. | 1480 |
| , psig, initial | 100 |
| Filter Cake, dstph (rate), each filter | 13.9 |
| , % moisture | 8.0 |
| , bulk density | 3.1 |
| , specific gravity | 3.8 |

Loadout

| | |
|---|---|
| Concentrate Storage, capacity, live | 12 hours |
| , total | 2 weeks |

## 3.7.2 PROCESS DESCRIPTION

### .1 General

The process consists of autogenous grinding of the primary crushed ore, differential lead/zinc flotation, concentrate dewatering, concentrate storage and loadout. The economic minerals in the Tom and Jason ores are galena and sphalerite, with some precious metals associated with the former. The grinding circuit incorporates fully autogenous primary grinding (refer to Section 2) followed by secondary pebble milling. The flotation scheme is generally typical for this type of ore mineralization; however, a low pulp pH is used, and a coarse lead circuit is incorporated to recover liberated galena in a concentrate at or close to final product grade. The concentrates are thickened then pressure filtered, thereby avoiding the need for drying. Final tailings are thickened at the disposal area, and reclaim water is returned to the process.

### .2 Basis

The milling circuit was designed for a feed capacity of 5000 dry short tons per day of ore, with the capacity of the grinding circuit being the main limiting factor. Nominal throughput is 4500 short tons per day.

The grinding mills have been sized on milling the hardest ore (Tom West), thus the design basis is probably conservative for the co-mingled Tom East and Tom West mill feed, and possibly for Jason ores.

In sizing the flotation circuit, the higher grade Tom East ore was used (11.13% Pb, 8.41% Zn), thus the capacities of the flotation/concentrate dewatering circuits are likewise conservative. As noted in Section 2.4, the selection of the flotation circuit was based upon testwork conducted on samples of Tom East and Tom West ores.

The process flow diagrams are presented in Drawings M-100, M-101 and M-102. Mechanical/process equipment is listed in Section 3.15, together with equipment size, quantity, etc.

.3 Crushed Ore Storage

Primary crushed ore storage has been provided adjacent to the concentrator. A 10,000 ton (2 days capacity) underground pocket will be excavated in the hill behind the concentrator for this purpose (refer to Drawing M-111). Ore will be delivered from the Tom mine by conveyor, and from Jason by rear dump truck. Should the rate of extraction from Jason be increased in the future, conveyor delivery can be readily accommodated, as shown on Drawing M-111. Furthermore, should bottom dump trucks eventually be selected in place of rear dump, the storage concept can be readily adapted to accommodate them. Major advantages of the system used for the study include:

- Minimum use of expensive structural materials.
- Minimum requirement for protection against ore freezing during storage. This is of particular concern because of the high probability that the ore from the Tom mine will be quite wet.

- o Capacity can be adjusted readily with minimum cost impact.

.4 Grinding

As noted in Section 3.4, ore will come initially from the Tom mine only for about 3 years after start up, then from both Tom and Jason mines and finally in the last few years of operation, from Jason mine only. The primary crushed ore will be withdrawn from the coarse ore stockpile at a controlled rate using vibrating feeders. Usually two of the three units will operate simultaneously to provide the required control of the grinding feed rate.

The primary crushed ore will be delivered to a double-deck vibrating screen where sized ore pebbles (minus 3 1/2 plus 1 1/2 inch) will be screened out and sent to a 100 ton capacity surge bin. The plus 3 1/2 and minus 1 1/2 inch products will be combined and sent to the 200 ton capacity primary mill feed bin. As the weight of pebble-sized fraction in the feed to the screen will be greater than that required for secondary grinding, the entire feed will be diverted direct to the primary mill feed bin for much of the time.

Based upon testwork conducted in 1984 (refer to Section 2), the grinding circuit will comprise a primary autogenous mill followed by secondary pebble mills; each stage will be close-circuited with cyclones. On a fully autogenous basis, the primary mill will draw 2400 HP at a loading of 30 to 35% of mill volume. Should it be found necessary to grind semi-autogenously to remove certain

critical size build-ups, a ball charge of up to 8% may be added which would lower mill volume to about 25%, but would draw the same total power.

The primary mill classifier overflow will be relatively fine at 80% passing 100 mesh. At this fineness, it is anticipated that a significant quantity of liberated lead mineral (galena) will be present in the pulp, thus a unit flotation circuit is included in the circuit to recover 'coarse' liberated lead. The feed to the coarse lead rougher unit cells will consist of primary cyclone overflow together with secondary grinding mill discharge. The coarse lead rougher froth will be cleaned in another single unit cell, and the coarse lead cleaner concentrate will be pumped to the lead cleaner flotation circuit. Concentrate grade will be monitored, and depending upon the quality, the concentrate from the unit cells may be sent either to the lead 3rd cleaners or to final lead concentrate product. Also, the unit cells will have the flexibility to be operated as a rougher-rougher scavenger configuration rather than as a rougher-rougher concentrate cleaner.

The combined coarse lead rougher and cleaner tailings will be pumped to the secondary cyclones; the cyclone overflow at 80% passing 325 mesh will be sent to the lead flotation conditioner tanks, and the underflow will be split and fed by gravity to the two secondary pebble mills. The secondary mills will require a pebble media of 6 to 10% of the total feed. At a full load of about 40% by volume, the secondary pebble mills will each require a 1500 HP motor drive. The secondary mills will

be rubber-lined, and will be equipped with discharge trommel screens to remove pebble chips.

The feed rate to the primary autogenous mill will be controlled by belt scale, integrated through the mill power draw and the bearing hydrostatic pressure. The pebble feed rate to the secondary mills will be controlled through power draw; each mill will be fed pebbles intermittently. The secondary cyclone feed pump (metal-lined) will be equipped with a variable speed drive to afford control of the level in the cyclone feed sump which, in turn, influences the overflow density and size split. Water addition to the grinding circuit will be adjusted generally by the ore feed rate.

For operating reliability, the slurry pumps in the grinding circuit will include installed stand-by units. The grinding bay will be serviced by a 35/5 ton overhead crane; this crane will likewise service the diesel electric generators which are located in a partitioned extension to the grinding bay. The crane will also be used to charge balls to the primary mill, when in the semi-autogenous grinding (SAG) mode, and to the lead concentrate regrind mill.

.5 Flotation

Secondary cyclone overflow will be conditioned with the appropriate flotation reagents (collector, gangue depressant, frother) in two agitated tanks in series. The conditioner discharge will be combined with recycled lead scavenger concentrate and with process water

(density control), and directed to the first of the lead rougher flotation cells. A lead rougher concentrate will be floated in three-1350 cu ft cells, and a scavenger concentrate in two-1350 cu ft cells. The large capacity cells have been selected both on cost considerations and on metallurgical performance results on similar applications.

The lead rougher concentrate will be upgraded in three cleaning stages, each stage consisting of four-600 cu ft cells. Reagent additions will be made where required in the cleaning circuit. The lead first and second cleaner tailings will be reground in an overflow ball mill in closed-circuit with cyclones. The regrind cyclone overflow will be directed to the lead regrind rougher flotation cells, with the concentrate upgraded in one cleaner stage. As with the coarse lead flotation circuit, the regrind lead circuit has the flexibility to be operated as a rougher-rougher scavenger configuration. The lead regrind cleaner concentrate will be directed to the lead scavenger feed.

The lead scavenger tailings will be pumped to the zinc conditioners (two tanks in series). A zinc rougher concentrate will be floated in three-1350 cu ft cells, and upgraded in three cleaning stages (first: four-350 cu ft, second: four-300 cu ft, and third: three-300 cu ft cells). Tailings from the zinc first cleaners will be returned to the zinc rougher feed. The zinc scavenger tailings (final tailings) will be pumped to the disposal area (refer Section 3.8).

Vertical open-impeller pumps will be used for transferring the various froth products. Curbed floor areas and in-floor sumps equipped with vertical slurry pumps are provided to contain and recover separately any spills of lead and zinc pulps. The lead and zinc flotation bays will be serviced by overhead 10 ton travelling cranes.

.6 Concentrate Dewatering

The concentrate product from the lead third cleaners will be pumped to a 70 foot diameter thickener located within the concentrator building. The thickener area is sufficient such that a flocculant is assumed to be unnecessary.

Pressure filtration of concentrate will be practiced; equipment with demonstrated experience for lead and zinc concentrate dewatering to low moisture contents is available for this duty. Pressure filtration has the advantage of lower operating costs, primarily fuel, over conventional vacuum filtration and drying.

Thickened lead concentrate will first be transferred to a surge tank from which the concentrate slurry will be pumped in alternate cycles to two 990 cu ft (28 cu m) pressure filters (Larox pressure filters have been selected for study purposes). Each of the two filters will operate on approximately nine minute cycles; each cycle will include a blow stage in which compressed air is blown through the filter cake to remove moisture. In general, the longer the blow stage, the less moisture will remain with the cake.

The lead filter cake at about 6-9 percent moisture will be discharged from the filter and will be conveyed to the lead concentrate storage area.

Equipment in the zinc concentrate circuit has been sized identical to that for lead, except the thickener which will be only 60 foot diameter.

Sizing of the pressure filters for study purposes is based upon rates obtained in actual applications on concentrates similar to those anticipated in this study. As noted at the beginning of this section, the higher grade Tom East ore was used for design purposes, and consequently the filter equipment size is likely conservative. Since the pressure filter output will be relatively constant, the anticipated equipment utilization with the blended Tom or Jason feeds may be low. Control instrumentation for both lead and zinc concentrate filtration will be through a programmable logic controller (PLC).

### .7 Concentrate Storage and Loadout

Lead and zinc concentrates will be delivered on separate conveyors to two separate storage buildings from which they will be reclaimed and loaded out into highway transport trucks (refer to Drawing M-116). Reclaim equipment is sized at 150 stph. A platform type truck scale is located in each loading shed, to provide accurate weighing of the product being shipped.

The study is based on the assumption that every effort will be made to ship concentrates daily, so that storage is required only for short periods when road transport is interrupted. As such, only a few hours of production should normally be contained in the "live" space immediately above the hopper and feeder. Should shipping be interrupted, the pile will accumulate and spill over into the "dead" storage of the conical pile, to be reclaimed as soon as possible after resumption of shipments. Reclaim will be accomplished by pushing the "dead" material into the "live" space over the hopper, using a dozer or front end loader.

The storage capacity provided in the 100 foot diameter domes for each of the concentrates represents at least 14 days production.

## .8 Reagent Systems

The selected reagent schedule has been developed from the results of the previous testwork programs (refer to Section 2). The system incorporates the use of selective collectors and depressants, and may be characterized from some other lead/zinc differential flowsheets by the use of sodium cyanide (only) for depression of sphalerite and pyrite. Lime will not be required for alkalinity control in flotation.

Table 3.7-1 indicates the reagent scheme, quantities, reagent dosages, and addition points. For study purposes the quantities of reagents used in the testwork have been applied; however, in commerical application optimization of reagents would likely result in less reagent quantities.

The equipment schemes selected for reagent preparation and distribution are indicated on Process Flow Diagram M-102. For the most part, reagent solutions will be prepared on one shift daily, and fed to the process at the desired quantities and concentrations from storage tanks. Cyanide solution will be prepared in an enclosed part of the reagent mix area, with proper ventilation.

Other chemicals and reagents may be required; but the quantities may not be significant. Among the items which may be needed, but which cannot be quantified at present, are:

- Hydrated lime for occasional pH adjustment.
- Either hydrated lime and liquid $SO_2$, or chlorine for cyanide destruction if and when it is necessary to discard tailings pond solutions to the local watercourse.
- Lime for precipitation of heavy metal ions present in acidic mine waters.
- Water softening chemicals for diesel generator cooling systems.
- Anti-scalent for process water systems.
- Sewage treatment chemicals.
- Flocculant for concentrate thickening and/or tailings thickening (if found to be necessary).

In particular, it should be noted that no provision has been made for the bulk handling of large quantities of lime, although such a system could be fitted in quite readily.

## REAGENTS

| Reagent | Use | Amount lb/ton | Strength, % wt. | Addition Points |
|---|---|---|---|---|
| $ZnSO_4$ | Zn depressant | 2.20 | 10 | Pb conditioner /flotation/ regrind circuit |
| $Na_2SO_3$ | Zn depressant | 2.50 | 5 | Pb conditioner /regrind circuit |
| $Na_2SiO_2$ | Slimes dispersant | 0.28 | 7.5 | Pb conditioner |
| NaCN | Zn & Pyrite depressant | 0.45 | 10 | Pb conditioner /flotation/ regrind circuit |
| AX-325 | Pb promotor | 0.25 | 10 | Pb conditioner /regrind |
| MIBC | frother | 0.15 | 100 | Pb & Zn flotation |
| AF-99E | frother | 0.30 | 100 | Pb & Zn flotation |
| $CuSO_4$ | Zn activator | 1.50 | 5 | Zn Conditioner |
| Xanthate | Zn promotor | 0.15 | 10 | Zn Conditioner |
| AF-25 | frother | 0.05 | 100 | Zn flotation |

TABLE 3.7-1

## .9 Process Control Instrumentation

The initial strategy is that the degree of sophistication of the control instrumentation will provide high plant efficiencies, but will minimize labour only to a degree. At a later date automated digital process control utilizing a centralized computer can be considered for optimization of metallurgical performance, reagent utilization, as well as productivity.

The grinding circuit control instrumentation will include measurement of the feed rate, cyclone feed sump level and inlet pressure (primary and secondary cyclones), with variable speed control on the secondary cyclone feed pump drive, and mass flow indication/reading on the secondary cyclone overflow. A particle size monitor (PSM) can be included later to measure and control the degree of fineness in the secondary cyclone overflow.

In the flotation circuits, pulp levels will be controlled using float-activated electronic level indicators and pneumatic dart valves on the discharge boxes of each cell bank. Adjustments to the reagent additions and to the air flow rates will be made manually in the initial control strategy.

Since the need to maintain optimum density of the concentrate thickener underflows is not critical for the subsequent pressure filtration stage, the thickener underflows will be controlled by density gauge and variable speed drive on the underflow pump.

The filters will be equipped with programmable logic controllers (PLC); operator attention for the filters will not be required.

The tailings pumping and pipeline system will be equipped with pressure transmitters, and a mass flow (nuclear density gauge, magnetic flowmeter) indicator/recorder.

A total of six automatic pulp samplers have been selected; these will be located on the following streams:

- secondary cyclone overflow
- coarse lead cleaner concentrate
- lead rougher concentrate
- lead scavenger tailings
- zinc rougher concentrate
- zinc scavenger tailings

The secondary cyclone overflow (plant feed) and the zinc scavenger (final) tailings will be equipped with two stage systems; an intermittent cutter followed by a vezin.

An on-stream X-ray analyzer system has also been incorporated to monitor five of the above six pulp streams (coarse lead cleaner concentrate excluded). Elements which will be analyzed include lead, zinc, iron and slurry density. Results will be printed at 5-10 minute intervals and the data used for operator control, but not for metallurgical purposes.

## 3.7.3 MATERIALS BALANCE

### .1 Design Flows

An ore and water balance, using the design flow rate, is presented in Table 3.7-2. As noted in Section 3.7.1.1, Operating Parameters, the design capacity is 5,000 dstpd versus a nominal capacity of 4,500 dstpd of ore feed. The material balance was calculated using a programmable micro-computer with the software package Lotus 1,2,3. Table 3.7-2 is a print-out of the program.

Most of the significant Stream Numbers from Table 3.7-2 are shown on the Process Flow Diagrams M-100, M-101 and M-102.

The feed grades, and product weight recoveries and grades, were selected on information provided to Bechtel Canada (refer to Section 3.7.2).

### .2 Minimum/Maximum Flow Ranges

Further materials balances were calculated using the programmable micro-computer to establish the minimum and maximum flow rates used for equipment selection and sizing. The basic assumptions used are noted in Table 3.7-3 and the resulting flow ranges are shown in Table 3.7-4.

The stream numbers correspond to those shown on Process Flow Diagrams M-100 and M-101. The figures in the centre column, Design Flow, are as presented in Table 3.7-2.

TOM / JASON PROJECT - Ore / Water Balance

Plant Feed (mstpy) : 1.575
Plant Feed (stpd) : 5000.00
Plant Feed (stph) : 208.33
Days Per Year : 350
Plant Availability : 90%

| Line No. | Stream Name | STPH Solids | STPH Water | STPH Pulp | % Solids | S.G. Solids | USGPM Water | USGPM Pulp | S.G. Pulp | % Weight | % Pb | % Zn | Distn. Pb | Distn. Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Plant Feed | 208.33 | 6.44 | 214.78 | 97.00 | 3.36 | 25.74 | 273.39 | 3.14 | 100.00 | 11.13 | 8.41 | 100.00 | 100.00 |
| 2 | Pebble Product | 16.67 | 0.52 | 17.18 | 97.00 | 3.36 | 2.06 | 21.87 | 3.14 | 8.00 | 11.13 | 8.41 | 8.00 | 8.00 |
| 3 | Pri. Mill Feed Product | 191.67 | 5.93 | 197.59 | 97.00 | 3.36 | 23.68 | 251.52 | 3.14 | 92.00 | 11.13 | 8.41 | 92.00 | 92.00 |
| 4 | Pri. Mill Feed | 191.67 | 5.93 | 197.59 | 97.00 | 3.36 | 23.68 | 251.52 | 3.14 | 92.00 | 11.13 | 8.41 | 92.00 | 92.00 |
| 5 | Pri. Mill Product | 383.33 | 164.29 | 547.62 | 70.00 | 3.36 | 656.26 | 1111.94 | 1.97 | 184.00 | 11.13 | 8.41 | 184.00 | 184.00 |
| 6 | Pri. Mill Feed Dilution | | 94.47 | 94.47 | | | 377.37 | 377.37 | 1.00 | | | | | |
| 7 | Pri.Cycl.Feed Dilution | | 56.42 | 56.42 | | | 225.38 | 225.38 | 1.00 | | | | | |
| 8 | Primary Cyclone Feed | 383.33 | 220.71 | 604.04 | 63.46 | 3.36 | 881.64 | 1337.32 | 1.80 | 184.00 | 11.13 | 8.41 | 184.00 | 184.00 |
| 9 | Pri.Cyclone Overflow | 191.67 | 156.82 | 348.48 | 55.00 | 3.36 | 626.43 | 854.27 | 1.63 | 92.00 | 11.13 | 8.41 | 92.00 | 92.00 |
| 10 | Pri.Cyclone Underflow | 191.67 | 63.89 | 255.56 | 75.00 | 3.36 | 255.21 | 483.05 | 2.11 | 92.00 | 11.13 | 8.41 | 92.00 | 92.00 |
| 11 | Pebble Feed (each mill) | 8.33 | 0.26 | 8.59 | 97.00 | 3.36 | 1.03 | 10.94 | 3.14 | 4.00 | 11.13 | 8.41 | 4.00 | 4.00 |
| 12 | Sec.Cycl.U/F Dilution | | 67.39 | 67.39 | | | 269.18 | 269.18 | 1.00 | | | | | |
| 13 | Ore Feed (each mill) | 306.61 | 165.10 | 471.71 | 65.00 | 3.34 | 659.50 | 1026.45 | 1.84 | 147.17 | 10.19 | 8.53 | 134.76 | 149.33 |
| 14 | Peb.Mill Prod.(each mill) | 314.94 | 165.36 | 480.30 | 65.57 | 3.34 | 660.53 | 1037.38 | 1.85 | 151.17 | 10.22 | 8.53 | 138.76 | 153.33 |
| 15 | Peb.Mill Prod. Dilution | | 89.21 | 89.21 | | | 356.37 | 356.37 | 1.00 | | | | | |
| 16 | Peb.Mill Circ.Product | 629.89 | 419.92 | 1049.81 | 60.00 | 3.34 | 1677.43 | 2431.14 | 1.72 | 302.35 | 10.22 | 8.53 | 277.52 | 306.66 |
| 17 | C.Lead Ro.Feed Dilution | | 18.18 | 18.18 | | | 72.60 | 72.60 | 1.00 | | | | | |
| 18 | C.Lead Rougher Feed | 821.55 | 594.92 | 1416.47 | 58.00 | 3.34 | 2376.46 | 3358.01 | 1.68 | 394.35 | 10.43 | 8.50 | 369.52 | 398.66 |
| 19 | C.Lead Rougher Spray | | 15.02 | 15.02 | | | 60.00 | 60.00 | 1.00 | | | | | |
| 20 | C.Lead Rougher Conc. | 11.78 | 27.49 | 39.27 | 30.00 | 4.23 | 109.81 | 120.93 | 1.30 | 5.65 | 40.00 | 4.00 | 20.32 | 2.69 |
| 21 | C.Lead Rougher Tail | 809.77 | 582.45 | 1392.22 | 58.16 | 3.33 | 2326.65 | 3297.08 | 1.69 | 388.69 | 10.00 | 8.57 | 349.19 | 395.97 |
| 22 | C.Lead Cleaner Spray | | 10.01 | 10.01 | | | 40.00 | 40.00 | 1.00 | | | | | |
| 23 | C.Lead Circuit Conc. | 3.93 | 11.78 | 15.71 | 25.00 | 5.20 | 47.06 | 50.08 | 1.25 | 1.88 | 60.00 | 2.00 | 10.16 | 0.45 |
| 24 | C.Lead Cleaner Tail | 7.85 | 25.72 | 33.58 | 23.39 | 3.87 | 102.75 | 110.85 | 1.21 | 3.77 | 30.00 | 5.00 | 10.16 | 2.24 |
| 25 | C.Lead Circuit Tail | 817.63 | 608.17 | 1425.79 | 57.35 | 3.34 | 2429.39 | 3407.93 | 1.67 | 392.46 | 10.19 | 8.53 | 359.35 | 398.21 |
| 26 | Sec. Cycl. Feed Dilution | | 34.25 | 34.25 | | | 136.82 | 136.82 | 1.00 | | | | | |
| 27 | Sec. Cyclone Feed | 817.63 | 642.42 | 1460.04 | 56.00 | 3.34 | 2566.21 | 3544.75 | 1.65 | 392.46 | 10.19 | 8.53 | 359.35 | 398.21 |
| 28 | Sec. Cyclone Overflow | 204.41 | 379.61 | 584.02 | 35.00 | 3.34 | 1516.40 | 1761.03 | 1.32 | 98.12 | 10.19 | 8.53 | 89.84 | 99.55 |
| 29 | Sec. Cyclone Underflow | 613.22 | 262.81 | 876.03 | 70.00 | 3.34 | 1049.81 | 1783.71 | 1.96 | 294.35 | 10.19 | 8.53 | 269.52 | 298.66 |
| 30 | Lead Conditioner Dilution | | 16.33 | 16.33 | | | 65.23 | 65.23 | 1.00 | | | | | |
| 31 | Lead Rougher Feed | 215.26 | 457.42 | 672.67 | 32.00 | 3.34 | 1827.20 | 2084.96 | 1.29 | 103.32 | 10.08 | 8.61 | 93.58 | 105.74 |
| 32 | Lead Rougher Spray | | 37.55 | 37.55 | | | 150.00 | 150.00 | 1.00 | | | | | |
| 33 | Lead Rougher Concentrate | 52.01 | 121.35 | 173.36 | 30.00 | 4.23 | 484.75 | 533.83 | 1.30 | 24.96 | 40.00 | 4.00 | 89.72 | 11.87 |
| 34 | Lead Rougher Tail | 163.25 | 373.62 | 536.86 | 30.41 | 3.12 | 1492.45 | 1701.13 | 1.26 | 78.36 | 0.55 | 10.07 | 3.86 | 93.87 |
| 35 | Lead Scavenger Feed | 187.69 | 476.39 | 664.08 | 28.26 | 3.14 | 1902.99 | 2141.67 | 1.24 | 90.09 | 1.41 | 9.81 | 11.39 | 105.11 |
| 36 | Lead Scavenger Spray | | 7.51 | 7.51 | | | 30.00 | 30.00 | 1.00 | | | | | |
| 37 | Lead Scavenger Conc. | 10.85 | 61.48 | 72.33 | 15.00 | 3.30 | 245.57 | 258.70 | 1.12 | 5.21 | 8.00 | 10.00 | 3.74 | 6.19 |
| 38 | Lead Scavenger Tail | 176.84 | 422.42 | 599.27 | 29.51 | 3.13 | 1687.42 | 1912.97 | 1.25 | 84.88 | 1.00 | 9.80 | 7.64 | 98.92 |
| 39 | Lead 1st Cleaner Spray | | 18.78 | 18.78 | | | 75.00 | 75.00 | 1.00 | | | | | |
| 40 | Lead 1st Cleaner Conc. | 40.56 | 94.64 | 135.21 | 30.00 | 4.67 | 378.06 | 412.79 | 1.31 | 19.47 | 50.00 | 3.00 | 87.46 | 6.95 |
| 41 | Lead 1st Cleaner Tail | 11.45 | 45.48 | 56.93 | 20.11 | 3.19 | 181.68 | 196.03 | 1.16 | 5.49 | 4.56 | 7.54 | 2.25 | 4.93 |
| 42 | Lead 2nd Cleaner Feed | 60.13 | 159.67 | 219.79 | 27.36 | 4.48 | 637.81 | 691.37 | 1.27 | 28.86 | 46.47 | 2.62 | 120.49 | 9.00 |
| 43 | Lead 2nd Cleaner Spray | | 18.78 | 18.78 | | | 75.00 | 75.00 | 1.00 | | | | | |
| 44 | Lead 2nd Cleaner Conc. | 43.69 | 115.18 | 158.87 | 27.50 | 5.04 | 460.11 | 494.72 | 1.28 | 20.97 | 58.00 | 1.00 | 109.28 | 2.49 |
| 45 | Lead 2nd Cleaner Tail | 16.44 | 63.26 | 79.70 | 20.62 | 3.47 | 252.70 | 271.65 | 1.17 | 7.89 | 15.81 | 6.94 | 11.21 | 6.51 |
| 46 | Lead 3rd Cleaner Feed | 51.06 | 140.73 | 191.78 | 26.62 | 4.98 | 562.15 | 603.07 | 1.27 | 24.51 | 56.94 | 1.08 | 125.38 | 3.14 |
| 47 | Lead 3rd Cleaner Spray | | 18.78 | 18.78 | | | 75.00 | 75.00 | 1.00 | | | | | |
| 48 | Lead 3rd Cleaner Conc. | 31.49 | 94.48 | 125.97 | 25.00 | 5.69 | 377.40 | 399.50 | 1.26 | 15.12 | 68.00 | 0.60 | 92.36 | 1.08 |
| 49 | Lead 3rd Cleaner Tail | 19.57 | 65.02 | 84.59 | 23.13 | 4.15 | 259.74 | 278.57 | 1.21 | 9.39 | 39.14 | 1.84 | 33.03 | 2.06 |

TABLE 3.7-2
Sheet 1

TOM / JASON PROJECT - Ore / Water Balance

Plant Feed (mstpy) : 1.575
Plant Feed (stpd) : 5000.00
Plant Feed (stph) : 208.33
Days Per Year : 350
Plant Availability : 90%

| Line No. | Stream Name | STPH Solids | STPH Water | STPH Pulp | % Solids | S.G. Solids | USGPM Water | USGPM Pulp | S.G. Pulp | % Weight | % Pb | % Zn | Distn. Pb | Distn. Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38 | Zinc Circ. - New Feed | 176.84 | 422.41 | 599.25 | 29.51 | 3.13 | 1687.38 | 1912.93 | 1.25 | 84.88 | 1.00 | 9.80 | 7.63 | 98.91 |
| 62 | Zinc Rougher Feed | 193.65 | 514.24 | 707.90 | 27.36 | 3.13 | 2054.20 | 2301.35 | 1.23 | 92.95 | 1.01 | 9.63 | 8.41 | 106.44 |
| 63 | Zinc Rougher Spray | | 12.52 | 12.52 | | | 50.00 | 50.00 | 1.00 | | | | | |
| 64 | Zinc Rougher Concentrate | 29.67 | 69.24 | 98.91 | 30.00 | 3.63 | 276.58 | 309.23 | 1.28 | 14.24 | 0.35 | 46.00 | 0.45 | 77.91 |
| 65 | Zinc Rougher Tail | 163.98 | 457.52 | 621.50 | 26.38 | 3.05 | 1827.62 | 2042.12 | 1.22 | 78.71 | 1.13 | 3.05 | 7.97 | 28.54 |
| 66 | Zinc Scavenger Spray | | 12.52 | 12.52 | | | 50.00 | 50.00 | 1.00 | | | | | |
| 67 | Zinc Scavenger Conc. | 10.15 | 46.24 | 56.39 | 18.00 | 3.13 | 184.70 | 197.64 | 1.14 | 4.87 | 1.00 | 10.00 | 0.44 | 5.79 |
| 68 | Zinc Scavenger Tail | 153.83 | 423.80 | 577.63 | 26.63 | 3.05 | 1692.91 | 1894.48 | 1.22 | 73.84 | 1.13 | 2.59 | 7.53 | 22.74 |
| 69 | Zinc 1st Cleaner Feed | 38.96 | 110.93 | 149.88 | 25.99 | 3.57 | 443.11 | 486.64 | 1.23 | 18.70 | 0.54 | 42.23 | 0.91 | 93.89 |
| 70 | Zinc 1st Cleaner Spray | | 10.01 | 10.01 | | | 40.00 | 40.00 | 1.00 | | | | | |
| 71 | Zinc 1st Cleaner Conc. | 32.29 | 75.35 | 107.64 | 30.00 | 3.70 | 300.99 | 335.87 | 1.28 | 15.50 | 0.40 | 50.00 | 0.56 | 92.16 |
| 72 | Zinc 1st Cleaner Tail | 6.66 | 45.59 | 52.25 | 12.75 | 3.07 | 182.11 | 190.77 | 1.09 | 3.20 | 1.21 | 4.57 | 0.35 | 1.74 |
| 73 | Zinc 2nd Cleaner Feed | 39.36 | 101.86 | 141.22 | 27.87 | 3.68 | 406.88 | 449.55 | 1.25 | 18.89 | 0.42 | 49.14 | 0.72 | 110.41 |
| 74 | Zinc 2nd Cleaner Spray | | 10.01 | 10.01 | | | 40.00 | 40.00 | 1.00 | | | | | |
| 75 | Zinc 2nd Cleaner Conc. | 30.08 | 70.18 | 100.26 | 30.00 | 3.78 | 280.35 | 312.14 | 1.28 | 14.44 | 0.20 | 55.00 | 0.26 | 94.42 |
| 76 | Zinc 2nd Cleaner Tail | 9.28 | 41.69 | 50.97 | 18.21 | 3.41 | 166.53 | 177.41 | 1.15 | 4.46 | 1.14 | 30.17 | 0.46 | 15.99 |
| 77 | Zinc 3rd Cleaner Spray | | 10.01 | 10.01 | | | 40.00 | 40.00 | 1.00 | | | | | |
| 78 | Zinc 3rd Cleaner Conc. | 23.01 | 53.69 | 76.70 | 30.00 | 3.83 | 214.46 | 238.46 | 1.28 | 11.04 | 0.10 | 58.00 | 0.10 | 76.17 |
| 79 | Zinc 3rd Cleaner Tail | 7.07 | 26.51 | 33.58 | 21.05 | 3.62 | 105.89 | 113.69 | 1.18 | 3.39 | 0.53 | 45.24 | 0.16 | 18.25 |
| 48 | Lead Concentrate | 31.49 | 94.47 | 125.96 | 25.00 | 5.69 | 377.37 | 399.47 | 1.26 | 15.12 | 68.00 | 0.60 | 92.35 | 1.08 |
| 80 | Lead Thickener U/F | 31.49 | 31.49 | 62.98 | 50.00 | 5.69 | 125.79 | 147.89 | 1.70 | 15.12 | 68.00 | 0.60 | 92.35 | 1.08 |
| 81 | Lead Thickener O/F | | 62.98 | 62.98 | | | 251.58 | 251.58 | 1.00 | | | | | |
| 82 | Lead Filter Feed (Avg.) | 31.49 | 31.49 | 62.98 | 50.00 | 5.69 | 125.79 | 147.89 | 1.70 | 15.12 | 68.00 | 0.60 | 92.35 | 1.08 |
| 83 | Lead Filter Cake (Avg.) | 31.49 | 2.74 | 34.23 | 92.00 | 5.69 | 10.94 | 33.03 | 4.14 | 15.12 | 68.00 | 0.60 | 92.35 | 1.08 |
| 84 | Lead Filtrate (Avg.) | | 28.75 | 28.75 | | | 114.85 | 114.85 | 1.00 | | | | | |
| 105 | Reclaim Water | | 357.87 | 357.87 | | | 1429.56 | 1429.56 | 1.00 | | | | | |
| 85 | Fresh Water Make-up | | 60.85 | 60.85 | | | 243.09 | 243.09 | 1.00 | | | | | |
| 86 | Lead Process Water | | 510.46 | 510.46 | | | 2039.08 | 2039.08 | 1.00 | | | | | |
| 78 | Zinc Concentrate | 23.01 | 53.69 | 76.70 | 30.00 | 3.83 | 214.46 | 238.46 | 1.28 | 11.04 | 0.10 | 58.00 | 0.10 | 76.17 |
| 87 | Zinc Thickener U/F | 23.01 | 23.01 | 46.02 | 50.00 | 3.83 | 91.91 | 115.91 | 1.59 | 11.04 | 0.10 | 58.00 | 0.10 | 76.17 |
| 88 | Zinc Thickener O/F | | 30.68 | 30.68 | | | 122.55 | 122.55 | 1.00 | | | | | |
| 89 | Zinc Filter Feed (Avg.) | 23.01 | 23.01 | 46.02 | 50.00 | 3.83 | 91.91 | 115.91 | 1.59 | 11.04 | 0.10 | 58.00 | 0.10 | 76.17 |
| 90 | Zinc Filter Cake (Avg.) | 23.01 | 2.00 | 25.01 | 92.00 | 3.83 | 7.99 | 31.99 | 3.12 | 11.04 | 0.10 | 58.00 | 0.10 | 76.17 |
| 91 | Zinc Filtrate (Avg.) | | 21.01 | 21.01 | | | 83.92 | 83.92 | 1.00 | | | | | |
| 92 | Fresh Water Make-up | | 3.39 | 3.39 | | | 13.53 | 13.53 | 1.00 | | | | | |
| 93 | Zinc Process Water | | 55.07 | 55.07 | | | 220.00 | 220.00 | 1.00 | | | | | |
| 68 | Zinc Scavenger Tail | 153.83 | 423.80 | 577.63 | 26.63 | 3.05 | 1692.91 | 1894.48 | 1.22 | 73.84 | 1.13 | 2.59 | 7.53 | 22.74 |
| 100 | Process Tailings | 153.83 | 423.80 | 577.63 | 26.63 | 3.05 | 1692.91 | 1894.48 | 1.22 | 73.84 | 1.13 | 2.59 | 7.53 | 22.74 |
| 101 | Tailings Thickener U/F | 153.83 | 125.86 | 279.69 | 55.00 | 3.05 | 502.77 | 704.33 | 1.59 | 73.84 | 1.13 | 2.59 | 7.53 | 22.74 |
| 102 | Tailings Thickener O/F | | 297.94 | 297.94 | | | 1190.15 | 1190.15 | 1.00 | | | | | |
| 103 | Settled Tailings | 153.83 | 65.93 | 219.76 | 70.00 | 3.05 | 263.35 | 464.92 | 1.89 | 73.84 | 1.13 | 2.59 | 7.53 | 22.74 |
| 104 | Tailings Decant Sol'n | | 59.93 | 59.93 | | | 239.41 | 239.41 | 1.00 | | | | | |
| 105 | Reclaim Water | | 357.87 | 357.87 | | | 1429.56 | 1429.56 | 1.00 | | | | | |
| 106 | Fresh Water For Process | | 64.24 | 64.24 | | | 256.62 | 256.62 | 1.00 | | | | | |

TABLE 3.7-2
Sheet 2

TOM / JASON PROJECT - Ore / Water Balance

Plant Feed (mstpy) : 1.575
Plant Feed (stpd) : 5000.00
Plant Feed (stph) : 208.33
Days Per Year : 350
Plant Availability : 90%

| Line No. | Stream Name | STPH Solids | STPH Water | STPH Pulp | % Solids | S.G. Solids | USGPM Water | USGPM Pulp | S.G. Pulp | % Weight | % Pb | % Zn | Distn. Pb | Distn. Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | Lead Regrind - New Feed | 27.88 | 108.74 | 136.62 | 20.41 | 3.34 | 434.38 | 467.68 | 1.17 | 13.38 | 11.19 | 7.19 | 13.46 | 11.44 |
| 51 | Regr. Cycl. Feed Dilution | | 2.79 | 2.79 | | | 11.14 | 11.14 | 1.00 | | | | | |
| 52 | Regrind Cyclone Feed | 139.41 | 247.84 | 387.26 | 36.00 | 3.34 | 990.04 | 1156.53 | 1.34 | 66.92 | 11.19 | 7.19 | 67.29 | 57.20 |
| 53 | Regrind Cyclone Overflow | 27.88 | 111.53 | 139.41 | 20.00 | 3.34 | 445.52 | 478.82 | 1.16 | 13.38 | 11.19 | 7.19 | 13.46 | 11.44 |
| 54 | Regrind Cyclone Underflow | 111.53 | 136.31 | 247.84 | 45.00 | 3.34 | 544.52 | 677.72 | 1.46 | 53.53 | 11.19 | 7.19 | 53.83 | 45.76 |
| 55 | Regrind Rougher Spray | | 3.76 | 3.76 | | | 15.00 | 15.00 | 1.00 | | | | | |
| 56 | Regrind Rougher Conc. | 6.89 | 27.56 | 34.45 | 20.00 | 3.87 | 110.11 | 117.21 | 1.17 | 3.31 | 30.00 | 5.00 | 8.92 | 1.97 |
| 57 | Regrind Rougher Tail | 20.99 | 87.72 | 108.71 | 19.31 | 3.20 | 350.41 | 376.60 | 1.15 | 10.08 | 5.02 | 7.91 | 4.54 | 9.47 |
| 58 | Regrind Cleaner Spray | | 1.25 | 1.25 | | | 5.00 | 5.00 | 1.00 | | | | | |
| 59 | Regrind Cleaner Conc. | 3.44 | 13.76 | 17.20 | 20.00 | 4.17 | 54.97 | 58.27 | 1.18 | 1.65 | 40.00 | 1.00 | 5.94 | 0.20 |
| 60 | Regrind Cleaner Tail | 3.45 | 15.05 | 18.50 | 18.65 | 3.62 | 60.13 | 63.94 | 1.16 | 1.66 | 20.03 | 8.99 | 2.98 | 1.77 |
| 61 | Regrind Circuit Tail | 24.44 | 102.77 | 127.22 | 19.21 | 3.25 | 410.54 | 440.54 | 1.15 | 11.73 | 7.14 | 8.06 | 7.52 | 11.24 |
| 86 | Lead Process Water | | 510.46 | 510.46 | | | 2039.08 | 2039.08 | 1.00 | | | | | |

TABLE 3.7-2
Sheet 3

## FLOW RANGE CRITERIA

| | BASIC ASSUMPTIONS | | | | |
|---|---|---|---|---|---|
| | FOR MINIMUM FLOW | | DESIGN FLOW | FOR MAXIMUM FLOW | |
| Feed Rate | | | | | |
| dstpd | 4500 | | 5000 | 5000 | |
| Feed Grades | | | | | |
| % Pb | 11.13 | 7.50 | 11.13 | 17.00 | 11.13 |
| % Zn | 8.41 | 5.50 | 8.41 | 12.50 | 8.41 |
| Primary Cyclones | | | | | |
| % Circulating Load | 150 | 100 | 100 | 100 | 50 |
| S.F. to U/F (1) | 0.6 | 0.5 | 0.5 | 0.5 | 0.5 |
| Secondary Cyclones | | | | | |
| % Circulating Load | 400 | 300 | 300 | 300 | 150 |
| S.F. to U/F (1) | 0.8 | 0.75 | 0.75 | 0.75 | 0.60 |

Note (1) Split factor of solids reporting to the underflow

Table 3.7-3

## DESIGN FLOW RANGES

| Stream Number | STREAM NAME | FLOW, USGPM MINIMUM | DESIGN | MAXIMUM |
|---|---|---|---|---|
| 5 | Pri. Mill Product | 900 | 1112 | 1250 |
| 6 | Pri. Mill Feed Dilution | 350 | 377 | 400 |
| 7 | Pri.Cycl.Feed Dilution | 170 | 225 | 300 |
| 8 | Primary Cyclone Feed | 1200 | 1337 | 1400 |
| 9 | Pri.Cyclone Overflow | 750 | 854 | 960 |
| 10 | Pri.Cyclone Underflow | 250 | 483 | 650 |
| 12 | Sec.Cycl.U/F Dilution | 150 | 269 | 330 |
| 13 | Ore Feed (each mill) | 550 | 1026 | 1250 |
| 14 | Peb. Mill Prod. (each mill) | 550 | 1037 | 1250 |
| 15 | Peb.Mill Prod. Dilution | 210 | 356 | 450 |
| 16 | Peb.Mill Circ.Product | 1300 | 2431 | 3000 |
| 17 | C.Lead Ro.Feed Dilution | 70 | 73 | 110 |
| 19 | C.Lead Rougher Spray | 40 | 60 | 100 |
| 20 | C.Lead Rougher Conc. | 80 | 121 | 350 |
| 22 | C.Lead Cleaner Spray | 25 | 40 | 70 |
| 23 | C.Lead Circuit Conc. | 35 | 50 | 220 |
| 25 | C.Lead Circuit Tail | 2300 | 3408 | 3800 |
| 26 | Sec. Cycl. Feed Dilution | 100 | 137 | 650 |
| 27 | Sec. Cyclone Feed | 3000 | 3545 | 3900 |
| 28 | Sec. Cyclone Overflow | 1650 | 1761 | 2000 |
| 29 | Sec. Cyclone Underflow | 900 | 1784 | 2200 |
| 30 | Lead Conditioner Dilution | 75 | 210 | 300 |
| 32 | Lead Rougher Spray | 100 | 150 | 200 |
| 33 | Lead Rougher Concentrate | 350 | 534 | 850 |
| 36 | Lead Scavenger Spray | 20 | 30 | 60 |
| 37 | Lead Scavenger Conc. | 70 | 114 | 180 |
| 38 | Lead Scavenger Tail | 1600 | 1872 | 2100 |
| 39 | Lead 1st Cleaner Spray | 50 | 80 | 160 |
| 40 | Lead 1st Cleaner Conc. | 250 | 413 | 650 |
| 41 | Lead 1st Cleaner Tail | 150 | 201 | 270 |
| 43 | Lead 2nd Cleaner Spray | 80 | 100 | 150 |
| 44 | Lead 2nd Cleaner Conc. | 300 | 442 | 700 |
| 45 | Lead 2nd Cleaner Tail | 280 | 347 | 450 |
| 47 | Lead 3rd Cleaner Spray | 50 | 80 | 160 |
| 48 | Lead 3rd Cleaner Conc. | 220 | 354 | 550 |
| 51 | Regr. Cycl. Feed Dilution | 240 | 487 | 900 |
| 52 | Regrind Cyclone Feed | 450 | 723 | 1150 |
| 53 | Regrind Cyclone Overflow | 190 | 293 | 550 |
| 54 | Regrind Cyclone Underflow | 280 | 430 | 660 |
| 55 | Regrind Rougher Spray | 10 | 15 | 30 |
| 56 | Regrind Rougher Conc. | 50 | 90 | 140 |

Table 3.7-4
Sheet 1

| Stream Number | STREAM NAME | FLOW, USGPM MINIMUM | DESIGN | MAXIMUM |
|---|---|---|---|---|
| 58 | Regrind Cleaner Spray | 5 | 5 | 10 |
| 59 | Regrind Cleaner Conc. | 30 | 58 | 90 |
| 61 | Regrind Circuit Tail | 170 | 255 | 380 |
| 62 | Zinc Rougher Feed | 1950 | 2170 | 2400 |
| 63 | Zinc Rougher Spray | 40 | 50 | 100 |
| 64 | Zinc Rougher Concentrate | 200 | 309 | 470 |
| 66 | Zinc Scavenger Spray | 40 | 50 | 100 |
| 67 | Zinc Scavenger Conc. | 70 | 108 | 170 |
| 68 | Zinc Scavenger Tail | 1500 | 1853 | 2100 |
| 70 | Zinc 1st Cleaner Spray | 20 | 40 | 100 |
| 71 | Zinc 1st Cleaner Conc. | 210 | 336 | 500 |
| 72 | Zinc 1st Cleaner Tail | 160 | 191 | 240 |
| 74 | Zinc 2nd Cleaner Spray | 20 | 40 | 70 |
| 75 | Zinc 2nd Cleaner Conc. | 200 | 312 | 450 |
| 76 | Zinc 2nd Cleaner Tail | 140 | 177 | 230 |
| 77 | Zinc 3rd Cleaner Spray | 20 | 40 | 70 |
| 78 | Zinc 3rd Cleaner Conc. | 150 | 238 | 350 |
| 79 | Zinc 3rd Cleaner Tail | 80 | 114 | 150 |
| 80 | Lead Thickener U/F | 100 | 148 | 220 |
| 81 | Lead Thickener O/F | 190 | 321 | 510 |
| 84 | Lead Filtrate | 70 | 115 | 180 |
| 87 | Zinc Thickener U/F | 80 | 116 | 170 |
| 88 | Zinc Thickener O/F | 120 | 206 | 320 |
| 91 | Zinc Filtrate | 50 | 84 | 140 |
| 100 | Process Tailings | 1700 | 1894 | 3000 |
| 101 | Tailings Thickener U/F | 640 | 704 | 780 |
| 102 | Tailings Thickener O/F | 1060 | 1190 | 2220 |
| 103 | Settled Tailings | 310 | 465 | 700 |

Table 3.7-4
Sheet 2

## 3.8 TAILINGS DISPOSAL AND RECLAIM WATER

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3.8.1 DESIGN CRITERIA
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- .2 Thickening
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3.8.2 LOCATION

3.8.3 TAILINGS
- .1 Tailings Pumping
- .2 Tailings Deposition
- .3 Tailings Storage
- .4 Tailings Area Facilities

3.8.4 RECLAIM WATER SYSTEM

## 3.8 TAILINGS DISPOSAL AND RECLAIM WATER

### 3.8.1 DESIGN CRITERIA

#### .1 Tailings Pumping

| | |
|---|---|
| Pumps, no. of lines | 1 + 1 standby |
| , no. of stages per line | 5 |
| , type | hard metal, centrifugal |
| , drive, Stages 1-4 | fixed speed |
| , drive, Stage 5 | variable speed |
| , flow, USGPM, design | 1895 |
| , , USGPM, range | 1500 - 2400 |
| , , % solids, design | 27 |
| Pipeline, number | 1 |
| , diameter, inches | 12 |
| , type | steel, insulated & heat traced |
| , length, feet (approx.) | 21,000 |
| , flow velocity, ft/sec, range | 3.5 - 6.0 |

#### .2 Thickening

| | |
|---|---|
| Thickener, type | conventional |
| , mechanism | centre-pier |
| , area, $ft^2$/dstpd, design | 8.5 |
| , size, diam, feet | 200 |

| | |
|---|---|
| Thickener U/F, dstph, design | 279.7 |
| , % solids minimum | 55 |
| Thickener O/F, USGPM, design | 1190 |

.3 Tailings Area

| | |
|---|---|
| Settled solids, % solids, design | 70 |
| Storage, initial, years | 10 |
| , volume required, $ft^3$ @ 70% solids | $288 \times 10^6$ |
| , capacity, tons @ 70% solids | $18.23 \times 10^6$ |
| , capacity, dst | $12.76 \times 10^6$ |

## 3.8.2 LOCATION

The Rat Lake area on the western portion of the Jason property was selected as the tailings disposal site for this study.

Locations which were considered for tailings disposal were all within reasonable proximity of the concentrator. They included:

- A site in the South Macmillan valley, approximately 5 kilometres north east of the concentrator site
- Rat Lake area
- A flat meadow area immediately west of the Rat Lake area
- In future, mined out sections of the Tom mine.

Other areas in the general vicinity which offer potential sites are described in Thompson's report of January 1981.

In the absence of geotechnical data or other bases of judgement for any of these areas, the Rat Lake area was selected for the following reasons:

- o Capacity to contain the anticipated volume/tonnage of tailings generated over the forecast life of the project, with minimum containment dam requirement.
- o Probably the most acceptable location environmentally.
- o Situated on Tom/Jason property.

The Rat Lake area is a basin located in the valley to the west of and above the Jason shaft. The easterly end of the basin drains by a narrow valley into the South Macmillan valley; the westerly end drains, also by a narrow gorge, into the Hess River drainage area. Both ends can be closed off by relatively small dams.

The basin serves as a catchment for only a very limited surrounding area. There are no streams flowing into the area; the only inflow is surface runoff from the immediately adjacent hillsides.

The flat meadow area immediately west of Rat Lake, and designated as alternate tailings area (Refer to Site Plan C-1) is not large enough to contain the total tailings, but

could serve to supplement Rat Lake, should this ever be determined desireable. However, this area is not wholly on Tom/Jason property.

The very high pumping head required to deposit tailings in the mined out areas of the Tom mine, would likely rule out this option, except as a last resort.

The disadvantage of Rat Lake area relative to locations in the South Macmillan valley is its elevation, some 100 metres higher than the concentrator.

### 3.8.3 TAILINGS

#### .1 Tailings Pumping

Tailings will be removed as underflow from the zinc scavenger cells to a surge tank, from which they will be pumped to a 200 ft diameter conventional thickener located at the tailings disposal area. Chlorinated sewage, floor wash from the reagent area, other floor wash unsuitable for direct return to the process, and Tom Mine drainage water, will be added to the tailings surge tank for pumping to the disposal site.

The tailings will be pumped from the concentrator by a 5-stage centrifugal, pump system, four stages having fixed speed motors, the fifth being variable speed. A second series of pumps is provided as installed standby. Both sets of pumps connect to a single 12 inch diameter schedule 40, insulated and heat traced

pipeline laid directly on a graded roadbed parallelling the road between the concentrator and Jason shaft, thence to the tailings area.

Pump Duty : Slurry @ 80% passing 37 microns
Design - 1900 USGPM, 27% solids 1.22 s.g.
Maximum - 2400 USGPM, 24% solids 1.19 s.g.

An emergency dump will be provided at the low point of the line in the South Macmillan valley. The dump valve will be located in a heated enclosure. The pond will be lined to prevent seepage to the environment. Pond capacity will be at least double the pipeline volume.

.2 Tailings Deposition

A thickened tailings disposal system has been selected for this study in order to:

- Minimize dam requirements.
- Minimize water or slimes buildup behind dams.
- Minimize possiblity of developing permanently frozen lenses or layers of ice in the tailings, with potential future instability as a result.
- Minimize potential for seepage of tailings water to the environment.

The technique has been successfully applied in other cold locations in Northern Canada, so it is reasonable to expect that it can be applied successfully at Tom/Jason. A sub-aerial system might also be applied.

The thickened tailings will be pumped to a limited number of distribution spigots located along the hillside. Spigot locations will be changed during operations in order to achieve maximum storage capacity from the site. The spigotted tailings are expected to deposit at a 6% slope down the hill with the toe of the slope at the tailings dam. Thickener overflow will flow by gravity to a polishing pond located downstream of the easterly tailings dam, from which it will be reclaimed for return to the concentrator.

.3 Tailings Storage

For the total production presently forecast at approximately 20 million tons of ore, a total of 16.2 million dry short tons of tailings will be produced. The settled tailings at 70% solids will total 23 million tons and require 370 million cubic feet of storage space.

This volume may be readily contained in the Rat Lake storage area shown on Site Plan C-1, which is capable of holding in excess of 500 million cubic feet with the dam crest at elevation at 1315 and tailings high point at 1360 as shown. Thus there is adequate space should ore reserves and mine life be extended. For the study, a dam crest elevation of 1305 has been provided, with a tailings high point of 1335 metres elevation. This will be sufficient for approximately 300 million cu ft of storage required for 10 years operation.

## .4 Tailings Area Facilities

Facilities provided at the tailings area include:

- A 200 ft diameter conventional thickener. Backfill will be placed against the thickener walls as insulation, and a floating "roof" provided over the liquid surface, and the thickener mechanism will be protected by an electrically heated enclosure. The thickener was located at the disposal site rather than at the concentrator because less power is required to pump diluted tailings from the concentrator, than to pump thickened tailings.

  The alternative of a high capacity thickener was not selected for the study because:

  a) there is no adequate data on which to select the size, testwork would be required;
  b) a high capacity thickener would require the use of flocculants. The application of flocculant at the remote tailings thickener location would involve increased operating costs.

- Tailings thickener underflow pumps, one operating and one installed standby, to pump the thickened tailings to the spigots via an 8" diameter pipeline. Pumps will be housed in an insulated, electrically heated pumphouse adjacent to the thickener.

- o A vertical concrete well within the easterly dam, with stop-logs, to control removal of any accumulation of runoff water, and/or water draining from the tailings. Such water will flow by gravity to a polishing pond.

- o A polishing pond, obtained by constructing a smaller dam in the valley below the easterly tailings dam. This pond will receive any outflow from the tailings area, plus the tailings thickener overflow, and will permit settling of solids from either source. It will be of adequate size and depth to serve as a reclaim water reservoir even in cold weather, and have an impervious liner to prevent seepage of the water to the environment.

### 3.8.4 RECLAIM WATER SYSTEM

A vertical well will be constructed within the polishing pond dam, which will serve as intake well for two vertical reclaim water pumps, one operating and one standby.

The reclaim water will be pumped to a nearby 15,000 gallon surge tank, from which it will flow by gravity back to the concentrator. The reclaim water pumps will be controlled by the water level in the surge tank. They will be housed in an insulated, electrically heated pumphouse. The surge tank will also be in a heated enclosure.

Normally there will be very little or no water draining from the tailings to the polishing pond. There may be a small amount of precipitation runoff. Any such water surplus to the needs of the plant, will be treated as necessary and released to the environment under controlled conditions.

The 8" diameter reclaim water line will be heat traced and insulated, and laid parallel to the tailings line, on the roadbed.

The reclaim water will be directed to the 10,000 gallon process water tank (TK-31) in the concentrator, from which it will feed to the grinding circuits and the lead flotation circuit.

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3.9.10 FENCING

## 3.9 SERVICES

### 3.9.1 WATER SUPPLY

#### .1 Source

There are three possible sources of water for the project in reasonable proximity to the plant site:

- The South Macmillan River, a meandering stream running down the valley past the site, fed by tributary streams coming off the mountains on either side. There was no data available on the flows in this stream throughout the year in the immediate site vicinity.

  The Water Survey of Canada established a water gauging station at South Macmillan Bridge No. 1 (mile 249 or km 413). Continuous daily discharge measurements taken from October 1974 through July of 1980 range from 47.4 cfs to 380 cfs, with maximum flows occurring in June amd minimum flows in March. This station is too remote from the site (37 km downstream) for the data to be reliable for plant design purposes. However, it is indicative of the range of flows to be expected and, in particular, it indicates that caution must be exercised to ensure that a water source is developed which will be adequate for the project both in quantity and quality during the period of low flows.

- Ground water in the valley. There is no data available to indicate if there is ground water flow available on a year-round basis.

- Mine water. Substantial water flows were encountered during the underground exploration work in the Tom Mine. This water was thought to be of surface origin. Flows range up to 539 GPM. The water tended to have a low pH, ranging from 4.7 to 7.1. There is insufficient data available concerning mine water reliability of supply or its quality, to assume its usage directly for plant purposes.

Because water resource data is so limited at this time, the following assumptions and study bases have been used:

- There will be sufficient water flow at some point along the South Macmillan River year around to permit its use for plant make-up water without the need to have a long term storage impoundment. It has been assumed that this point is immediately downstream of the juncture of Sekie Creek No. 1. The make-up water requirement is to be kept to a minimum by maximizing the use of reclaim water.

  This assumption must be verified, preferably by a number of years of year-round stream monitoring in the immediate area. Observations should be made simultaneously of other potential sources, as backup in case the local source proves unreliable.

- Domestic water requirements will be obtained from the river water supply. The water will be filtered and chlorinated prior to distribution.

- o Mine water will not be used in the plant. It will be sent to the tailings disposal site.

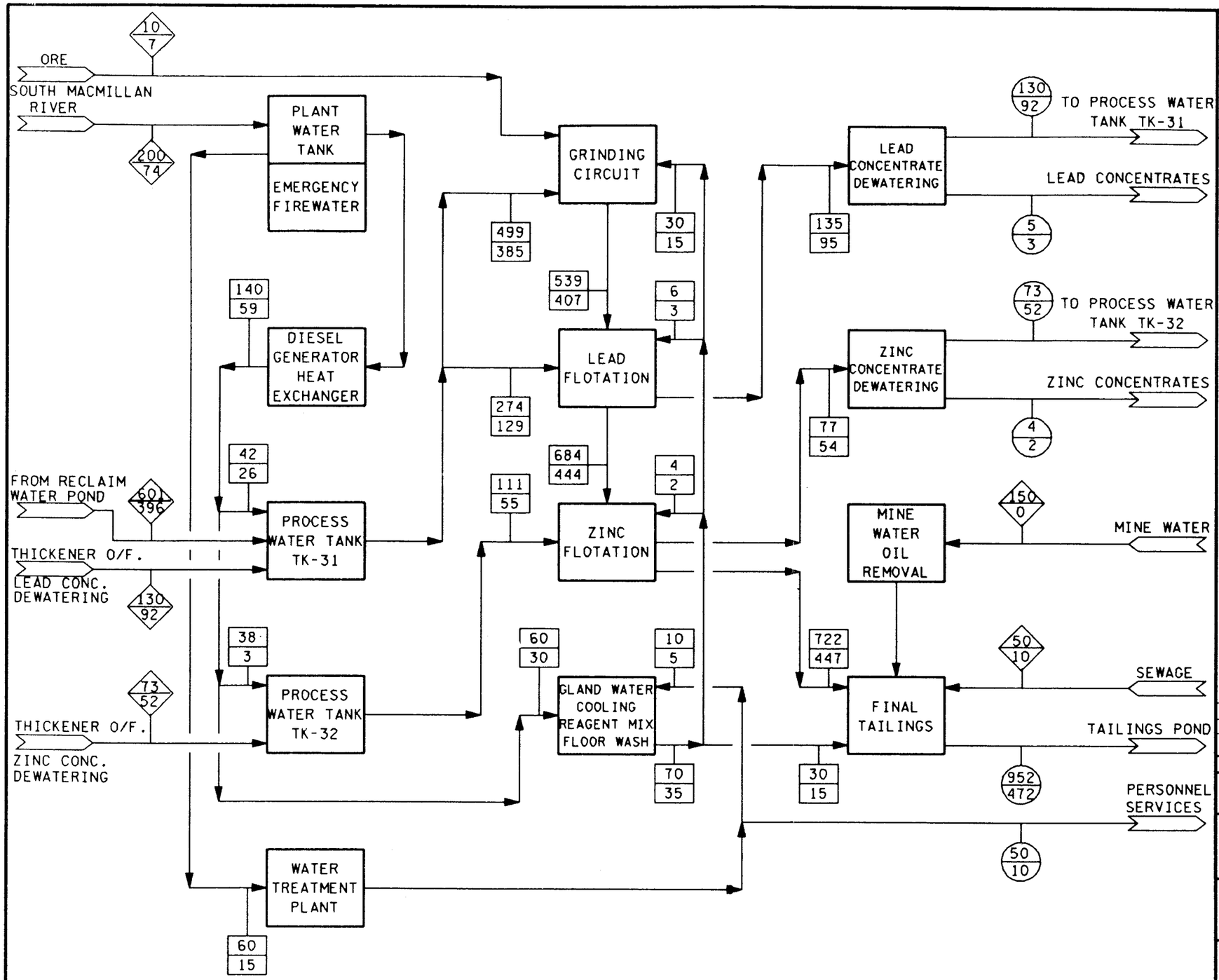
.2 Water Balance

The overall site solution and water balance block flow diagram Drawing M-200 shows major flow quantities, sources, and dispositions.

.3 Supply System

A water supply pond will be excavated adjacent to the river. It will be approximately 200 ft square by 20 ft deep in the central area, with natural banks, and the bottom slopes protected from erosion with coarse waste rock. It will be joined to the river by a short channel. This arrangement will minimize sediment transport into the pond. The 20 ft pond depth is intended to provide necessary protection against freezing during the winter.

An electrically heated pumphouse and two 400 USGPM vertical pumps set in a concrete well with an intake, are provided to meet the approximate 300 USGPM typical water demand. Water will be carried in a 6 inch diameter traced and insulated pipe, laid on a gravel berm beside the road, to the plant water tank located near the Tom mine portal. This tank, 1,000,000 U.S. gallon capacity, will serve as a reservoir for plant make-up and potable water supply, and for fire protection, the lower portion of the tank being dedicated to fire usage. The tank will be insulated, and provided with electric immersion heaters near the outlet connections.




LEGEND:

50/10 INPUT

MAX. STPH (TYPICAL) / NOM. STPH (TYPICAL) — 952/472 OUTPUT

722/447 TRANSFER (IN PLANT)

NOTES:

1. UNITS

   1.0 TON=240 US GALS.

   1.0 STPH=4.0 USGPM.

| NO. | DATE | REVISION | BY | CH'K | DESIGN SUPVR. | ENG'R | CHIEF ENG'R | CLIENT |
|---|---|---|---|---|---|---|---|---|
| 3 | 84/8/ | ISSUED FOR REPORT | FA | | | RR | | |

SCALE — DESIGNED R.RICHARDS DRAWN F.W.ANDERSON

BECHTEL CANADA ENGINEERS LIMITED
TORONTO, ONTARIO

HUDSON BAY MINING AND SMELTING CO.,LIMITED
AND
ABERFORD RESOURCES LTD.
CAPITAL COST STUDY TOM/JASON PROJECT

SOLUTION AND WATER BALANCE BLOCK FLOW DIAGRAM

| JOB No. | DRAWING No. | REV. |
|---|---|---|
| 16988 | 100-M-200 | A |

CANADA

QS2:[30,11]100M200.DGN

### .4 Distribution System

Make-up water will be gravity fed from the tank to the power plant where the required amount will be used to cool the diesel generators then fed as make-up, together with water flowing directly from the main tank, to the process water tanks or distributed throughout the concentrator and service facility for other uses.

A portion will be bled off for treatment, i.e. chlorination and filtering, prior to distribution for potable water uses throughout the concentrator and service facility, and to the accommodations facility. The sizing of this system is based on a usage of 50 USGPD per person. A 3 inch traced and insulated pipe is provided, laid on a gravel berm beside the road from the plant to the accommodations. See Section 3.11 for description of the water system at the accommodations facility.

## 3.9.2 ELECTRIC POWER GENERATION

### .1 Power Generation

There is no public or private utility presently generating electric power in the vicinity of Tom/Jason project, although there have been studies carried out to establish the potential for developing hydro-electric projects to extend the NCPC service area. One such site is located at Ross Canyon near the junction of the Ross and Pelly Rivers. In the absence of firm commitments for such a development, it has been assumed for this study that public power will

not be available for the project, and the project will have to generate its own requirements. Additionally, it was decided to base the study on use of diesel generator units, consistent with current practice at most remote sites.

Total connected load has been estimated to be approximately 19.5 MW (excluding installed standby equipment). Applying a demand factor of 0.85 and a coincidence factor of 0.80, normal operating load is estimated at 13.3 MW. To size the generator installation, a 15 percent factor has been added to take into consideration co-incidental motor starting loads, diversity loss, and load surges (e.g. accelerating load of Jason mine hoist). This results in a generation peak capacity requirement of 15.25 MW. Distribution of the loads is summarized in Table 3.9-1 (figures are rounded off).

LOAD DISTRIBUTION BY FACILITY

| | |
|---|---|
| Tom mine - operating phase | 2,800 |
| Jason mine - operating phase | 3,600 |
| Concentrator/Service facility | 10,300 |
| Yard | 200 |
| Heat tracing | 1,100 |
| Accommodation | 1,100 |
| Contingency, 2% | 400 |
| Total | 19,500 kW |

TABLE 3.9 - 1

Selection of the number and size of generators required to power the project has been based on considerations of:

- o Flexibility of the system to meet load variations and load growth.
- o Capital cost.
- o Operating reliability and cost, including fuel efficiency.

It is common for remote site installations to be served by X plus 2 units, where X equals the number of units required to meet normal peak operating loads, one additional unit is on standby in case of failure of an operating unit, and one additional unit is considered to be under major maintenace or rebuild, perhaps awaiting a major component which can only be shipped during a limited shipping "window". Because it is considered that Tom/Jason will be accessible year-round (except for short weather closures of the road) and therefore major components can be shipped in relatively quickly, only X plus 1 units are included for this study. Accordingly, a total of 5 units, each capable of generating approximately 3.8 MW have been provided. Space is available in the power plant for an additional unit, should future load development so require. It should be noted that the units selected are actually rated at 4.14 MW, but are downrated because of the elevation of the site.

An emergency diesel generator unit is located at the accommodation complex, to provide "life support" power in case of catastrophic failure of the central power plant, or failure of the distribution feeder to the complex.

## 3.9.3 ELECTRICAL SYSTEM

### .1 Power System

The power will be supplied by the diesel generator sets having a nominal output of 4.16 kV, 3 phase, 0.8 PF, 60 Hz. Each generator will be complete with static exciter, voltage regulator, relaying, metering, synchronizing, surge protection, annunciation systems and space heaters, resistance temperature detectors (RTDs) embedded in the stator winding, Class F insulation for the stator and rotor windings but limited to Class B temperature rise. The bearings will have RTDs for temperature detection.

### .2 Distribution and Utilization Voltages

Distribution of power will be generally by means of cable in tray within the plant area, by overhead pole line to remote facilities, and by interlocked armoured cable within the mine area. Control cables will be installed in a similar manner.

Distribution voltage will be 4.16 kV, 3 phase, 60 Hz resistance grounded, except for the overhead pole lines to the Jason Mine area, and the feeders in to the Tom underground substations, which will be at 13.8 kV.

Inplant system nominal voltages will be:

4.16 kV, 3 phase, 60 Hz, resistance grounded.
600 volt, 3 phase, 3 wire, solidly grounded.
600/347 volt, 3 phase, 4-wire, solidly grounded.
120/208 volt, 3 phase, 4-wire, solidly grounded.

Utilization will be:

4.16 kV, 3 phase, 60 Hz.
600 volt, 3 phase, 60 Hz.

Control voltage will be 120 volt, 1 phase, 60 Hz on 4.16 kV motor starters and 600 volt MCC's; 125 volt dc on the 4.16 kV switchgear and 48 volt dc annunciation systems.

Direct current at 125 V supplied by storage batteries and battery chargers will be used for closing and tripping the generator and distribution air circuit breakers located in the 5 kV class switchgear.

.3 Switchgear

The switchgear will be of the metal-clad, drawout air circuit breaker type with bus bar construction. Enclosures will be free-standing steel structures for indoor service.

The switchgear line up will contain the breakers associated with the diesel generators, feeders to the load centres and other loads, and tie breakers. A ring bus with intermediate tie breakers has been considered, to provide additional security against localised switchgear failures.

The feeder breakers will have instantaneous overcurrent, time overcurrent and ground fault detection which will trip the feeder breaker(s) to isolate the fault.

The 4.16 kV, 250 MVA air circuit breakers will be of the draw-out, stored energy, magnetic air break type, 3-pole, single throw, mechanically and electrically trip free, electrically operated with 125V dc close and trip mechanisms. The circuit breaker stored energy device will employ a dc motor-charged compression spring. Each breaker will have both "test" and "disconnected" drawout positions, in which it may be left with the door closed. Breakers will be provided with emergency manual trips, and a clear visual indication of their "open" or "closed" condition.

Surge protection will be provided on the main bus.

A set of three potential transformers 4200/120 volt will be connected to the 4.16 kV generator switchgear bus for relaying, metering and synchronization purposes.

Three sets of current transformers of suitable ratio will be installed in the switchgear for each generator for relaying, metering and synchronization purposes.

.4 Unit Substations

Unit substations will be used to transform the 4.16 kV distribution voltage to 600V power distribution purposes.

A manually, group-operated 4.16 kV, 600A indoor metal-clad fused loadbreak switch will be used ahead of the dry-type power transformers.

The unit substation main metering compartment will have the following:

Ammeter, demand type
Voltmeter
Selector switches
KWH meter
Ground fault detection equipment.

The unit substation branch feeder metering compartment will house the following:

Ammeters, demand
Ammeter selection switches
KWH meters.

.5 Motor Controls

Motor control starters will generally be grouped in motor control centre enclosures located in the electrical room. Short circuit and overload protection will be provided for each motor circuit.

Synchronous and squirrel cage induction (S.C.I.) motor starters for 4 kV motors will be 400 A, 50 MVA full voltage non-reversing type contactors with solid state motor protection relays, complete with current limiting fuses.

Starters for 575 V motors will be the combination fused-disconnect switch across-the-line type.

All control voltages will be 120 V obtained with individual control transformers in each starter.

.6 Motor Control Centres

All 575 V motors up to and including 200 hp will be fed from motor control centres, which utilize fused disconnect switches and magnetic contactors.

The motor control centres will be plug-in type.

.7 Motors

Motors less than 1/2 hp will be rated 115-volt, 60 Hz.

Motors 1/2 to 200 hp inclusive will be rated 575 V, 3-phase, 60 Hz.

Motors above 200 hp will be rated 4 kV, 3-phase, 60 Hz.

Motors will be suitable for across-the-line, full-voltage starting, continuous duty, and provided with Class F insulation but limited to Class B temperature rise at rated load.

All 4 kV S.C.I. motors will be housed in totally-enclosed fan cooled enclosure.

575 S.C.I. motors will be totally-enclosed fan cooled or totally enclosed non-ventilated enclosures.

Synchronous motors will be 0.8 power factor machines.

.8 Lighting

The average interior illumination level in the operating areas will be 30 foot candles. This may be

supplemented in certain areas to meet specific requirements. Lighting is provided for main yard areas and for main travel roads.

| Maintained Lighting Levels | Foot Candles |
|---|---|
| Operating Areas | 30 |
| Conveyors | 10 |
| Yard and Roadways | 1-2 |
| Shops | 50 |
| Offices | 80 - 100 |
| Control Rooms | 80 - 100 |

All industrial area lighting and yard area floodlighting will be controlled from centrally located lighting panelboards. Lighting in offices and control rooms will be controlled from wall switches.

Automatically actuated emergency lighting will be provided for minimum personnel safety requirements. Individual self-charging, 8 hour battery units will be used in areas where needed, such as control rooms, stairs and places where momentary loss of illumination may create a safety hazard.

.9 Welding and Power Outlets

Welding and power outlets will be installed at appropriate locations for supplying portable welders and similar loads.

Each outlet will service an area within 100 foot radius.

.10 Grounding System

For safety of personnel a grounding system consisting of soft drawn bare copper conductors will be provided for all electrical equipment. A ground mass network of bare stranded copper cable and ground rods will be set in the earth around each building. Major structural steel members of each building perimeter and all equipment such as generators, switchgears, unit substations, high and low voltage motor control centers, H.V. motors, panels, etc. will be connected to the ground network. All grounding systems will be inter-connected where feasible.

.11 Electrical and Control Room

The construction for the electrical rooms will be concrete floor slab and fire rated steel sandwich panel walls.

Electrical rooms will be ventilated and pressurized with filtered air.

Electrical rooms will be designed with mandoors and equipment doors sized to accommodate the largest equipment.

.12 Electrical Control Philosophy

Electrical control will be accomplished via a Programmable Controller (PC) in conjunction with a Distributed Digital Control (DDC) system.

The processors of the PC-DDC system will be located in the main control room, as well as the analog input/output (I/O) of the DDC. The discrete I/O's of the PC-DDC will be located in the electrical room. Data exchange between these devices in the control room and the electrical room will be performed by means of a data highway/data link.

Generally, process devices and some process related drives will be controlled by the PC-DDC system, with "local" and "remote" modes of control. A locally selectable "test" facility will be provided.

For other drives that will be controlled locally only, status information will be fed into the PC-DDC system on a selective basis.

All conveying systems will be protected by slip detection and permissively interlocked by means of zero speed switches. Conveyors will be equipped with manual reset pull-cord safety stop switches and side travel switches. All conveying systems are equipped with pre-startup audible warning devices.

### 3.9.4 HEATING AND VENTILATION

#### .1 Heating

Heating needs for the concentrator and for the service building will be met primarily through recovery of waste heat from the diesel generator operation. Engine exhaust gas hot water heaters and engine jacket water heat exchangers are provided to recover the waste heat, which will be distributed to heaters

located throughout the complex by an ethylene glycol circulating system. Two package oil-fired hot water heaters, 5 million BTU each, are provided to supplement the waste heat system in emergency and at times of low power load. For this study it has been assumed that these heaters will burn diesel fuel rather than provide for receipt and storage of a second fuel. A detailed cost/benefit analysis of these alternatives should be undertaken at the detail design stage.

Individual small "remote" buildings will be heated electrically.

.2 Ventilation

Ventilation air will be supplied by make-up air/heater units located throughout the plant.

The reagent mixing area is provided with two fume exhaust fans, one of which is dedicated to the enclosed sodium cyanide mixing room.

The concentrate storage domes are non-ventilated, to prevent dust from migrating to the environment. Mobile equipment operating in these buildings will have ventilated/filtered cabs for operator protection.

## 3.9.5 FIRE PROTECTION - PLANT COMPLEX

Fire protection for the plant comprises the following:

- Fire protection piping loop, standpipe and hose stations all to meet Underwriter's standards including: an 8" pipe header loop all around the

inside perimeter wall of the complex with 2" vertical standpipes to the upper levels of the plant; hose stations on all working levels; pumper hose connections at strategic locations on the outside perimeter wall. The loop is gravity fed from the dedicated 600,000 gallon lower portion of the 1,000,000 U.S. gallon water tank.

- o Sprinklers in the warehouse, office section, and selected shop areas.

- o Halon extinguishing system in the process control room, and a dry gas type automatic extinguishing system in the power plant (over the diesel generator engines).

- o A combination ladder/pumper fire truck stationed in the heated garage which is integral with the gatehouse and ambulance garage.

- o Electric booster pump and emergency diesel booster pump installed on the main loop.

- o Portable extinguishers.

- o A supervised central alarm system comprising pullboxes and coded horn.

### 3.9.6 WASTE DISPOSAL

#### .1 Sewage

Sanitary sewage from the personnel facilities in the concentrator and service building will be piped to a

collection tank, where it will receive primary treatment prior to being mixed with tailings in the tailings surge tank. Sewage treatment facilities have been sized on the basis of 50 USGPD per capita.

.2 Garbage

An oil-fired incinerator is provided for burning of all rubbish and garbage generated by the plant and by the accommodations complex, prior to burial. This unit will also serve the construction phase.

## 3.9.7 COMMUNICATIONS

1. Outside

The communications system from the site to outside will be a standard commercial telephone system, satellite based, supplied by NorthwesTel Inc., with equipment leased from them. Twelve channels comprising 10 voice and 2 data are considered appropriate. This will permit controlled long distance by employees, Telex and data transmission and TV.

.2 In-Plant

In-plant communications systems comprising strategically located telephones and loudspeakers are provided. These are tied into the central communications room in the plant office. Mobile equipment will be have radio sets for communication.

### 3.9.8 PLANT COMPRESSED AIR

Compressed air for service and maintenance usage in the concentrator is produced by two 300 CFM, 110 psig compressors, and distributed via piping loop to usage points.

An air dryer is provided to obtain instrumentation air from the service system.

Two service air compressors, rated at 500 CFM, 110 psig, are provided for the maintenance shops.

Separate compressors, three at 1010 CFM, are provided for the pressure filtering operation.

All compressor installations are provided with requisite cooling water supply, silencers, receivers, etc.

### 3.9.9 FUEL OIL

#### .1 Supply

It has been assumed that only one grade of fuel oil will be used at the plant, i.e. diesel fuel. It will be truck delivered and transferred to storage tanks. It will be used for power generation, supplementary plant heating, accommodations heating and to fuel some of the mobile equipment. It is acknowledged that some fuel supply cost savings may be possible by using diesel fuel for diesel engines and fuel oil for heating purposes. However, there would be high potential for error in transferring from delivery truck to storage tanks, with potential for fouling of

diesel engines. Thus this alternative has been left for future detailed evaluation.

.2 Storage

A fuel storage capacity equal to at least one month's consumption has been considered necessary, to allow for delivery interruptions, and provide for operational needs.

Average monthly diesel fuel consumption, for power generation only in high production years, has been estimated at 390,000 U.S. gallons (see Operating Costs, Section 4). Allowing for a 30 percent above average usage during peak winter conditions plus usage by mobile equipment, a storage capacity of 600,000 U.S. gallons has been provided in two 300,000 gallon main tanks. As noted in Section 3.11 an additional seven day capacity tank is provided at the accommodation complex.

## 3.9.10 FENCING

Security fencing is provided between the North Canol Road and the plant complex, with control gates at each point of entry. Short lengths of fence, with gates, are provided where other facility roads join the North Canol Road.

# 3.10 BUILDINGS

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- .2 Seismic
- .3 Structural

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3.10.7 MISCELLANEOUS BUILDINGS

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## 3.10 BUILDINGS

### 3.10.1 DESIGN CRITERIA

.1 Climatic: Extracted from National Building Code
Ref. Tungsten (Cantung)

Design Temperatures, 2 1/2% basis

| | |
|---|---|
| January | -49°C |
| July | 26°C dry bulb |
| | 16°C wet bulb |
| Precipitation, annual | 380 mm |
| 1 day rain | 51 mm |

(Note: Annual total of 508.5 mm has been recorded at the site.)

| | |
|---|---|
| Ground snow load | 3.0 kN/m$^2$ (62 psf) |

Wind, reference pressure

| | |
|---|---|
| 1 in 10 years | 0.29 kN/m$^2$ (6.1 psf) |
| 1 in 30 years | 0.39 kN/m$^2$ (8.1 psf) |

.2 Seismic: Zone 2

.3 Structural:

| | |
|---|---|
| Frames | Steel |
| Roofing & Siding | formed steel, prepainted |

| | | |
|---|---|---|
| Insulation | Roofs | R-30 |
| | Walls | R-20 |
| Floors | on grade | concrete slab |
| | elevated | open mesh steel grating, checkered plate, or elevated concrete on steel deck. |

3.10.2 GENERAL

The concentrator/service facility/power plant/office building has been designed as a single integrated complex to:

- o Minimize travel and handling for people and materials between activities.
- o Minimize extent and cost of common services.
- o Reduce amount of exterior walls and thus minimize heat losses.

The power plant has been located in line with the grinding bay of the concentrator, with a laydown area between them which also provides access to the high bay maintenance shops. Thus the 35 ton overhead travelling crane required for servicing the grinding mills will also be available for major maintenance of the generators. A set of crane doors has been provided which allow travel of the crane between the two areas when necessary, yet achieve effective closing off of the power plant from the other areas during normal operations.

The location of the complex has been so selected that structural and major equipment foundations are assumed to be on competent rock, and permafrost foundations avoided.

### 3.10.3 CONCENTRATOR

The concentrator (refer to Drawings M-113, 114, 115) is divided into three main bays: grinding, control, flotation and dewatering. As noted above the grinding bay is serviced by a 35 ton overhead crane. The ore bin and pebble bin are located in an annex to the grinding bay, with the floor level some 20 feet high than the grinding area floor to reduce excavation requirements.

A control bay, housing the electrical switchgear and central control room, as well as the compressor room, is located between the grinding and flotation bays. This location being central to the operations, facilitates operator travel and reduces electrical cable run lengths.

The flotation bay contains the lead and zinc flotation and pumping equipment as well as thickening and filtering in two separate parallel sections, each serviced by an overhead service crane. This bay also holds the reagent storage, mixing and distribution area. The floor areas are curbed to contain like spillages so they can be recovered and returned to their respective circuits.

The reagent storage and mixing area is located along the outside wall, with a truck door at one end for entry of bags, drums or containers which will be moved to the upper floor for storage, then fed into the mixing tanks in the lower floor enclosed room. The sodium cyanide mixing room is enclosed separately from the balance of the system.

The area beneath the thickeners is depressed to provide a space to dump and contain the thickener contents in case of operating upsets.

Floors are concrete, sloped where appropriate to facilitate washdown.

Elevated floors are established at levels to facilitate access to equipment and easy movement of personnel from one area to another. There are at least two stair sets from one main level to another. Generous open spaces or hatches are provided so that all major equipment on the lower floors can be serviced with the help of overhead cranes.

Doors or other openings facilitate interconnections between the service facility and the concentrator.

### 3.10.4 POWER PLANT AND SERVICE FACILITY

The service facility (refer to Drawing M-117) has been sized so that, together with the cold warehouse (but excluding the power plant area) a total of approximately 90,000 square feet of floor space will be available, allocated as shown on the drawing and listed in Table 3.10-1. The 90,000 square feet is consistent with space provided for similar facilities at other operating plants. No detail of subdivisions within the major areas is shown on the drawing; this is subject to the specific requirements of the operators, and would be defined during the design for construction phase. Costs for finishing and equipping these service areas have been included in the capital cost estimate based on experience with other projects. High and low bay shop areas are equipped with overhead travelling service cranes.

Service Facility - Space Allocation

| | |
|---|---|
| High Bay Shops and Laydown Area | 20,750 SF |
| Low Bay Shops | 10,500 SF |
| Offices for Shops | 7,500 SF |
| Warehouse - heated, including tool crib | 22,500 SF |
| Warehouse - cold | 5,000 SF |
| General Administration Offices, including operating and maintenance management, engineering, geology, communications, transportation, and analytical laboratory | 13,500 SF |
| Dry, washroom, lunchroom, lamp room, mine offices | 10,500 SF |

Table 3.10 -1

## 3.10.5 CONVEYOR GALLERIES

Conveyors, where they run above ground, are carried in enclosed galleries. These are of structural steel framing, clad with formed insulated steel siding and roofing, and are heated.

The conveyors carrying concentrate from the filters to the storage structures, are in double gallery as far as the head end of the zinc concentrate conveyor. The lead concentrate conveyor continues in a single width gallery.

### 3.10.6 CONCENTRATE STORAGE AND LOADOUT

The concentrate storage structures will be unheated dome type prefabricated structures of insulated plywood panel construction, and having a concrete floor and low concrete ring wall foundation. This type of structure is commonly used for storage of salt and sand by highways departments.

A floor hopper and concrete reclaim conveyor tunnel house the loadout belt feeders and conveyors. Steel framed sheds, clad with insulated steel siding and roofing and equipped with electrically operated doors at each end, are provided for protection of the truck loading operation. These are arranged for truck drive-through of each separately, to avoid spill contamination of one concentrate with the other. Platform type truck scales, to provide maximum accuracy of product weighing, are located in each building.

### 3.10.7 MISCELLANEOUS BUILDINGS

Miscellaneous other buildings for the Tom/Jason project are listed on Table 3.10-2. Buildings required for the construction phase only are not listed, unless specifically intended for later production phase use. Dimensions given for the smaller buildings are approximate, for study purposes. Where practical, pre-engineered or pre-fabricated structures will be used for the miscellaneous smaller buildings.

## MISCELLANEOUS BUILDINGS

| Building | Dimensions | Notes |
|---|---|---|
| Concentrator | See Drawing M-113 | |
| Service Facility | See Drawing M-117 | |
| Ore Storage Superstructure | See Drawing M-111 | |
| Cold Warehouse | 50' x 100' x 8' | From Construction |
| River Water Pumphouse | 15' x 15' x 12' | |
| Reclaim Water Pumphouse | 15' x 15' x 12' | |
| Tailings Thickener Pumphouse | 15' x 20' x 12' | |
| Reclaim Water Tank Enclosure | 20' x 25' x 16' | |
| Tailings Dump Valve Enclosure | 10' x 10' x 8' | |
| Fuel Oil Pumphouse | 15' x 15' x 12' | |
| Airstrip Terminal | 20' x 40' x 8' | Trailer Type |
| Concentrate Loadout Sheds | See Drawing M-116 | |
| Gatehouse/Firetruck/ Ambulance Garage | 50' x 50' x 12' | |
| Jason Hoist House | 130' x 40' x 12' | |
| Jason Repair Shed | 60' x 40' x 12' | |
| Explosive Storage | 18' x 12' x 7' | |
| Blasting Caps Storage | 16' x 8' x 7' | |

Table 3.10-2

# 3.11 ACCOMMODATIONS

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3.11.1 SCOPE

3.11.2 LOCATION AND ACCESS

3.11.3 SERVICES

3.11.4 DISCUSSION

3.11.5 COSTS

## 3.11 ACCOMMODATIONS

### 3.11.1 SCOPE

Accommodations facilities for the Tom/Jason project include the following:

Personnel living quarters
Kitchen/dining facilities
Food storage/freezer
Laundry
Infirmary
Commissary
Recreational facilities
Mechanical support facility
Accommodation administration

The complex is sized to serve all permanent project personnel including catering and camp administration. It is estimated that this population will total 450 persons. Approximately one third of this number will be off site at any given time, so sleeping accommodations have been provided for the full 450, but infrastructure provided for 300 people.

### 3.11.2 LOCATION AND ACCESS

The location selected for the accommodation complex, for this study, is across the South Macmillan River, to the north east of the plant. See Drawing C-1. This is a lightly wooded area with a southern exposure, which receives more sunlight than areas in closer proximity to the plant.

As such it is considered to be more attractive and to contribute positively to personnel satisfaction and lesser turnover. Earlier site investigation work carried out by Thompson Geotechnical Consultants indicated that ground conditions are suitable for such a development. However, this location is outside the existing Tom Jason property boundary.

Access to the area will be by a short private road leading in from the North Canol Road at a point approximately 2 km north east of the plant, just past the new highway bridge across the river.

It should be noted that an alternative location exists within the Tom property boundary, about 500 to 800 metres to the east of the plant complex, and on the same side of the Canol Road. The area is on a north-west facing slope, and would receive less sun exposure. However, it presents the potential for reduced capital and operating costs because of:

- Shorter power line, water line, access road.
- Elimination of need for accommodations water tank.
- Potential for use of waste heat from the power plant to provide at least part of the heating requirement.

### 3.11.3 SERVICES

Electric power will be supplied to the facility from the main generating plant by overhead pole line. A 750 kW, 600V emergency diesel generator will be located at the facility to provide "life support" power in case of power line failure or catastrophic failure of the main power plant.

Domestic water will be piped from the plant to a 130,000 gallon tank (120,000 gallons reserved for fire protection) located near the facilities. This tank will serve primarily as the fire protection reservoir for the complex, since it is located so far from the main fire water tank.

A package sewage treatment plant will be located adjacent to the complex, to handle sewage generated there. Treatment to produce environmentally acceptable liquid effluent and sludge suitable for subsequent landfill disposal will be provided.

Fire protection will be provided by an electric driven fire pump and back-up diesel pump, a sprinkler system, standpipes with hose cabinets, pumper connections, and hand extinguishers.

The accommodations complex, being remote from the plant, will be heated by a set of oil-fired package hot water heaters, located in the mechanical suport facility. A seven day capacity fuel oil storage tank is included.

It should be noted that the water tank, the sewage treatment plant and the fuel oil tank referred to above are included in the Yard Facilities portion of the cost estimate.

### 3.11.4 DISCUSSION

The scope of accommodation facilities listed above is common for remote site projects, i.e. those which have no developed towns nearby in which the personnel can live. However, the

quality and extent of the facilities provided at each site differs, being influenced by:

- the owner's corporate philosophy;
- regulatory requirements;
- project economics;
- economic conditions in the industry and the localities from which the labour force is drawn at the time the development takes place;
- project accessibility;
- project location general environment conditions (desireable living location?);
- personal preferences on the part of those involved in project implementation;
- provision (or not) for family accommodation;
- current (at the time of development) practice at other comparable projects.

Costs are influenced by:

- quality of construction materials and finishes;
- extent of utilization of prefabricated units versus custom built on site;
- extent of recreation facilities provided, e.g. satellite T.V., swimming pool, gymnasium, saunas, etc.
- policy re private versus shared rooms, private versus shared versus "public" washroom facilities;
- services and infrastructure requirements;
- ratio of personnel on-site at any given time to total number of personnel.

For this study, which is based on fly-in, fly-out of employees on a relatively frequent rotation basis, the following guidelines have been assumed:

- o No family accommodations will be provided.
- o A private bedroom will be provided for each employee, which will remain "his" and not used by anyone else, even though the employee may be off-site for vacation or other reasonably extended period. This has been found to be important in reducing employee turnover at one project.
- o Bedrooms will have private bathrooms, or the bathroom will be shared by the adjoining bedroom.
- o Bedrooms will be approximately 120 square feet in size, excluding bathroom.
- o Recreation facilities will not include swimming pool or gymnasium.

### 3.11.5 COSTS

Because of the wide range of costs which can be encountered and the subjective nature of many of the selections which impact the costs of accommodations facilities, it was agreed that only a reasonable cost allocation be made for these facilities which would be neither at the top nor the bottom of the range. This has been achieved by identifying costs for provision of comparable scope facilities at existing remote projects on an average all-in cost per-bed basis, as listed below. These costs have been adjusted to 1985 levels, and to remove extraordinary site specific influences.

| | |
|---|---|
| Greenex Lead Zinc Project, West Greenland | $20,000/bed |
| Polaris Lead Zinc Project, Little Cornwallis Island, NWT (custom built on site) | $65,300/bed |
| Lupin Gold Mine, Contwoyto Lake, NWT | $18,400/bed |

In addition the following current costs were obtained for the supply of "construction standard" camp, and for a range of modular relocatable style living accommodations for northern oilfields operating facilities:

| | |
|---|---|
| Construction Camp | $10,500/bed |
| Modular Housing | $10,000 to $35,000/bed |

Based on the above, $22,000 per bed (total $9,900,000) has been included in the cost estimates for the Tom/Jason project for the provision of a 450 bed accommodations facility, inclusive of infrastructure and reflecting the requirement to provide full facilities for only the 300 people on site at any given time.

## 3.12 TRANSPORTATION AND OFFSITE FACILITIES

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3.12.1 REVIEW

3.12.2 AIRSTRIP

3.12.3 NORTH CANOL ROAD
- .1 Current Condition
- .2 Planned Improvements

3.12.4 HAINES TERMINAL

## 3.12 TRANSPORTATION AND OFFSITE FACILITIES

### 3.12.1 REVIEW

The remote location of the Tom/Jason project, described in Section 1.13, imposes substantial problems of logistics and transportation for movement of personnel to and from the site, supplies to the site, and product from the site to market. For this study, the following base parameters were established:

- The project will be operated on a fly-in, fly-out basis. Personnel will be rotated to/from Whitehorse using charter or commercial air carriers, flying in to a private air strip to be constructed near the site. Refer to Section 3.12.2.

- Supplies, including diesel fuel for power generation, will be trucked to the site from the most appropriate source, via the Yukon highway system. Much of this traffic will be as back haul to the concentrate shipping. The last leg of the route will be the North Canol Road, which must be upgraded to meet the service requirements. The current condition of this road, and plans for upgrading are described in Section 3.12.3.

  The estimate of costs for this upgrading is currently being updated by the Department of Highways, Public Works Canada, and is expected to be available in mid 1985. As such, no other estimate has been prepared for this study. Whether or not a portion of these costs will have to be borne by the project, (and if

so, what portion?) will require negotiation with government authorities. The economic feasibility of the project, and its sensitivity to participation in the costs of upgrading the road, will have to be analysed at various levels of such participation.

- Concentrates, produced at the rate of 1150 to 1200 tpd, will be hauled by truck 635 miles to Haines, Alaska, for loading to ocean vessels for transport to buyers. Assuming a 40 ton payload, this traffic will comprise approximately 30 truckloads per day average. For this study, it has been assumed that the concentrate trucking will be handled by a contractor who will provide equipment and service facilities for his operation in his contract price. Therefore, no such facilities have been provided for at the site, at any intermediate points, or at the port, in the capital cost study.

  It is assumed that the trucking contractor will use containers, carried on a tractor/trailer/pup trailer arrangement, for concentrates an for backhaul of supplies.

### 3.12.2 AIRSTRIP

A 1500 ft. long gravel airstrip, suitable for landing light aircraft and Twin Otters, is currently in existence in the South Macmillan valley just across the North Canol Road from the proposed concentrator location. No lights or fuelling facilities are available.

It is considered that this strip will be inadequate to support the 5-7 days per week fly-in, fly-out program planned for the plant operations, largely because of the unpredictability of weather conditions. As a result, a new airstrip will be required. For this study, it is proposed to locate this new strip on a plains area approximately 50 km south of the present site. Another potential site which has been suggested is near Fuller Lake, approximately 7 km by road from the plant site. In any event, it has been assumed that a suitable, relatively level site can be located, and the land acquired for such a strip.

The runway will be 3500' x 100', gravel surfaced. Equipment will include runway lights, a non-directional radio beacon, and Hazaltine Instrumental Landing System. A heated waiting room, capable of accommodating approximately 20 people and having its own package diesel generator, washroom and potable water supply, will be provided in a 20' x 40' trailer type structure. No hangar or fuelling facilities are included.

This airstrip will be more than adequate for landing Twin Otters and able to receive other STOL type aircraft such as Dash-7 or Dash-8, should these be flown by the contracted aircraft operators. In addition, the runway length will accommodate the larger aircraft which will reduce costs for personnel rotation during the construction phase.

Employees will be shuttled to/from the airstrip by buses, based at the plant site. Communications between the plant site and the airstrip will be by radio.

Prior to proceeding with the project, the final location of a suitable airstrip must be determined. The potential for building and operating a strip jointly with other area metallurgical operations should be examined.

### 3.12.3 NORTH CANOL ROAD

The North Canol Road extends from Ross River (km 230) to the Yukon/NWT border (km 463), a distance of 233 km, passing the proposed plant at km 450.

#### .1 Current Condition

The North Canol is classified as a "summer only" recreational road used by hunters, fishermen, trappers, outriggers and campers. Some exploration is currently being carried out in the Macmillan Pass area, with nominal movement of drill equipment, fuel and supplies along the North Canol. Load limits as follows are dictated by the Pelly River ferry at the settlement of Ross River:

32,600 kg (72,000 lbs.)
18.3 metres long (60 feet)
3.6 metres wide (12 feet)

The North Canol from km 281 to km 463 is maintained by the Department of Highways with two graders, one loader and one dozer from a mid-point maintenance camp. The southern section from km 281 to km 230 is maintained by the highway crew responsible for the Robert Campbell highway.

In general, the North Canol is sufficient for what it is classified as: "summer only" recreational road. The average width is 4 to 5 metres. The thirty river and stream crossings are 3.6 metres wide, wood structures, except Macmillan No. 1 which is a Bailey-type structure (38,000 kg capacity above $-35^{o}C$ and 28,000 kg below $-35^{o}C$). The average safe driving speed is 40 km/hour. Visibility of on-coming vehicles is limited and dangerous because of frequent sharp turns, elevation adjustments, and re-vegetation along the right-of-way.

The ferry crossing over the Pelly River takes three to four minutes. The average traffic load is approximately twenty vehicles per day. The ferry crossing is in operation eight hours per day from about June 1 to October 15 depending on the ice break-up in spring and the freeze-up in fall of the Pelly River.

The continuous blading of the road by the maintenance crew has left the surface virtually pothole-free except for a 20 km stretch from km 281 to 261. This area has little surfacing material, resulting in an exposed boulder and rock road bed. Uneven, horizontal characteristics of the North Canol (basically follows the contour of the land, no built-up sections) results in drainage problems and minor flooding of sections.

## .2 Planned Improvements

It is understood that the government's current and long range program for the North Canol Road is in two phases.

The Phase I program has been planned in conjunction with Northern Affairs, Public Works Canada, and Amax Canada. It comprises:

- o Survey and design the full length from Yukon/Northwest Territories border (km 463) to Ross River (km 230).
- o Soils exploration program including right-of-way drill holes (every 100 metres) and borrow area location.
- o Upgrade and re-route 25 percent (57 km) of the North Canol worst areas.

When completed in 1987-88, the North Canol will be suitable for construction freight haulage to enable Amax to develop the MacTung project using normal transport payloads of 20,000 kg (44,000 lbs).

The government estimated expenditure for Phase I is $24 million (1983 dollars), of which approximately $4 million is committed, with $6 million planned but not approved for 1985.

A summary of government Phase I program by area is as follows:

| Chainage (km) | Reason for Upgrading |
|---|---|
| 240-244.2 | Steep grade (1985 program) |
| 255.8-262.6 | Steep grade (in progress) |
| 268.8-281.1 | Steep grade (1985 program) |
| 287-288 | Replace structure |
| 315-323.5 | Steep grade, replace structure |
| 333-334 | Horizontal and vertical alignment |
| 348.5-354.5 | Horizontal alignment, replace structure |
| 408-414 | Re-route South Macmillan No. 1 crossing |
| 451.5-463(1) | Macmillan Pass icing, snow drift, three structures to replace |
| Pelly River 230(2) | Replace ferry with two-lane bridge |

(1) Beyond Tom/Jason property, serves Amax property. $1.9 of $11.9 million cost for roads and structures.

(2) The government is upgrading the ferry capacity in 1985 to 38,200 kg (84,000 lbs.) and 21.3 metres (70 ft.) length.

A summary of government budgetary costs in 1983 dollars:

| | |
|---|---|
| Pelly River bridge | $ 5.9 million |
| 57 km of road and structures | 11.9 million |
| Contingency 20 percent | 3.5 million |
| Design 15 percent | 2.7 million |
| | $24.0 million |

All structures in Phase I will be built to the width required for the ultimate 12.5 metre subgrade width.

All road alignment and upgrading will have a 8.5 metre subgrade width.

Phase II, the long range plan, is to re-construct the remaining 75 percent of North Canol to 8.5 metre subgrade width with 10 centimetres of gravel surface, 80 km/hour highway, maximum grade 8 percent. This quality of road, equivalent to the Robert Campbell Highway, is geared towards serving large scale lead-zinc concentrate haulage from the Macmillan Pass region.

The estimated cost for Phase II is $58 million in 1983 dollars. To construct North Canol to 12.5 metre subgrade with 0.5 metre surface material would cost an additional $30 million (Alaska Highway quality).

The government prefers construction to be performed by native and northern contractors. Work would progress at approximately 20 km per season, allowing eight or

nine years to complete Phase II. This time frame is strictly based on the preferred contractors' capabilities. Without definitive commitments from the mining industry, it has been suggested that none of Phase II would likely proceed and Phase I may stop after 1985.

All surface structures will be replaced in the Phase I/PhaseII program. Except for the Pelly River bridge and Macmillan No. 1 bridge, all structures will be multiplate highway culverts of various sizes.

The government completed a three-year survey program in 1984. Drawings and estimates of the costs of the upgrading program will be updated during the 1984-85 winter period and available by June 1985.

### 3.12.4 HAINES TERMINAL

A concentrates handling, storage and shipping terminal at Haines, Alaska will include the following:

- Concentrates storage building - 150 ft x 360 ft.
- Office, laboratory and electrical building.
- Quadrant type ship loader.
- Truck unloader.
- Vibrating feeders, belt conveyors and sampling system.

- Shiploading belt scale.

- Ship fender extension.

Concentrates will be removed from the trailers by gantry unloaders, which will transport the containers to the appropriate storage section of the divided storage building, to be dumped and the concentrates piled by bulldozer. Reclaim will be by the bulldozer pushing the concentrates to reclaim hoppers, thence onto belt conveyors leading to the shiploader. Belt scales and a sampler are provided on the conveying system. The ship fender extension would probably be done by the City of Haines, although the costs are included in this estimate.

## 3.13 FURTHER WORK

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3.13.1 INTRODUCTION

3.13.2 BASIC DATA DEVELOPMENT

.1 Water Supply
.2 Geotechnical
.3 Survey and Mapping
.4 Metallurgical
.5 Environmental
.6 Airstrip
.7 Property Acquisition

3.13.3 OPTIMIZATION STUDIES

## 3.13 FURTHER WORK

### 3.13.1 INTRODUCTION

The project facilities described in this report, and to which the capital cost estimate applies, have been developed based on available technical information about the mineral deposits and the site. Best judgements have been applied to the information, where appropriate. Where information was not available, assumptions have been made. These judgements and assumptions are noted in a number of instances through the text of the report. The further work necessary to verify these assumptions and to provide data for detail design engineering, or to obtain test material to be given to equipment vendors in support of equipment warranty requirements, is summarized in this section. Minor optimization studies to size and select equipment are not listed, as they would comprise a part of the detail design phase.

None of these items is considered crucial to the technical viability of the project, although some could impact costs to the point of jeopardizing the financial viability.

### 3.13.2 BASIC DATA DEVELOPMENT

#### .1 Water Supply

An assured water supply year-round is essential to the plant operation. It has been assumed that this is available at the juncture of Sekie Creek No. 1 and the South Macmillan River. However there is virtually no

data on which to base this assumption. Should there be insufficient water at this point during the low flow season of late winter, it will be necessary to either impound sufficient water to carry over this period, or extend the supply line to a location where flows are adequate. Either course of action can be expected to involve higher costs.

A stream monitoring program should be established to verify the above assumption, or to find an alternative source. This program should be directed particularly to the low flow season, and should extend over several seasons.

.2 Geotechnical

The geotechnical data upon which this report was based was limited in terms of the area covered and must be considered preliminary, though adequate for this type of report for the areas covered.

No data exists for the proposed or alternative tailings storage areas. In addition, no data exists for alternative process plant locations on the Jason property which may offer cost advantages. (For a review of previous geotechnical work and draft recommendations for additional work, refer to Thompson Geotechnical Consultants letter and report to Bechtel Canada Ltd., January 28, 1985).

Further preliminary geotechnical work should be undertaken as follows:

- It has been assumed that the Rat Lake area will be geotechnically suitable for construction of the tailings storage facility. To verify this assumption, a program should be defined and work undertaken to examine foundations conditions for the dams even though the dams required for the thickened tailings system are relatively minor, determine the availability of dam construction materials, assess seepage and ground water conditions, and obtain all necessary data for permitting. Should the Rat Lake site be determined totally unsuitable, a new site must be selected and the cost impact determined.

- Alternative sites for the production facilities should be identified which offer reduced capital and/or operating costs using the various concepts contained in this report as bases. This analysis would also provide the scope for preliminary geotechnical investigations which should be conducted in these areas to confirm their potential, determine excavation and foundations conditions and ensure that satisfactory foundation conditions exist.

  Additional data should also be obtained for the site selected for this report. The most cost effective location may then be selected and the capital cost estimate modified accordingly.

- A geotechnical investigation should be carried out in the area of the proposed Jason shaft and ventilation raise, to develop data to assess shaft and raise collaring and hoist foundation conditions.

Detailed geotechnical investigations must be performed prior to commencement of detail design at the selected facility locations to develop accurate soil and foundation conditions and design criteria.

In the conduct of the investigations referred to above, extra caution should be exercised to identify if permafrost and ice lenses are present, and if so, their extent.

.3 Survey and Mapping

There are survey and mapping discrepancies in the available data for the Macmillan Pass area. This is described in Thompson Geotechnical Consultants' report "Investigation of Survey and Mapping Discrepancies on the Tom Project", March 1983. These discrepancies must be corrected and data adjusted, to ensure that an accurate survey grid and accurate elevations for the areas of the property to be developed are available prior to commencement of design work.

Accurate contours, generally to 5 metre intervals (to 2 metre intervals in the immediate vicinity of construction areas), will be required throughout the development area.

.4 Metallurgical

Prior to detailed engineering, a number of metallurgical investigations are required to optimize the process flow sheet and to finalize equipment sizing and selection.

Recommended activities related to the process flow sheet include:

- Conduct bench flotation tests using sample composites which are generally typical of the predicted co-mingled Tom and Jason mill feeds.

- Examine the use of alternative reagent schedules which may provide practical benefits of lesser cost and complexity, and be more environmentally acceptable. For instance, a high lime-low cyanide route may offer certain advantages over the system selected for the study which does not utilize lime for pH control.

- Examine on bench scale the degree (quantity, grade) to which coarse lead can be recovered from the primary ground feed.

- Carry out mineralogical examinations on polished sections of selected products from the bench-scale flotation tests as a guide to optimizing metallurgical performance.

- Test, on pilot plant scale, the flow sheet developed from bench-scale work to determine the influence of circulating plant streams on the process metallurgy and to finalize the process criteria.

Investigations regarding equipment selections include:

- o Conduct further tests in the Aerofall 18 inch diameter mill on fresh samples of Tom, Jason and mixed ores.

- o Run pilot-scale grinding tests on bulk samples of typical feed to establish the optimum grinding circuit configuration and establish more fully the operating parameters of power, loadings, classification, etc.

- o Undertake laboratory tests on products from the test work noted above to establish the area requirements for the lead and zinc concentrate thickeners, and the final tailings thickener. The merits of using flocculants would be examined at the same time.

- o Conduct laboratory tests to establish the area requirements for pressure filtration of the flotation concentrates.

Refer to Section 2 for other discussions re further metallurgical work.

.5 Environmental

- o Climatic data should be accumulated for the immediate area, with particular reference to snowfall (quantity, pockets or areas of high accumulation) and wind (velocity, prevailing directions). Furthermore, areas of potential

construction activity should be closely observed for avalanche activity, so that areas exposed to this hazard may be avoided. These observations should be extended over several seasons if possible.

- o Perform requisite environmental studies to confirm the environmental acceptability of the selected tailings disposal site, and define any environmental protective measures to be built into the design.

- o Perform environmental background surveys, including ground water flows and analyses.

.6 Airstrip

A location for the operating plant airstrip must be determined, and survey and geotechnical data obtained as required for construction. The alternative of sharing or development of an airstrip jointly with other minerals plants in the area may be explored.

.7 Property Acquisition

Any property required for the project development and not currently under the control of HBM & S or Aberford should be acquired.

### 3.13.3 OPTIMIZATION STUDIES

To enhance the accuracy of the cost estimates for the Tom/Jason project and arrive at an optimized project definition prior to establishing an overall appropriation budget for project development, optimization studies should be carried out including:

- The rates of extraction from the two mines may be evaluated with the objective of eliminating duplication of facilities or oversizing facilities, primarily ore crushing and haulage systems.

- The location of production facilities should be analysed, considering costs for ore haulage, tailings handling, and water supply lines (make-up and reclaim).

- The location of accomodations complex relative to the other plant facilities should be reviewed, with objective of reducing costs of providing services to the complex.

- The terminal facilities at Haines, Alaska may be optimized in terms of the tonnages of concentrates to be stored, and the type of shiploader to be used. Given firm definition of the sizes and types of ships which are expected to be loaded, and frequency of arrival, significant cost reductions may be obtainable.

## 3.14 MECHANICAL EQUIPMENT LIST

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3.14.1 INTRODUCTION

EQUIPMENT LISTS

Area 100 - Tom Mine - Production Phase
Area 200 - Jason Mine - Production Phase
Area 200 - Jason Mine - Conveyor Option
Area 300 - Coarse Ore Storage
Area 300 - Concentrator - Grinding
Area 300 - Concentrator - Pb Flotation
Area 300 - Concentrator - Zn Flotation
Area 300 - Concentrator - Pb Dewatering
Area 300 - Concentrator - Zn Dewatering
Area 300 - Concentrator - Reagent Feed
Area 300 - Concentrator - Miscellaneous
Area 500 - Service Facility
Area 600 - Accommodations
Area 700 - Yard
Area 700 - Mobile Equipment

## 3.14 MECHANICAL EQUIPMENT LIST

### 3.14.1 INTRODUCTION

The major mechanical equipment required for the Tom/Jason project is listed on the following pages. The lists, which are arranged by facility or area, identify the specific equipment covered by the capital cost estimate prepared by Bechtel and presented in Section 3.2. Where equipment items have not been identified specifically for costing purposes, they are grouped in "lots".

Mine development and production equipment is covered in HBM&S Mining Department's costs and is not included in these lists. Construction equipment is listed only if purchased as permanent plant equipment and used for construction.

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 100 - TOM MINE - PRODUCTION PHASE

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 100-CN-01/03 | Crushing Area Service Crane | 3 | 28' span | 15 ton | 20 | |
| 100-CP-01,02 | Mine Air Compressor | 2 | | 3500 CFM | 800 | One Standby |
| 100-CR-01/03 | Jaw Crusher | 3 | 42" x 48" | | 150 | |
| 100-CV-01/03 | Feeder Belt Conveyor | 3 | 42" x 50' | 400 STPH | 10 | |
| 100-CV-04 | Tom East Belt Conveyor "C" | 1 | 42" x 1230' | 400 STPH | 30 | |
| 100-CV-05 | Tom West Belt Conveyor "B" | 1 | 42" x 1754' | 400 STPH | 250 | |
| 100-CV-06 | Main Belt Conveyor "A" | 1 | 42" x 8918' | 400 STPH | 150 | |
| 100-DC-01/03 | Dust Collector, Cyclone Type | 3 | | | | |
| 100-FA-01/03 | Dust Collector Fan | 3 | | 5000 CFM | 15 | |
| 100-FA-04,05 | Mine Air Heater Fan | 2 | | | 15 | |
| 100-FE-01/07 | Vibrating Feeder | 7 | 42" x 8' | 400 STPH | 15 | |
| 100-HE-01,02 | Mine Air Heater | 2 | | 20 x $10^6$ BTUH | | One from development phase |
| 100-MA-01/03 | Tramp Iron Magnet | 3 | | 5 kW | 7 | |
| | Propane Storage Tanks | 2 | | | | By Vendor |

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 200 - JASON MINE - PRODUCTION PHASE

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 200-BN-01, 02 | Ore Bin | 2 | | 750 Ton | | |
| *200-CN-01 | Crushing Area Service Crane (U/G) | 1 | 28' span | 15 Ton | 20 | |
| 200-CP-01,02 | Mine Air Compressor | 2 | | 3500 CFM | 700 | One standby |
| *200-CR-01 | Jaw Crusher (U/G) | 1 | 42 x 48 | | 150 | |
| *200-CV-25 | Feeder Belt Conveyor (U/G) | 1 | 42" x 50' | 400 STPH | 10 | |
| *200-CV-26 | Belt Conveyor (U/G) | 1 | 42" x 540' | | 25 | |
| *200-DC-01 | Dust Collector, Cyclone Type (U/G) | 1 | | | | |
| 200-FA-01 | Dust Collector, Fan (U/G) | 1 | | 5000 CFM | 15 | |
| 200-FA-02 | Mine Ventilation Fan | 1 | | | 450 | |
| 200-FE-15/17 | Vibrating Feeder (1 U/G)* | 3 | 42" x 8 | 400 STPH | 15 | |
| 200-H -01 | Mine Hoist | 1 | | | 1800 | DC |
| 200-HE-01 | Heater, Mine Air | 1 | | 20 x $10^6$BTUH | | |
| *200-MA-01 | Tramp Iron Magnet (U/G) | 1 | | | 7 | |
| 200-TE-01 | Mine Water Oil Skimmer | 1 Lot | | | 3 | |
| | Propane Storage Tanks | 2 | | | | By Vendor |

*Crushing Station Equipment included with HBMS mining costs

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 200 - JASON MINE - CONVEYOR OPTION

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 200-CV-11 | Feeder Belt Conveyor | 1 | 42" x 65' | 400 STPH | 10 | Future option |
| 200-CV-12 | Belt Conveyor | 1 | 42" x 5902' | 400 STPH | 100 | Future option |
| 200-CV-13 | Belt Conveyor | 1 | 42" x 6295' | 400 STPH | 150 | Future option |
| 200-CV-14 | Belt Conveyor | 1 | 42" x 3279' | 400 STPH | 125 | Future option |

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 300 - COARSE ORE STORAGE

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 300-CV-07 | Shuttle Belt Conveyor | 1 | 42" x 50' | 400 STPH | 10 + 5 | |
| 300-CV-08 | Reclaim Belt Conveyor | 1 | 42" x 451' | 275 STPH | 50 | |
| 300-FE-08/10 | Vibrating Feeder | 3 | 36" x 8' | 275 STPH | 10 | |
| 300-HE-01 | Heater, Oil-Fired c/w fan | 1 | | 700 x $10^3$BTUH | 5 | |

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 300 - CONCENTRATOR - GRINDING

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 300-BN-01 | Ore Bin | 1 | 20'Ø x 20' | 200 Tons | | |
| 300-BN-02 | Pebble Bin | 1 | 12'Ø x 20' | 100 Tons | | |
| 300-CS-01 | Primary Cyclone | 1 Set | 2 @ 30" | | | One standby |
| 300-CS-02 | Secondary Cyclone | 1 Set | 12 @ 10" | | | Two clusters |
| 300-CV-09 | Pebble Belt Conveyor | 1 | 24" x 35' | 30 STPH | 2 | |
| 300-CV-10 | Primary Mill Belt Conveyor | 1 | 36" x 35' | 250 STPH | 5 | |
| 300-CV-11A | Primary Mill Belt Scale | 1 | 36" | 250 STPH | | |
| 300-CV-15 | Pebble Mill Belt Conveyor | 1 | 24" x 32' | 20 STPH | 2 | |
| 300-CV-15A | Pebble Mill Belt Scale | 1 | 24" | 20 STPH | | |
| 300-CV-16 | Pebble Mill Feed Belt Conveyor | 1 | 24" x 28' | 20 STPH | 2 | Reversible |
| 300-FE-11 | Primary Mill Belt Feeder, w/Platework | 1 | 48" x 23' | 250 STPH | 5 | |
| 300-FE-12 | Pebble Mill Belt Feeder, w/Platework | 1 | 36" x 12' | 20 STPH | 2 | |
| 300-FT-01 | Coarse Pb Rougher Flotation Machine | 2 Cells | 300 CF/Cell | | 2 @ 25 | 900 RPM |
| 300-FT-02 | Coarse Pb Cleaner Flot. Machine | 1 Cell | 300 CF | | 25 | 900 RPM |
| 300-ML-01 | Primary Mill, Autogenous, with Drive & Ancillaries | 1 | 24'Ø x 11' | | 2400 | 240 RPM |
| 300-ML-02,03 | Pebble Mill, with Drive & Ancillaries | 2 | 14'Ø x 22' | | 1500 | 240 RPM |
| 300-PP-01,02 | Primary Cyclone Feed Pump | 2 | 10 x 8 Metal | 1400 USGPM | 100 | One standby |
| 300-PP-03,04 | Coarse Pb Rougher Feed Pump | 2 | 12 x 10 Metal | 3000 USGPM | 125 | One standby |
| 300-PP-05 | Coarse Pb Rougher Froth Pump | 1 | 4" | 150 USGPM | 5 | |

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 300 - CONCENTRATOR - GRINDING

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 300-PP-06,07 | Secondary Cyclone Feed Pump | 2 | 12 x 10 Metal | 3900 USGPM | 200 | One standby |
| 300-PP-08 | Coarse Lead Cleaner Froth Pump | 1 | 3" R.L. | 50 USGPM | 5 | |
| 300-SC-01 | Pebble Screen, Double Deck | 1 | 5' x 12' | 275 STPH | 5 | |

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 300 - CONCENTRATOR - Pb FLOTATION

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 300-CS-03 | Pb Regrind Cyclone | 1 Set | 4 @ 15" | | | |
| 300-FT-03 | Pb Rougher Flotation Machine | 3 Cells | 1350CF/Cell | | 3 @ 75 | 900 RPM |
| 300-FT-05 | Pb Scavenger Flotation Machine | 2 Cells | 1350CF/Cell | | 2 @ 75 | 900 RPM |
| 300-FT-07 | Pb 1st Cleaner Flotation Machine | 4 Cells | 600 CF/Cell | | 4 @ 40 | 900 RPM |
| 300-FT-09 | Pb 3rd Cleaner Flotation Machine | 4 Cells | 600 CF/Cell | | 4@ 40 | 900 RPM |
| 300-FT-11 | Pb 2nd Cleaner Flotation Machine | 4 Cells | 600 CF/Cell | | 4 @ 40 | 900 RPM |
| 300-FT-13 | Pb Regrind Rougher Flotation Machine | 2 Cells | 300 CF/Cell | | 2 @ 25 | 900 RPM |
| 300-FT-14 | Pb Regrind Cleaner Flotation Machine | 1 Cell | 300 CF | | 25 | 900 RPM |
| 300-ML-04 | Pb Regrind Ball Mill, c/w Drive & Ancillaries | 1 | 9'Ø x 12' | 500/240 | | |
| 300-PP-09 | Pb Scavenger Froth Pump | 1 | 6" R.L. | 260 USGPM | 10 | |
| 300-PP-10 | Pb Scavenger Tails Pump | 1 | 12" x 10" R.L. | 2100 USGPM | 75 | |
| 300-PP-11 | Pb Rougher Froth Pump | 1 | 8" R.L. | 550 USGPM | 20 | |
| 300-PP-12 | Pb 1st Cleaner Froth Pump | 1 | 8" R.L. | 500 USGPM | 25 | |
| 300-PP-13 | Pb 3rd Cleaner Froth Pump | 1 | 8" R.L. | 450 USGPM | 20 | |
| 300-PP-14 | Pb 2nd Cleaner Froth Pump | 1 | 8" R.L. | 500 USGPM | 25 | |
| 300-PP-15,16 | Pb Regrind Feed Pump | 2 | 10" x 8" R.L. | 1150 USGPM | 50 | One standby |
| 300-PP-17 | Pb Regrind Rougher Froth Pump | 1 | 4" R.L. | 140 USGPM | 5 | |
| 300-PP-18 | Pb Regrind Tails Pump | 1 | 8" x 6" R.L. | 440 USGPM | 20 | |
| 300-PP-19 | Pb Regrind Cleaner Froth Pump | 1 | 3" R.L. | 60 USGPM | 5 | |
| 300-TK-01,02 | Pb Conditioner Tank, w/Agitator | 2 | 12'Ø x 14' H | 12000 USG | 25 | |

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 300 - CONCENTRATOR - Zn FLOTATION

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 300-FT-15 | Zn Rougher Flotation Machine | 3 Cells | 1350 CF/Cell | | 3 @ 75 | 900 RPM |
| 300-FT-17 | Zn Scavenger Flotation Machine | 2 Cells | 1350 CF/Cell | | 2 @ 75 | 900 RPM |
| 300-FT-19 | Zn 1st Cleaner Flotation Machine | 4 Cells | 300 CF/Cell | | 4 @ 25 | 900 RPM |
| 300-FT-21 | Zn 2nd Cleaner Flotation Machine | 4 Cells | 300 CF/Cell | | 4 @ 25 | 900 RPM |
| 300-FT-23 | Zn 3rd Cleaner Flotation Machine | 3 Cells | 300 CF/Cell | | 3 @ 25 | 900 RPM |
| 300-PP-20 | Zn Rougher Froth Pump | 1 | 6" R.L. | 350 USGPM | 15 | |
| 300-PP-21 | Zn Scavenger Froth Pump | 1 | 6" R.L. | 200 USGPM | 15 | |
| | Zn 1st Cleaner Tails Sump | | | | | |
| 300-PP-22 | Zn 1st Cleaner Tails Pump | 1 | 5" x 4" R.L. | 240 USGPM | 10 | |
| 300-PP-23 | Zn 1st Cleaner Froth Pump | 1 | 6" R.L. | 500 USGPM | 20 | |
| | Zn 2nd Cleaner Tails Sump | 1 | | | | |
| 300-PP-24 | Zn 2nd Cleaner Tails Pump | 1 | 5" x 4" R.L. | 230 USGPM | 10 | |
| 300-PP-25 | Zn 2nd Cleaner Froth Pump | 1 | 6" R.L. | 350 USGPM | 20 | |
| 300-PP-26 | Zn 3rd Cleaner Froth Pump | 1 | 6" R.L. | 250 USGPM | 20 | |
| 300-PP-75,76 | Process Water Pump, (Zinc Flotation) | 2 | | 250 USGPM | 15 | One standby |
| 300-TK-03,04 | Zn Conditioner Tank, w/Agitator | 2 | 12'Ø x 14'H | 12000 USG | 25 | |
| 300-TK-32 | Process Water Tank, (Zinc Flotation) | 1 | 6'Ø x 8' | 2000 USG | | |

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 300 - CONCENTRATOR - Pb DEWATERING

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 300-CV-17,18 | Pb Collector Conveyor | 2 | 48" x 20' | 20 STPH | 3 | |
| 300-CV-19 | Pb Concentrate Conveyor | 1 | 24" x 350' | 40 STPH | 7.5 | |
| 300-CV-23 | Pb Concentrate Loadout Conveyor | 1 | 24" x 170' | 150 STPH | 25 | |
| 300-FE-14 | Pb Concentrate Belt Feeder | 1 | 36" x 15' | 150 STPH | 15 | |
| 300-FL-01,02 | Pb Pressure Filter, (Larox PF28) | 2 | | $28m^2$ | 40 | |
| 300-PP-27 | Pb Thickener U/F Pump | 1 | | 150 USGPM | 3 | |
| 300-PP-28 | Pb Thickener O/F Pump | 1 | | 260 USGPM | 5 | |
| 300-PP-29,30 | Pb Filter Feed Pump | 2 | 5 x 4 R.L. | 1200 USGPM | 25 | One standby |
| 300-TK-05 | Pb Thickener, c/w Mechanism | 1 | 70'Ø | | 5 | |
| 300-TK-06 | Pb Surge Tank, (Filter Feed) w/Agitator | 1 | 14'Ø x 16'H | 18000 USG | 5 | |

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 300 - CONCENTRATOR - Zn DEWATERING

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 300-CV-20,21 | Zn Feeder Conveyor | 2 | 48" x 20' | 15 STPH | 3 | |
| 300-CV-22 | Zn Concentrate Conveyor | 1 | 24" x 300' | 30 STPH | 7.5 | |
| 300-CV-24 | Zn Concentrate Loadout Conveyor | 1 | 24" x 170' | 150 STPH | 25 | |
| 300-FE-13 | Zn Concentrate Belt Feeder | 1 | 36" x 15' | 150 STPH | 15 | |
| 300-FL-03,04 | Zn Pressure Filter, (Larox PF28) | 2 | | $28m^2$ | 40 | |
| 300-PP-31 | Zn Thickener U/F Pump | 1 | | 120 USGPM | 3 | |
| 300-PP-33,34 | Zn Filter Feed Pump | 2 | 5 x 4 R.L. | 1000 USG | 20 | One standby |
| 300-TK-07 | Zn Thickener, c/w Mechanism | 1 | 60'Ø | | 5 | |
| 300-TK-08 | Zn Filter Feed Surge Tank, w/Agitator | 1 | 14'Ø x 16'H | 18000 USG | 5 | |

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 300 - CONCENTRATOR - REAGENT FEED

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 300-FA-05 | Reagent Fume Exhaust Fan, NaCN | 1 | 1500 CFM | | 2 | |
| 300-FA-06 | Reagent Fume Exhaust Fan, General | 1 | 750 CFM | | 1 | |
| 300-PP-35 | Sodium Silicate System | 1 Lot | | | | |
| 300-PP-37 | Copper Sulphate System | 1 Lot | | | | |
| 300-PP-38 | Zinc Sulphate System | 1 Lot | | | | |
| 300-PP-40 | Sodium Cyanide System | 1 Lot | | | | |
| 300-PP-42 | Sodium Sulphite System | 1 Lot | | | | |
| 300-PP-44 | Xanthate System | 1 Lot | | | | |
| 300-PP-45,47 | Frother System | 3 Lots | | | | |
| 300-PP-48,49 | Promoter System | 2 Lots | | | | |

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 300 - CONCENTRATOR - MISCELLANEOUS

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 300-CN-01,02 | Service Crane, Flotation Area | 2 | 68' span | 10 ton | 20 | |
| 300-CP-01,02 | Plant Air Compressor & Accessories | 2 | | 300 CFM 110 PSIG | 75 | One standby |
| 300-CP-03/05 | Filter Air Compressor, c/w Receivers (2 @ 1500 CF) | 3 | | 1010 CFM @ 100 psig | 250 | One standby |
| 300-CX-01 | Chlorination System, (Sewage) | 1 | | | | |
| 300-DR-01 | Instrument Air Dryer & Accessories | 1 | | 200 CFM | | |
| 300-FA-01 | Flotation Air Blower | 1 | | 6000 CFM @ 2.5 psi | 100 | |
| 300-FA-02 | Flotation Air Blower | 1 | | 6400 CFM @ 3.0 psi | 150 | |
| 300-FA-03,04 | Flotation Air Blower | 2 | | 8500 CFM @ 5 psi | 250 | One standby |
| 300-PP-51/62 | Sump Pumps | 12 | 2 1/2" | | 5 | |
| 300-PP-63,64 | Process Water Pump, (Grinding & Lead Flotation) | 2 | | 2260 USGPM | 75 | One standby |
| 300-PP-65,66 | Tailings Pump, 1st Stage | 2 | 10 x 10 x 21 Metal | 2400 USGPM | 200 | One standby |
| 300-PP-67,68 | Tailings Pump, 2nd Stage | 2 | 10 x 10 x 21 Metal | 2400 USGPM | 200 | One standby |
| 300-PP-69,70 | Tailings Pump, 3rd Stage | 2 | 10 x 10 x 21 Metal | 2400 USGPM | 200 | One standby |
| 300-PP-71,72 | Tailings Pump, 4th Stage | 2 | 10 x 10 x 21 Metal | 2400 USGPM | 200 | One standby |
| 300-PP-73,74 | Tailings Pump, 5th Stage | 2 | 10 x 10 x 21 Metal | 2400 USGPM | 200 | Varispeed |
| 300-PP-79,80 | Sewage Transfer Pump | 2 | | 50 USGPM | 1 1/2 | One standby |
| 300-PP-81,82 | Gland Seal Water Pump | 2 | | 100 USGPM | 20 | One standby |
| 300-SA-01/06 | Pulp Samplers, Automatic | 6 | | | 1 | |
| 300-TK-31 | Process Water Tank, (Grinding & Lead Flotation) | 1 | 11'Ø x 15' | 10000 USG | | |

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 300 - CONCENTRATOR - MISCELLANEOUS

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 300-TK-35 | Sewage Collecting Tank | 1 | | 3000 USG | | |
| 300-TK-36 | Tailings Surge Tank | 1 | 12'Ø x 12' H | 10000 USG | | |
| | Ventilation and Air Handling Equipment | 1 Lot | | | | |

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 500 - SERVICE FACILITY

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 500-CK-01/05 | High Temperature Engine Cooler | 5 | | | | |
| 500-CK-06/10 | Low Temperature Engine Cooler | 5 | | | | |
| 500-CN-01 | Service Crane, Grinding & Generator Areas | 1 | 66' Span | 35/5 Ton | 50/10 | |
| 500-CN-02 | Service Crane, High Bay Shop | 1 | 58' Span | 25 Ton | 40/10 | |
| 500-CN-03 | Service Crane, Low Bay Shops | 2 | 58' Span | 10 Ton | 20 | |
| 500-CP-01,02 | Service Air Compressor | 2 | | 500 SCFM | 125 | |
| 500-DG-01/05 | Diesel Generators, c/w Auxiliaries | 5 | | 4 MW | | |
| 500-FL-01,02 | Domestic Water Filter | 2 | | 60 USGPM | | One standby |
| 500-HE-01,02 | Oil-fired Heating System Water Heater | 2 | | $5 \times 10^6$ BTUH | | |
| 500-HX-01/05 | Hot Water Heating Heating Heat Exchanger | 5 | | | | |
| 500-HX-10 | Domestic Hot Water Heat Exchanger | 1 | | | | |
| 500-HX-15/19 | Fuel Oil Preheater | 5 | | | | |
| 500-HX-20/24 | Process Water Preheater | 5 | | | | |
| 500-HX-25/29 | Exhaust Gas Water Heater | 5 | | | | |
| 500-PP-01 | Fire Pump, Electric | 1 | | 1000 USGPM | 75 | |
| 500-PP-02 | Fire Pump, Diesel | 1 | | 1000 USGPM | | |
| 500-PP-04,05 | Hot Water Heating Circ. Pump | 2 | | | 60 | One standby |
| 500-PP-06,07 | Domestic Water Pump | 2 | | 60 USGPM | 3 | One standby |
| 500-PP-08,09 | Domestic Hot Water Pump | 2 | | 20 USGPM | 1 | One standby |
| 500-PP-10/14 | High Temperature Cooling Water Circ. Pump | 5 | | | 20 | |
| 500-PP-15/19 | Low Temperature Cooling Water Circ. Pump | 5 | | | 10 | One standby |

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 500 - SERVICE FACILITY

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 500-PP-20/23 | Hot Water Heating Secondary Circ. Pump | 4 | | | 10 | |
| 500-TE-01 | Domestic Water Treatment Plant, Package Unit (Concentrator, Power Plant & Service Facility) | 1 | | 60 USGPM | 5 | |
| 500-TK-03 | Domestic Water Tank | 1 | | 1000 USG | | |
| 500-TK-35,36 | Domestic Hot Water Tank | 2 | | 1250 USG | | |
| 500-TK-37 | Expansion Tank, Low Temperature Cooling Water | 1 | | 200 USG | | |
| 500-TK-38 | Expansion Tank, Heating System | 1 | | 200 USG | | |
| 500-TK-39 | Expansion Tank, High Temperature Cooling Water | 1 | | 200 USG | | |
| | Machine Shop Equipment | 1 Lot | | | | |
| | Electric Shop Equipment | 1 Lot | | | | |
| | Pipe Shop Equipment | 1 Lot | | | | |
| | Carpentry Shop Equipment | 1 Lot | | | | |
| | Welding Equipment | 1 Lot | | | | |
| | Fork Lift Trucks, Shops | 2 | | 5000 lb. | | |
| | Fork Lift Trucks, Warehouse | 2 | | 4000 lb. | | |
| | Vehicle Servicing Equipment | 1 Lot | | | | |
| | Warehouse Storage Racks | 1 Lot | | | | |
| | Service Elevator | 1 | | 10,000 lb. | 10 | |

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 600 - ACCOMMODATIONS

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 600-GE-01 | Emergency Generator | 1 | | 750 kW | | Construction |
| 600-PP-01 | Fire Pump, Electric | 1 | | 1000 USGPM | 75 | |
| 600-PP-02 | Fire Pump, Diesel | 1 | | 1000 USGPM | | |
| 600-PP-03,04 | Water Supply Pump | 2 | | 50 USGPM | 7 1/2 | One standby |

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 700 - YARD

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| 700-PP-01,02 | Fresh Water Intake Pump | 2 | | 400 USGPM | 30 | One standby |
| 700-PP-03 | Gasoline Fuelling Station | 1 Lot | | | 1 | |
| 700-PP-04,05 | Diesel Fuel Transfer Pumps | 2 | | | 3 | |
| 700-PP-06,07 | Tailings U/F Pump (one with adjust. speed motor) | 2 | 8 x 6 x 18 R.L. | 700 USGPM | 100 | One standby |
| 700-PP-08,09 | Reclaim Water Pump, (Vertical) | 2 | | 1600 USGPM | 150 | One standby |
| 700-PP-10 | Diesel Fuelling Station | 1 Lot | | | 1 | |
| 700-SK-01,02 | Truck Scales, Concentrate | 2 | 10' x 50' | 40 tons | | |
| 700-SK-03 | Truck Scales, Incoming Materials | 1 | 10' x 50' | 40 tons | | |
| 700-TE-01 | Sewage Treatment Plant, Package Unit, Accommodations | 1 | | 60 USGPM | 3 | |
| 700-TK-01,02 | Diesel Fuel Storage Tank | 2 | 40'Ø x 32'H | 300,000 USG | | |
| 700-TK-03 | Gasoline Storage Tank | 1 | 8'Ø x 30' Lg | 10,000 USG | | |
| 700-TK-04 | Plant Water Storage Tank, Insulated | 1 | 60'Ø x 50'H | $1x10^6$ USG | 13 | Process & Fire Protection |
| 700-TK-08 | Tailings Thickener Tank, c/w Mechanism | 1 | 200'Ø | | 10 | |
| 700-TK-09 | Reclaim Water Surge Tank | 1 | 16'Ø x 10'H | 15000 USG | | |
| | Tailings Polishing Pond Effluent Treatment | 1 Lot | | | | |
| 700-TK-10 | Water Tank, Domestic & Fire, Accommodations | 1 | 25'Ø x 35' H | 130,000 USG | | |
| 700-TK-11 | Emergency Fuel Tank, Accommodations | 1 | | 7 days | | |
| | Incinerator, Garbage | 1 | | | | Construction |

BECHTEL JOB NO. 16988
HUDSON BAY MINING & SMELTING COMPANY LTD.
TOM/JASON PROJECT
EQUIPMENT LIST
AREA 700 - MOBILE EQUIPMENT

| EQUIP. NO. | MECHANICAL EQUIPMENT | NO. EA. | SIZE | NOMINAL CAPACITY EACH | H.P. EACH | COMMENT |
|---|---|---|---|---|---|---|
| | Personnel Bus | 2 | 40 Pass. | | | Construction |
| | Ambulance | 1 | | | | Construction |
| | Fire Truck | 1 | | | | Construction |
| | Pick Up Truck | 4 | 3/4 ton | | | Construction |
| | Dump Truck | 2 | 5 ton | | | Construction |
| | Stake Body Truck | 2 | 5 ton | | | |
| | Front End Loader | 1 | 1/2 cy | | | |
| | Front End Loader | 1 | 1 cy | | | |
| | Front End Loader | 2 | 2 cy | | | Construction (1) |
| | Road Grader | 1 | | | | Construction |
| | Bulldozer | 1 | D-8 | | | Construction |
| | Snow Plow/Blower | 2 | | | | |
| | Mobile Crane | 1 | 35 ton | | | Construction |
| | Product Haul Trucks | | | | | By Contractor |
| | Ore Trucks | 3 | 35 ton | | | |

## 3.15 DRAWINGS

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| 100-M-101 | LEAD AND ZINC FLOTATION CIRCUITS PROCESS FLOW DIAGRAM |
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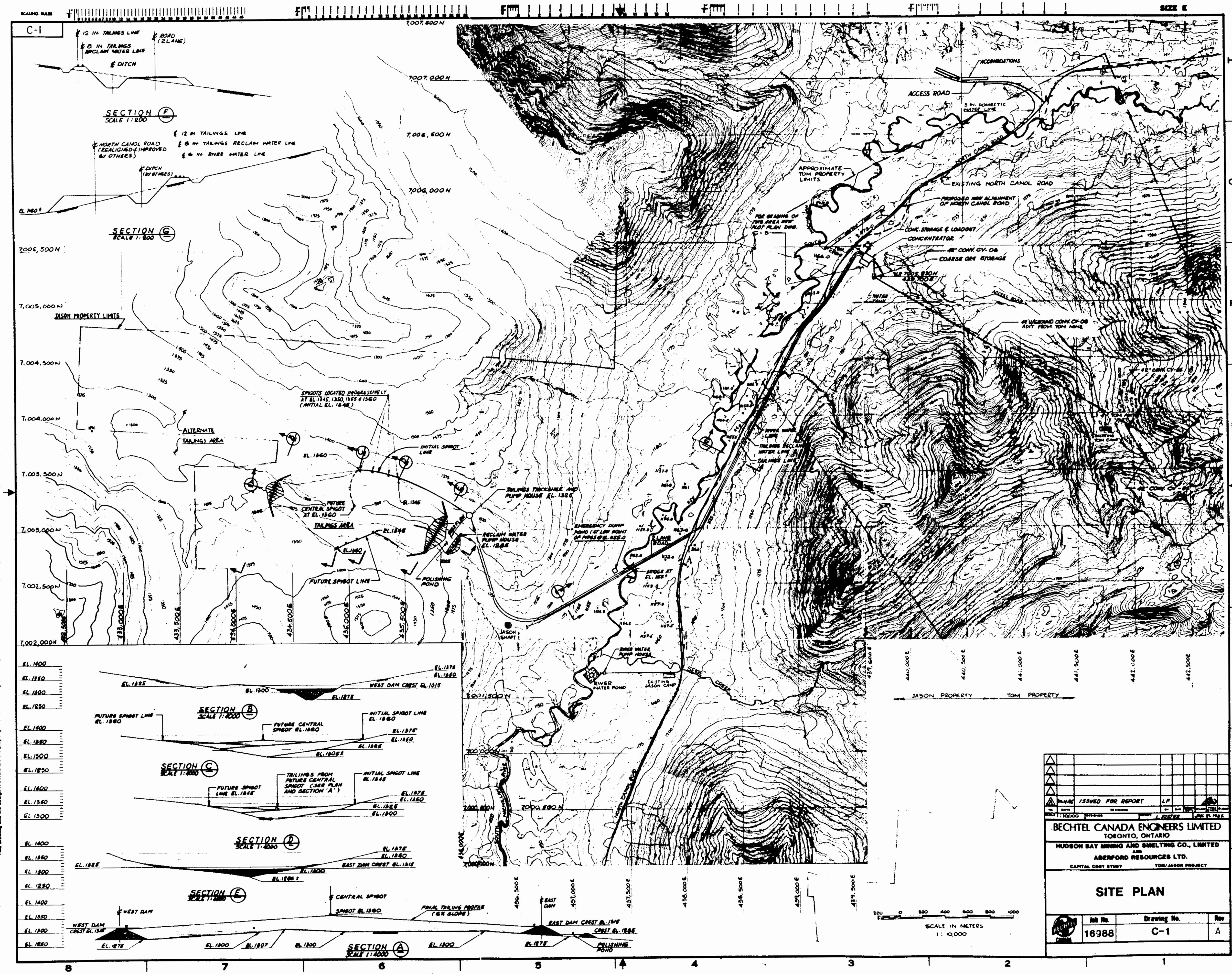
C-1
SECTION F
SCALE 1:200
12 IN. TAILINGS LINE
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DITCH
ROAD (2 LANE)
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NORTH CANOL ROAD (REALIGNED & IMPROVED BY OTHERS)
8 IN. RIVER WATER LINE
JASON PROPERTY LIMITS
ALTERNATE TAILINGS AREA
SPIGOTS LOCATED PROGRESSIVELY AT EL. 1345, 1350, 1355 & 1360 (INITIAL EL. 1348)
INITIAL SPIGOT LINE
FUTURE CENTRAL SPIGOT AT EL. 1360
TAILINGS AREA
FUTURE SPIGOT LINE
POLISHING POND
TAILINGS THICKENER AND PUMP HOUSE EL. 1385
RECLAIM WATER PUMP HOUSE EL. 1365
EMERGENCY DUMP POND (AT LOW POINT OF PIPES @ EL. 1165.0)
JASON SHAFT 1
RIVER WATER PUMP HOUSE
RIVER WATER POND
EXISTING JASON CAMP
SEKIE CREEK
NORTH CANOL ROAD
ACCOMMODATIONS
ACCESS ROAD
3 IN. DOMESTIC WATER LINE
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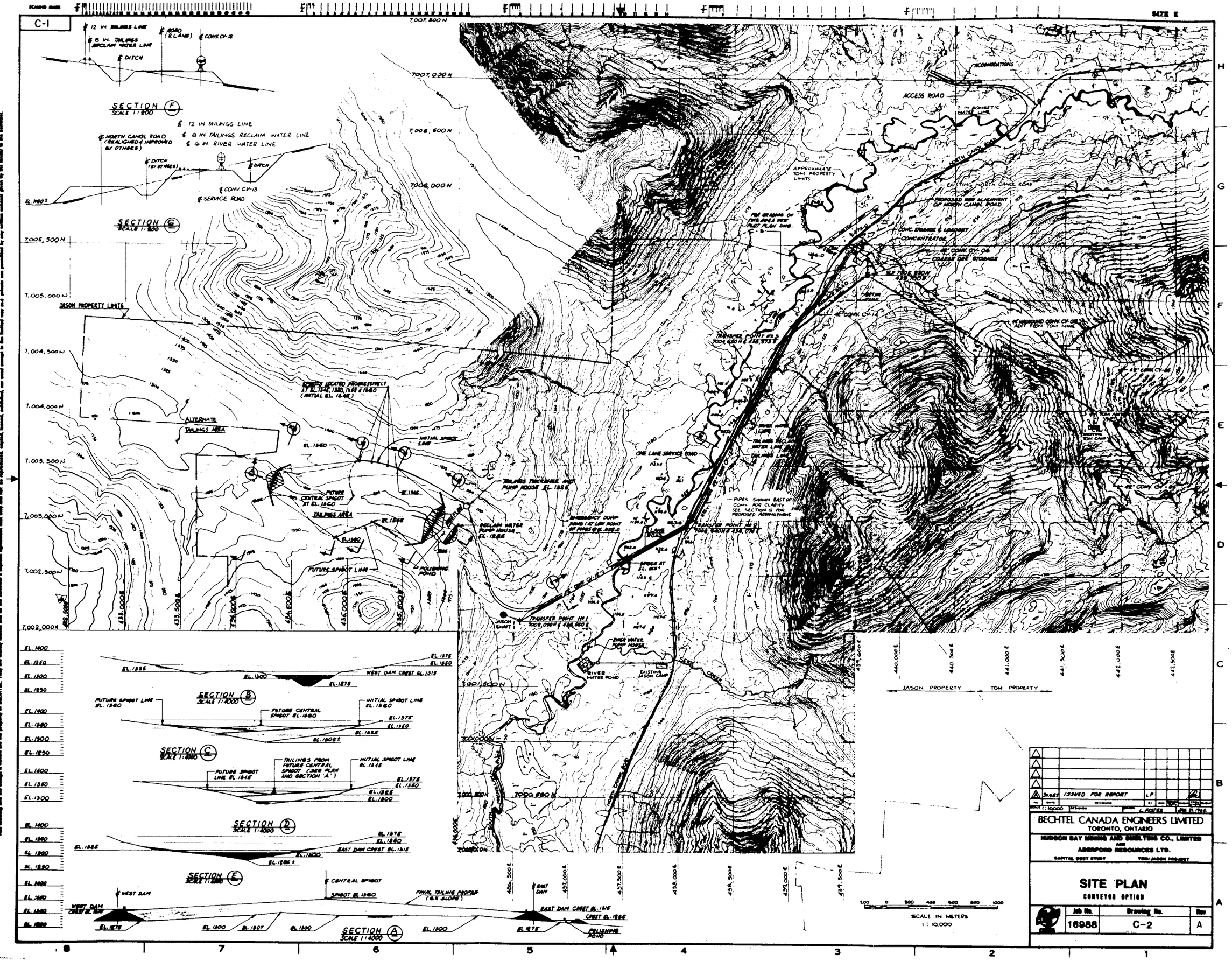
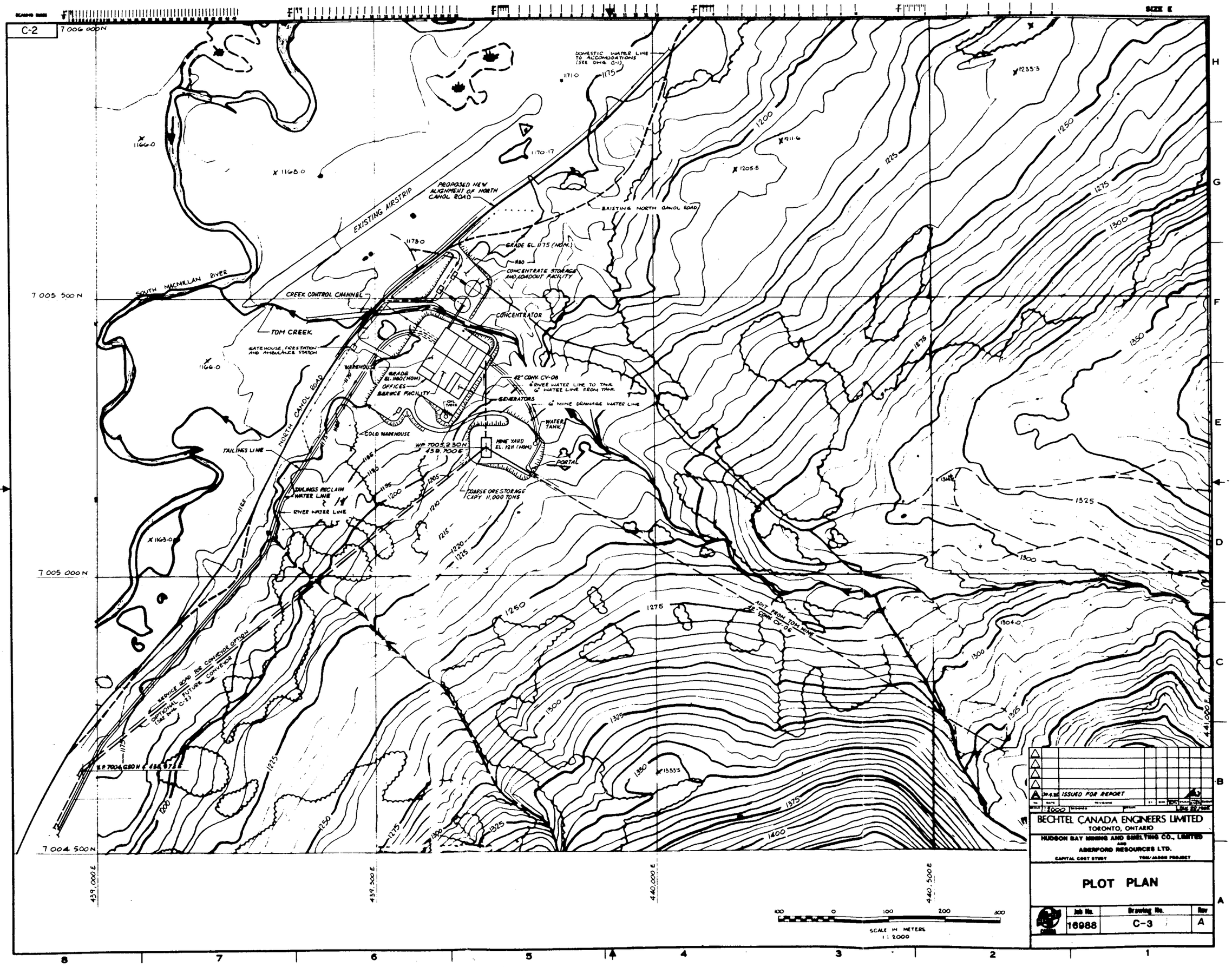
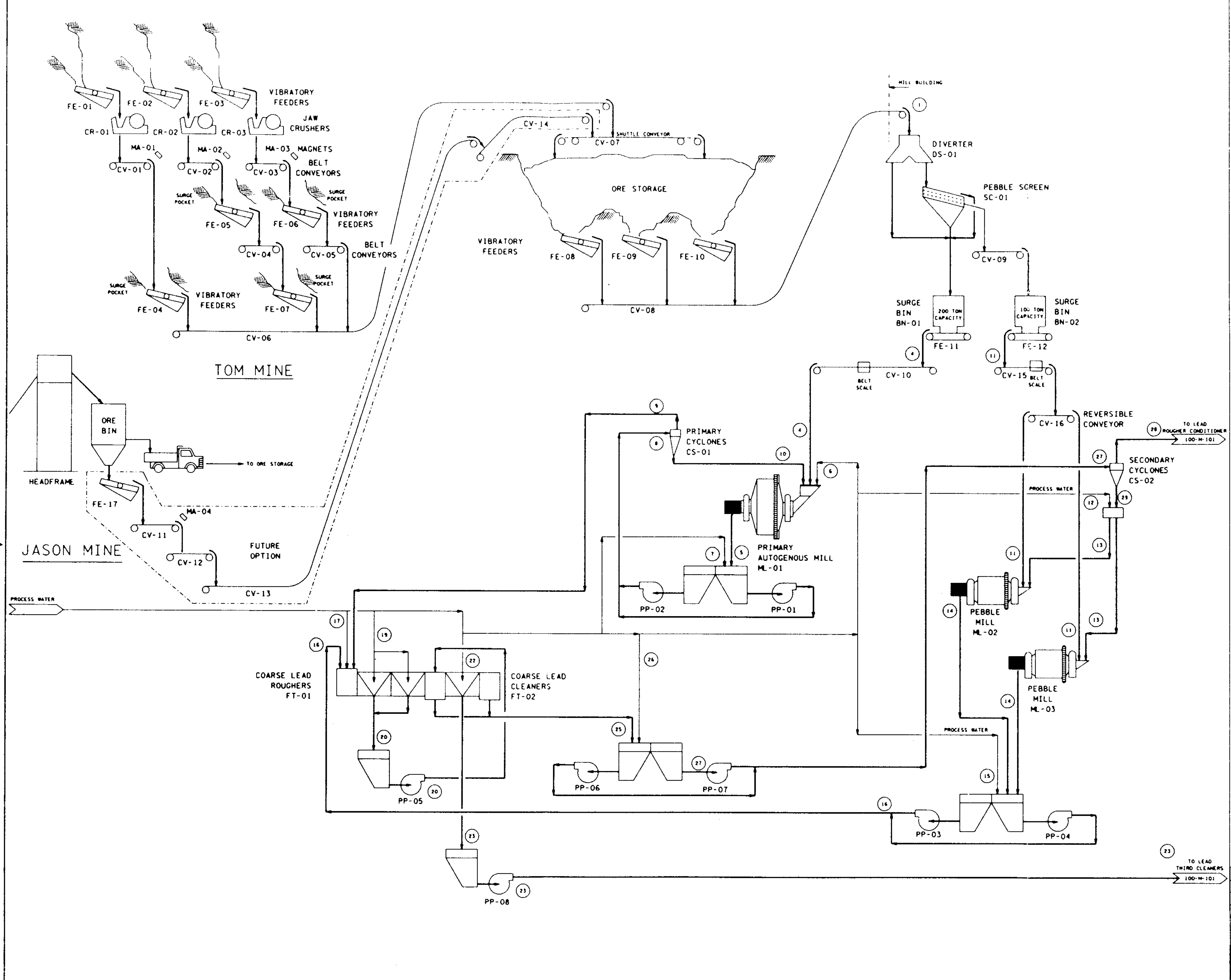
EXISTING NORTH CANOL ROAD
PROPOSED NEW ALIGNMENT OF NORTH CANOL ROAD
CONC. STORAGE & LOADOUT
CONCENTRATOR
COARSE ORE STORAGE
ADIT FROM TOM MINE
JASON PROPERTY
TOM PROPERTY
SECTION B
SCALE 1:4000
SECTION C
SCALE 1:4000
SECTION D
SCALE 1:4000
SECTION E
SECTION A
SCALE 1:4000
WEST DAM CREST EL. 1315
EAST DAM CREST EL. 1315
CENTRAL SPIGOT
SPIGOT EL. 1360
FINAL TAILING PROFILE (2% SLOPE)
SCALE IN METERS
1 : 10,000
ISSUED FOR REPORT
BECHTEL CANADA ENGINEERS LIMITED
TORONTO, ONTARIO
HUDSON BAY MINING AND SMELTING CO., LIMITED
AND
ABERFORD RESOURCES LTD.
CAPITAL COST STUDY
TOM/JASON PROJECT
SITE PLAN
Job No. 16988
Drawing No. C-1
Rev A


C-1
SECTION F
SCALE 1:200
SECTION G
SCALE 1:200
SECTION B
SCALE 1:4000
SECTION C
SCALE 1:4000
SECTION D
SCALE 1:4000
SECTION E
SCALE 1:4000
SECTION A
SCALE 1:4000
JASON PROPERTY LIMITS
ALTERNATE TAILINGS AREA
TAILINGS AREA
FUTURE SPIGOT LINE
POLISHING POND
ACCESS ROAD
APPROXIMATE TOM PROPERTY LIMITS
EXISTING NORTH CANOL ROAD
PROPOSED NEW ALIGNMENT OF NORTH CANOL ROAD
CONCENTRATOR
ONE LANE SERVICE ROAD
RIVER WATER POND
EXISTING JASON CAMP
JASON PROPERTY
TOM PROPERTY
SCALE IN METERS
1 : 10,000
ISSUED FOR REPORT
BECHTEL CANADA ENGINEERS LIMITED
TORONTO, ONTARIO
HUDSON BAY MINING AND SMELTING CO., LIMITED
AND
ABERFORD RESOURCES LTD.
CAPITAL COST STUDY
TOM/JASON PROJECT
SITE PLAN
CONVEYOR OPTION
Job No.
16988
Drawing No.
C-2
Rev
A


C-2
7 006 000 N
7 005 500 N
7 005 000 N
7 004 500 N
439,000 E
439,500 E
440,000 E
440,500 E
441,000 E
SIZE E
DOMESTIC WATER LINE TO ACCOMODATIONS (SEE DWG C-1)
EXISTING AIRSTRIP
PROPOSED NEW ALIGNMENT OF NORTH CANOL ROAD
EXISTING NORTH CANOL ROAD
GRADE EL. 1175 (NOM.)
CONCENTRATE STORAGE AND LOADOUT FACILITY
SOUTH MACMILLAN RIVER
CREEK CONTROL CHANNEL
CONCENTRATOR
TOM CREEK
GATEHOUSE, FIRESTATION AND AMBULANCE STATION
WAREHOUSE
GRADE EL. 1180 (NOM)
OFFICES
SERVICE FACILITY
42" CONV. CV-08
6" RIVER WATER LINE TO TANK
6" WATER LINE FROM TANK
GENERATORS
6" MINE DRAINAGE WATER LINE
WATER TANK
NORTH CANOL ROAD
COLD WAREHOUSE
MINE YARD EL. 1211 (NOM)
PORTAL
TAILINGS LINE
TAILINGS RECLAIM WATER LINE
RIVER WATER LINE
COARSE ORE STORAGE CAPY 11,000 TONS
ADIT FROM TOM MINE
SERVICE ROAD FOR CONVEYOR OPTION
OPTIONAL FUTURE CONVEYOR
SCALE IN METERS
1 : 2000
ISSUED FOR REPORT
BECHTEL CANADA ENGINEERS LIMITED
TORONTO, ONTARIO
HUDSON BAY MINING AND SMELTING CO., LIMITED
AND
ABERFORD RESOURCES LTD.
CAPITAL COST STUDY
TOM/JASON PROJECT
PLOT PLAN
Job No.
16988
Drawing No.
C-3
Rev
A

SIZE E

100-M-100




| STREAM NUMBER | 1 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 19 | 20 | 22 | 23 | 25 | 26 | 27 | 28 | 29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | ORE FEED | PRIMARY MILL FEED | PRIMARY MILL DISCHARGE | PRIMARY MILL DILUTION | PRIM CYCL. FEED DILUTION | PRIMARY CYCLONE FEED | PRIMARY CYCLONE OVERFLOW | PRIMARY CYCLONE UNDERFLOW | SEC. MILL PEBBLE (EACH) | SEC. MILL FEED DILUTION | SEC. MILL FEED (EACH) | SEC. MILL DISCHARGE (EACH) | SEC. MILL DISCHARGE DILUTION | SEC. MILL DISCHARGE TOTAL | COARSE PB RO. DILUTION | COARSE PB RO. SPRAY | COARSE PB RO. CONC. | COARSE PB CLNR. SPRAY | COARSE PB CLNR. CONC. | COARSE PB CIRCUIT TAILS | SEC CYCL FEED DILUTION | SEC CYCL FEED | SEC CYCL OVERFLOW | SEC CYCL UNDERFLOW |
| STPH - SOLIDS | 108.3 | 101.7 | 383.5 | - | - | 383.5 | 101.7 | 281.7 | 8.3 | - | 306.6 | 316.4 | - | 634.9 | - | - | 11.6 | - | 3.4 | 817.6 | - | 817.6 | 204.6 | 613.1 |
| - WATER | 6.4 | [illegible] | 164.3 | 93.5 | 82.4 | 220.7 | 186.8 | 65.4 | 0.3 | 67.4 | 169.1 | 169.4 | 89.2 | 419.9 | 18.3 | 19.0 | 27.8 | 10.0 | 11.8 | 640.7 | 34.3 | 842.4 | 579.6 | 263.8 |
| - SLURRY | 114.7 | [illegible] | 547.6 | 93.5 | 82.4 | 604.0 | 288.5 | 356.6 | 8.6 | 67.4 | 471.7 | 480.3 | 89.2 | 1054.8 | 18.3 | 19.0 | 39.3 | 10.0 | 18.7 | 1458.3 | 34.3 | 1660.0 | 784.0 | 876.0 |
| WEIGHT %SOLIDS | 97.0 | 97.0 | 70.0 | - | - | 63.5 | 35.0 | 79.0 | 97.0 | - | 65.0 | 65.6 | - | 60.0 | - | - | 30.0 | - | 25.0 | 57.4 | - | 50.0 | 35.0 | 70.0 |
| SOLIDS SPECIFIC GRAVITY | 3.36 | 3.36 | 3.36 | - | - | 3.36 | 3.36 | 3.36 | 3.36 | - | 3.34 | 3.34 | - | 3.34 | - | - | 4.25 | - | 5.20 | 3.34 | - | 3.34 | 3.34 | 3.34 |
| USGPM | | | 1111.5 | 357.4 | 329.4 | 1317.5 | 894.3 | 403.1 | | 269.3 | 1026.5 | 1037.4 | 356.4 | 2431.1 | 73.6 | 60.0 | 126.5 | 40.0 | 50.1 | 3407.5 | 136.8 | 3544.6 | 1761.0 | 1783.7 |
| SLURRY SPECIFIC GRAVITY | | | 1.97 | 1.00 | 1.00 | 1.80 | 1.63 | 2.11 | | 1.00 | 1.64 | 1.69 | 1.00 | 1.73 | 1.00 | 1.00 | 1.30 | 1.00 | 1.24 | 1.67 | 1.00 | 1.65 | 1.32 | 1.96 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| NOTES | | | | | | | | | | | | | | | | | | | | | | | | |

A ISSUED FOR REPORT

DESIGNED R. RICHARDS DRAWN F.E. ANDERSON

BECHTEL CANADA ENGINEERS LIMITED
TORONTO, ONTARIO

HUDSON BAY MINING AND SMELTING CO., LIMITED
AND
ABERFORD RESOURCES LTD.

CAPITAL COST STUDY — TOM/JASON PROJECT

ORE HANDLING, STORAGE AND GRINDING CIRCUIT PROCESS FLOW DIAGRAM

| Job No. | Drawing No. | Rev |
|---|---|---|
| 16988 | 100-M-100 | A |

BECHTEL CANADA

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SIZE E

100-M-101

COARSE LEAD CONCENTRATE 100-M-100

PROCESS WATER 100-M-200

SECONDARY CYCLONE OVERFLOW 100-M-100

LEAD CONDITIONERS TK-01 & TK-02 AG-01 & 02

LEAD ROUGHERS FT-03

LEAD SCAVENGERS FT-05

LEAD FIRST CLEANERS FT-07

LEAD THIRD CLEANERS FT-09

LEAD SECOND CLEANERS FT-11

LEAD REGRIND MILL ML-04

LEAD REGRIND ROUGHERS FT-13

LEAD REGRIND CLEANERS FT-14

PP-09 PP-10 PP-11 PP-12 PP-13 PP-14 PP-15 PP-16 PP-17 PP-18 PP-19

TO LEAD CONCENTRATE THICKENER 100-M-100

PROCESS WATER 100-M-200

ZINC CONDITIONERS TK-03&04 AG-03 & 04

ZINC ROUGHERS FT-15

ZINC SCAVENGERS FT-17

ZINC FIRST CLEANERS FT-19

ZINC THIRD CLEANERS FT-23

ZINC SECOND CLEANERS FT-21

PP-20 PP-21 PP-22 PP-23 PP-25 PP-26

TO ZINC CONCENTRATE THICKENER 100-M-102

TAILINGS SURGE TANK TK-36

TAILINGS PUMPS PP-65/74

TAILINGS THICKENER TK-08

700-PP-06/07

700-PP-10/11

SETTLING POND

TAILINGS AREA

PP-24

SURGE TANK 700-TK-09

TO PROCESS WATER TANK TK-31 100-M-200

| STREAM NUMBER | 23 | 28 | 30 | 32 | 33 | 36 | 37 | 38 | 39 | 40 | 41 | 43 | 44 | 45 | 47 | 48 | 51 | 52 | 53 | 54 | 55 | 56 | 58 | 59 | 61 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | COARSE PB CLNR. CONC. | SEC. CYCLONE OVERFLOW | PB COND. DILUTION | PB RO. SPRAY | PB RO. CONC. | PB SCAV. SPRAY | PB SCAV. CONC. | PB SCAV. TAIL | PB FIRST CLNR. SPRAY | PB FIRST CLNR. CONC. | PB FIRST CLNR. TAIL | PB SECOND CLNR. CONC. | PB SECOND CLNR. TAIL | PB SECOND CLNR. CONC. | PB THIRD CLNR. SPRAY | PB THIRD CLNR. CONC. | REGR. CYCL. DILUTION | REGR. CYCL. FEED | REGR. CYCL. OVERFLOW | REGR. CYCL. UNDERFLOW | REGR. RO. SPRAY | REGR. RO. CONC. | REGR. CLNR. SPRAY | REGR. CLNR. CONC. | REGR. CLNR. TAIL |
| STPH - SOLIDS | 5·2 | 304·4 | - | - | 53·0 | - | 10·9 | 176·8 | - | 40·6 | 11·8 | - | 43·7 | 16·9 | - | 37·5 | - | 198·4 | 27·8 | 111·8 | - | 6·9 | - | 5·4 | 24·4 |
| - WATER | 8·8 | 570·6 | 16·3 | 57·6 | 122·4 | 7·9 | 61·9 | 633·6 | 18·8 | 94·6 | 68·8 | 18·8 | 115·2 | 61·9 | 18·8 | 94·5 | 2·8 | 247·8 | 111·8 | 194·5 | 7·8 | 27·6 | 1·3 | 13·8 | 108·8 |
| - SLURRY | 14·1 | 874·0 | 16·3 | 57·6 | 175·4 | 7·9 | 72·8 | 810·2 | 18·8 | 135·2 | 77·0 | 18·8 | 158·9 | 78·8 | 18·8 | 132·0 | 2·8 | 307·2 | 139·4 | 306·3 | 7·8 | 34·5 | 1·3 | 19·2 | 132·8 |
| WEIGHT %SOLIDS | 36·0 | 35·0 | - | - | 30·0 | - | 14·0 | 21·6 | - | 30·0 | 15·1 | - | 27·8 | 20·6 | - | 28·0 | - | 64·0 | 20·0 | 36·0 | - | 20·0 | - | 27·0 | 18·2 |
| SOLIDS SPECIFIC GRAVITY | 0·50 | 3·46 | - | - | 4·35 | - | 3·30 | 3·19 | - | 3·47 | 3·19 | - | 3·04 | 3·47 | - | 5·69 | - | 5·34 | 3·81 | 3·84 | - | 3·87 | - | 4·19 | 3·28 |
| USGPM | 50·1 | 1764·0 | 64·5 | 150·0 | 533·8 | 30·0 | 289·7 | 1915·9 | 75·0 | 478·8 | 196·0 | 75·0 | 494·7 | 271·9 | 75·0 | 390·8 | 11·1 | 1196·5 | 478·8 | 677·7 | 15·0 | 172·2 | 5·0 | 98·5 | 442·7 |
| SLURRY SPECIFIC GRAVITY | 1·25 | 1·82 | 1·00 | 1·00 | 1·50 | 1·00 | 1·12 | 1·29 | 1·00 | 1·31 | 1·16 | 1·00 | 1·28 | 1·17 | 1·00 | 1·24 | 1·00 | 1·34 | 1·16 | 1·46 | 1·00 | 1·19 | 1·00 | 1·15 | 1·19 |
| NOTES | | | | | | | | | | | | | | | | | | | | | | | | | |

| STREAM NUMBER | 62 | 63 | 64 | 66 | 67 | 68 | 70 | 71 | 72 | 74 | 75 | 76 | 77 | 78 | 86 | 93 | 100 | 101 | 102 | 103 | 104 | 105 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | ZN RO. FEED | ZN RO. SPRAY | ZN RO. CONC. | ZN SCAV. SPRAY | ZN SCAV. CONC. | ZN SCAV. TAIL | ZN FIRST CLNR. SPRAY | ZN FIRST CLNR. CONC. | ZN FIRST CLNR. TAIL | ZN SECOND CLNR. SPRAY | ZN SECOND CLNR. CONC. | ZN SECOND CLNR. TAIL | ZN THIRD CLNR. SPRAY | ZN THIRD CLNR. CONC. | PB CIRCUIT PROCESS WATER | ZN CIRCUIT PROCESS WATER | PROCESS TAILINGS | TAILS THKNR UNDERFLOW | TAILS THKNR OVERFLOW | SETTLED TAILINGS | TAILINGS DECANT SOLUTION | RECLAIM WATER |
| STPH - SOLIDS | 195·6 | - | 19·7 | - | 10·2 | 165·8 | - | 93·6 | 4·7 | - | 30·1 | 6·8 | - | 25·0 | - | - | 165·8 | 165·8 | - | 165·8 | - | - |
| - WATER | 614·2 | 12·5 | 69·2 | 15·9 | 46·2 | 423·8 | 10·0 | 79·4 | 46·6 | 10·0 | 70·5 | 41·7 | 10·0 | 59·9 | 530·5 | 95·0 | 435·8 | 133·9 | 257·9 | 258·4 | 19·4 | 157·4 |
| - SLURRY | 809·8 | 12·5 | 88·9 | 15·9 | 56·4 | 589·6 | 10·0 | 173·0 | 51·3 | 10·0 | 100·5 | 48·5 | 10·0 | 84·9 | 530·5 | 95·0 | 601·6 | 299·7 | 257·9 | 424·2 | 19·4 | 157·4 |
| WEIGHT %SOLIDS | 24·2 | - | 22·0 | - | 18·0 | 28·6 | - | 54·0 | 12·5 | - | 30·0 | 14·2 | - | 29·5 | - | - | 27·5 | 55·0 | - | 39·0 | - | - |
| SOLIDS SPECIFIC GRAVITY | 3·13 | - | 3·48 | - | 3·15 | 3·05 | - | 4·70 | 3·07 | - | 3·78 | 3·41 | - | 3·85 | - | - | 3·05 | 3·09 | - | 3·09 | - | - |
| USGPM | 2301·4 | 50·0 | 209·2 | 60·0 | 197·6 | 1864·5 | 40·0 | 715·9 | 190·5 | 40·0 | 313·1 | 177·4 | 40·0 | 238·8 | 2091·1 | 250·0 | 1854·8 | 704·3 | 882·5 | 444·5 | 334·5 | 1475·6 |
| SLURRY SPECIFIC GRAVITY | 1·33 | 1·00 | 1·28 | 1·00 | 1·14 | 1·22 | 1·00 | 1·28 | 1·09 | 1·00 | 1·28 | 1·18 | 1·00 | 1·28 | 1·00 | 1·00 | 1·25 | 1·69 | 1·09 | 1·89 | 1·00 | 1·00 |
| NOTES | | | | | | | | | | | | | | | | | | | | | | |

| NO. | DATE | REVISIONS | BY | CHK | ENGR | PROJ ENGR |
|---|---|---|---|---|---|---|
| A | 86.06.26 | ISSUED FOR REPORT | F.A. | | | R.R. |

SCALE — DESIGNED R.RICHARDS DRAWN F.B.ANDERSON

BECHTEL CANADA ENGINEERS LIMITED
TORONTO, ONTARIO

HUDSON BAY MINING AND SMELTING CO., LIMITED AND ABERFORD RESOURCES LTD.

CAPITAL COST STUDY — TBM/MOOSE PROJECT

LEAD AND ZINC
FLOTATION CIRCUITS
PROCESS FLOW DIAGRAM

| Job No. | Drawing No. | Rev |
|---|---|---|
| 16988 | 100-M-101 | A |

CANADA

8 7 6 5 4 3 2 1

H G F E D C B A

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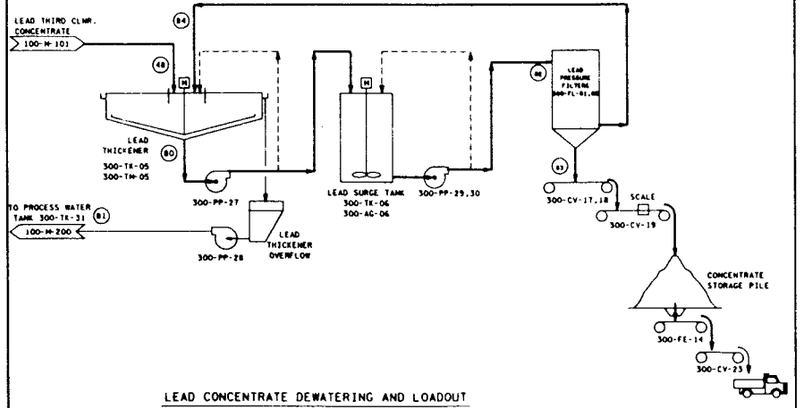
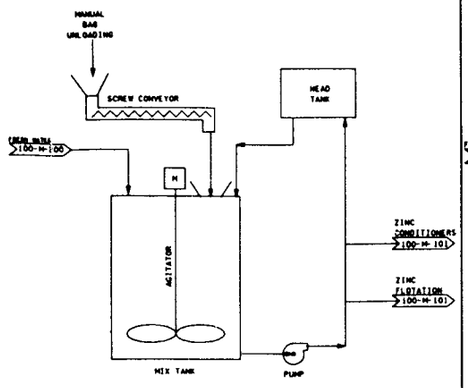
SIZE E

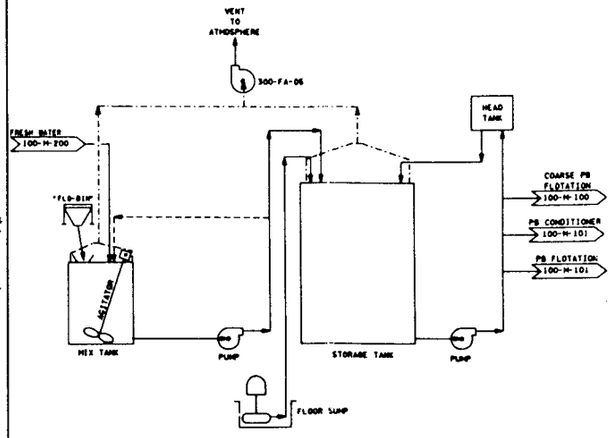
100-M-102



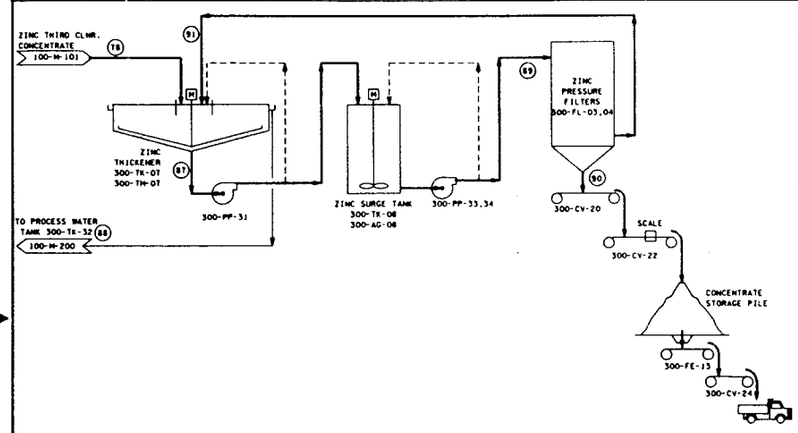

LEAD CONCENTRATE DEWATERING AND LOADOUT



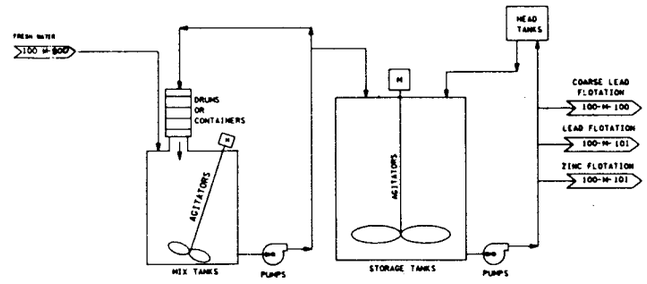

COPPER SULPHATE REAGENT SYSTEM



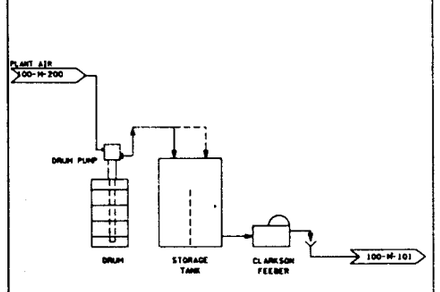

SODIUM CYANIDE REAGENT SYSTEM



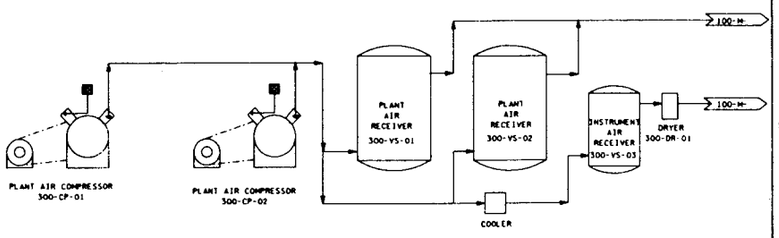

ZINC CONCENTRATE DEWATERING AND LOADOUT



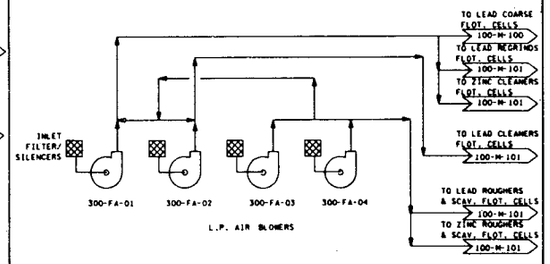

SODIUM SILICATE, SODIUM SULPHITE, ZINC SULPHATE AND XANTHATE REAGENT SYSTEMS (TYPICAL)



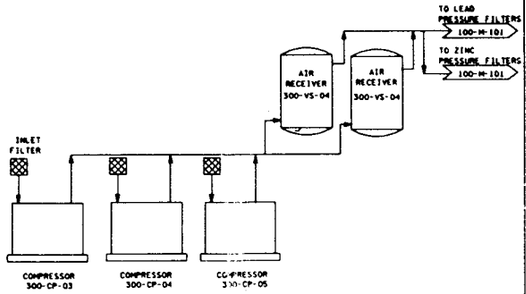

FROTHERS AND PROMOTERS REAGENT SYSTEMS (TYPICAL FOR FOUR SETS)




PLANT AIR SYSTEM




FLOTATION AIR BLOWER SYSTEM




PRESSURE FILTER AIR SYSTEM

| STREAM NUMBER | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 87 | 88 | 89 | 90 | 91 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | PB THIRD CLEANER CONC. | ZN THIRD CLEANER CONC. | PB THIRD UNDERFLOW | PB THIRD OVERFLOW | PB FILTER FEED (AVG.) | PB FILTER CAKE (AVG.) | PB FILTER FILTRATE | ZN THIRD UNDERFLOW | ZN THIRD OVERFLOW | ZN FILTER FEED (AVG.) | ZN FILTER CAKE (AVG.) | ZN FILTER FILTRATE |
| STPH - SOLIDS | 81.9 | 23.0 | 31.5 | - | 31.9 | 31.5 | - | 25.0 | - | 23.0 | 23.0 | - |
| - WATER | 94.6 | 53.7 | 31.5 | 63.0 | 84.5 | 2.7 | 81.8 | 25.0 | 30.7 | 23.0 | 2.0 | 21.0 |
| - SLURRY | 126.0 | 76.7 | 63.0 | 63.0 | 65.0 | 34.2 | 28.8 | 46.0 | 30.7 | 46.0 | 25.0 | 21.0 |
| WEIGHT %SOLIDS | 25.0 | 30.0 | 50.0 | - | 50.0 | 92.0 | - | 50.0 | - | 50.0 | 92.0 | - |
| SOLIDS SPECIFIC GRAVITY | 5.69 | 3.83 | 5.69 | - | 5.69 | 5.69 | - | 3.83 | - | 3.83 | 3.83 | - |
| USGPM | 5990.9 | 2358.6 | 1479 | 2946 | 1479 | - | 1149 | 1189 | 1226 | 1189 | - | 1159 |
| SLURRY SPECIFIC GRAVITY | 1.26 | 1.25 | 1.70 | 1.00 | 1.70 | - | 1.00 | 1.69 | 1.00 | 1.69 | - | 1.00 |
| NOTES | | | | | | | | | | | | |

| NO. | DATE | REVISIONS | BY | CHK | ENGR | PROJ ENGR |
|---|---|---|---|---|---|---|
| A | 30-N-82 | ISSUED FOR REPORT | F.A. | | | |

SCALE — DESIGNED R.RICHARDS — DRAWN F.B ANDERSON

BECHTEL CANADA ENGINEERS LIMITED
TORONTO, ONTARIO

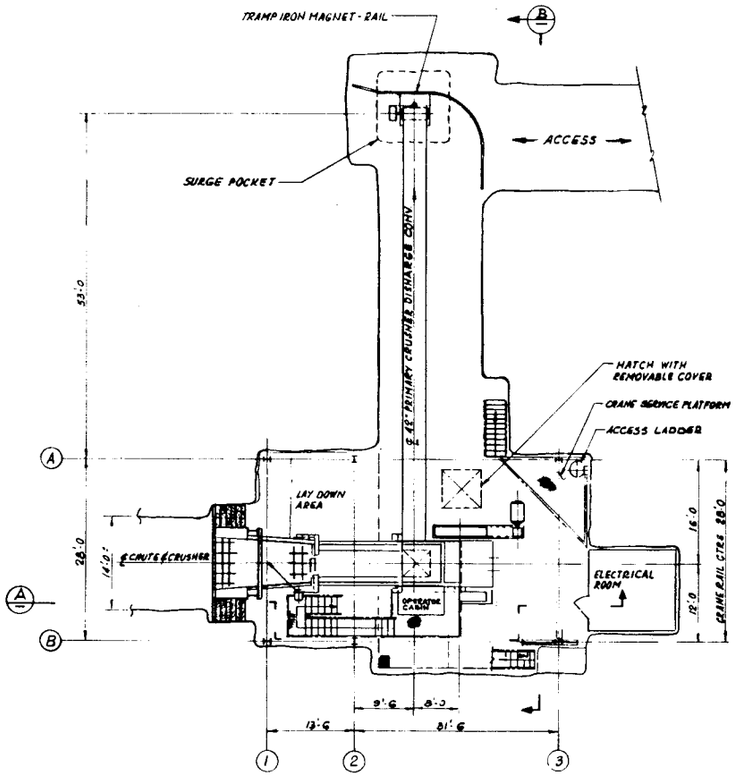
HUDSON BAY MINING AND SMELTING CO., LIMITED AND ABERFORD RESOURCES LTD.
CAPITAL COST STUDY — TOMJASON PROJECT

CONCENTRATE DEWATERING & LOADOUT, REAGENT AND AIR SYSTEMS PROCESS FLOW DIAGRAM

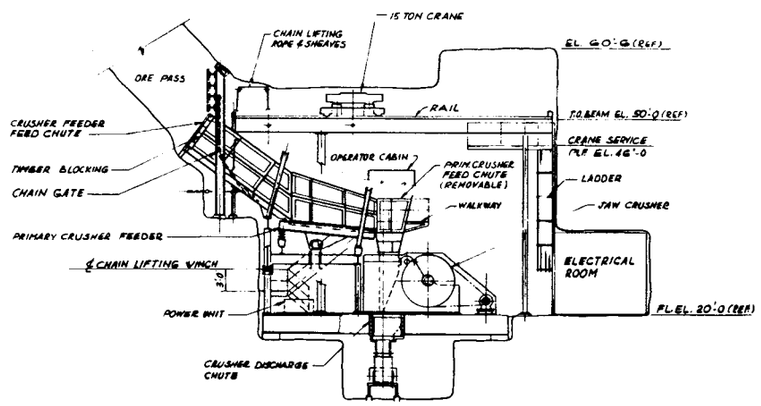
| Job No. | Drawing No. | Rev |
|---|---|---|
| 16988 | 100-M-102 | A |

CANADA

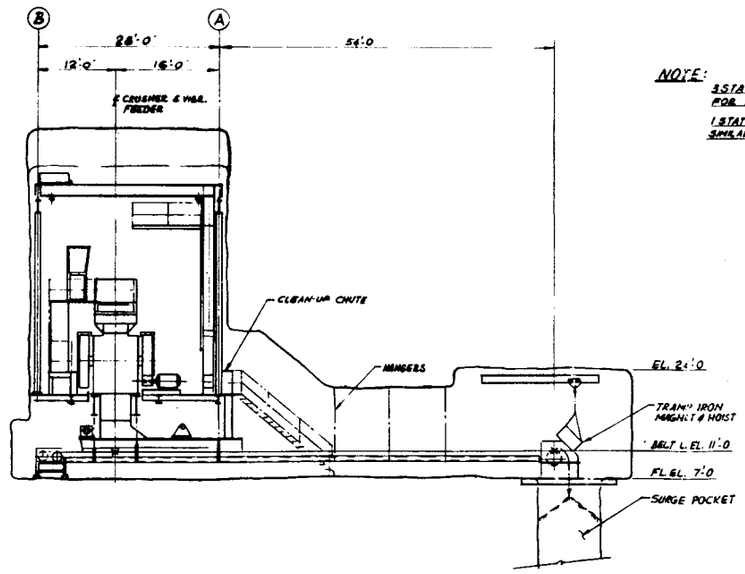
M-110




PLAN




ELEVATION (A)




ELEVATION (B)

NOTE:
3 STATIONS REQUIRED AS SHOWN, FOR TOM MINE
1 STATION REQUIRED FOR JASON MINE, SIMILAR

| No. | DATE | REVISION | BY | CHK | APP'D |
|---|---|---|---|---|---|
| A | JAN 6/65 | ISSUED FOR REPORT | | | |

SCALE 1/8" = 1'-0 | DESIGNED | DRAWN L.FISTER | JAN 6, 1965

BECHTEL CANADA ENGINEERS LIMITED
TORONTO, ONTARIO

HUDSON BAY MINING AND SMELTING CO., LIMITED AND ABERFORD RESOURCES LTD.
CAPITAL COST STUDY — TOM/JASON PROJECT

# TYPICAL U/G CRUSHING STATION

| Job No. | Drawing No. | Rev |
|---|---|---|
| 16988 | M-110 | A |

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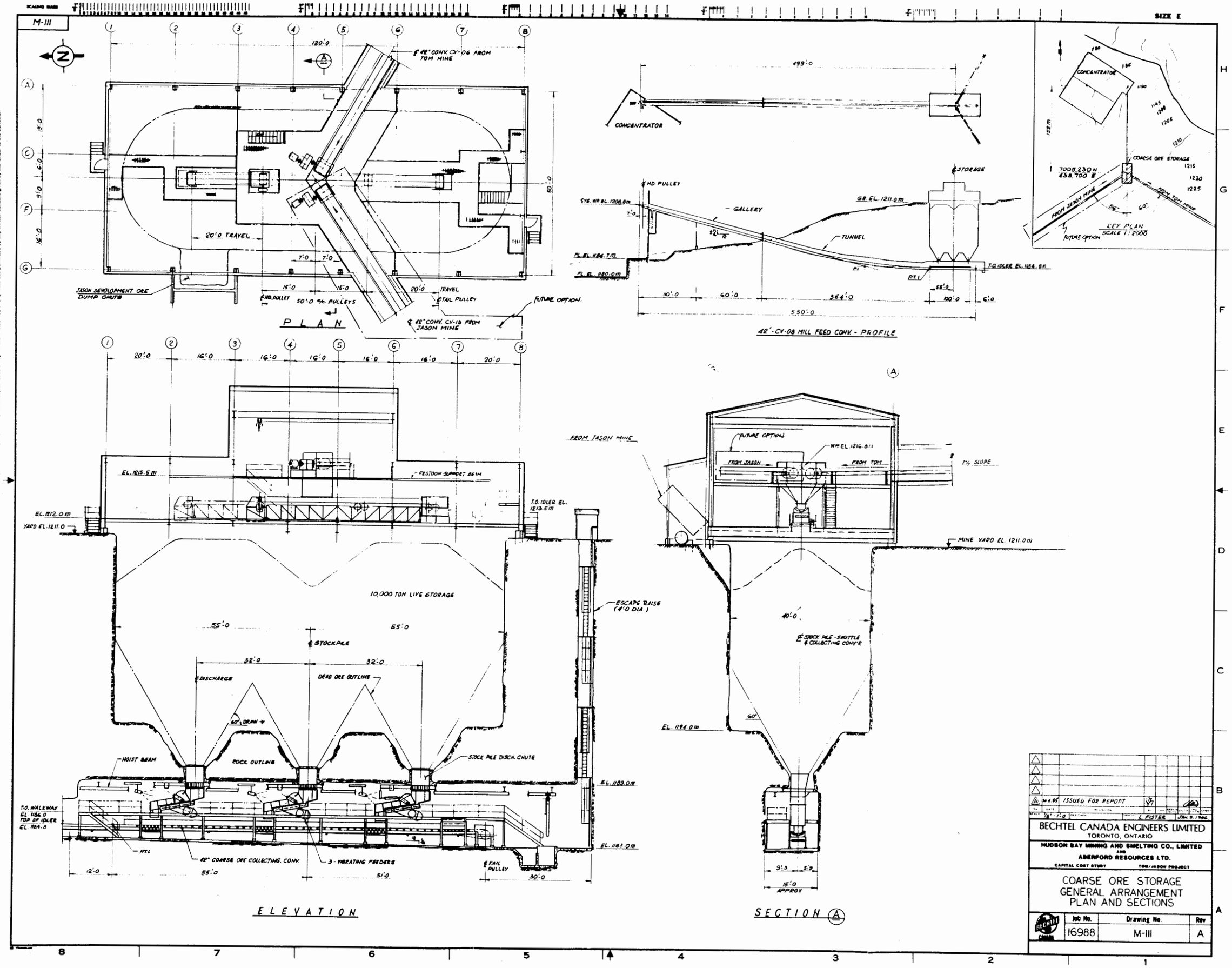
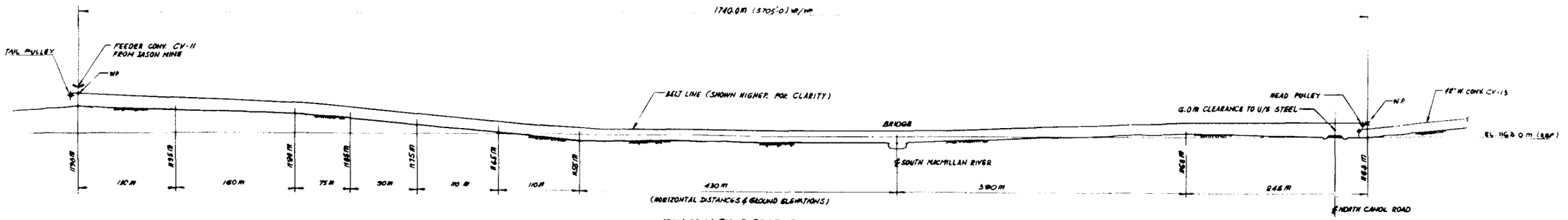
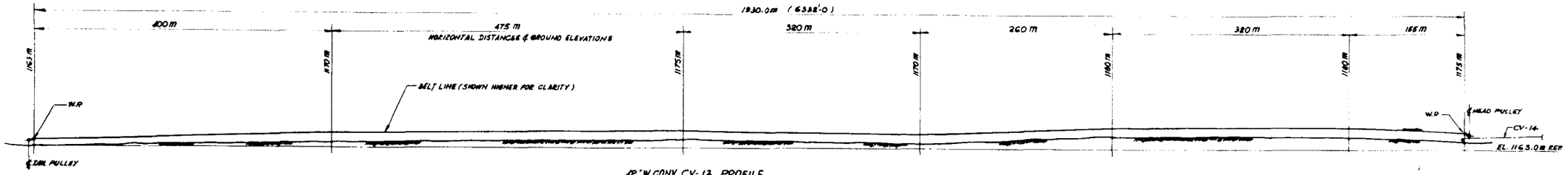

M-111
SIZE E
PLAN
ELEVATION
SECTION A
42"-CV-08 MILL FEED CONV. - PROFILE
KEY PLAN
SCALE 1:2000
CONCENTRATOR
COARSE ORE STORAGE
FROM JASON MINE
FROM TOM MINE
FUTURE OPTION
10,000 TON LIVE STORAGE
ESCAPE RAISE (4'0 DIA.)
STOCKPILE
DISCHARGE
DEAD ORE OUTLINE
ROCK OUTLINE
HOIST BEAM
STOCK PILE DISCH. CHUTE
42" COARSE ORE COLLECTING CONV.
3-VIBRATING FEEDERS
TAIL PULLEY
MINE YARD EL. 1211.0m
1% SLOPE
ISSUED FOR REPORT
BECHTEL CANADA ENGINEERS LIMITED
TORONTO, ONTARIO
HUDSON BAY MINING AND SMELTING CO., LIMITED
AND
ABERFORD RESOURCES LTD.
CAPITAL COST STUDY
TOM/JASON PROJECT
COARSE ORE STORAGE
GENERAL ARRANGEMENT
PLAN AND SECTIONS
Job No. 16988
Drawing No. M-111
Rev A

SCALING RULER — SIZE E

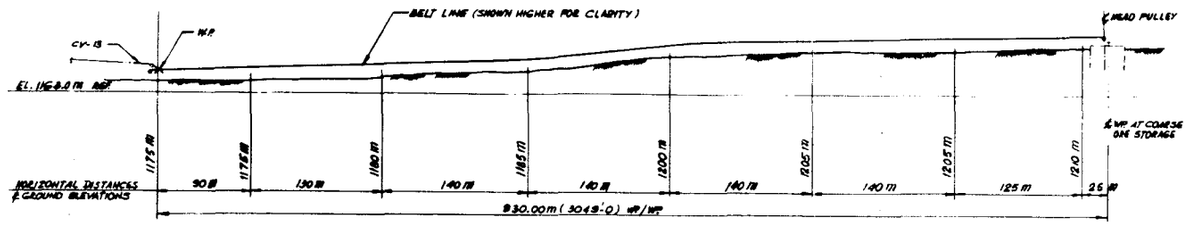
M-112




42"W. CONV. CV-12 PROFILE
SCALE 1: 2000

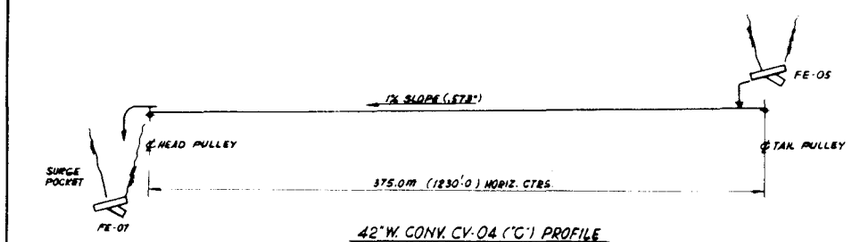



42"W. CONV. CV-13 PROFILE
SCALE 1: 2000

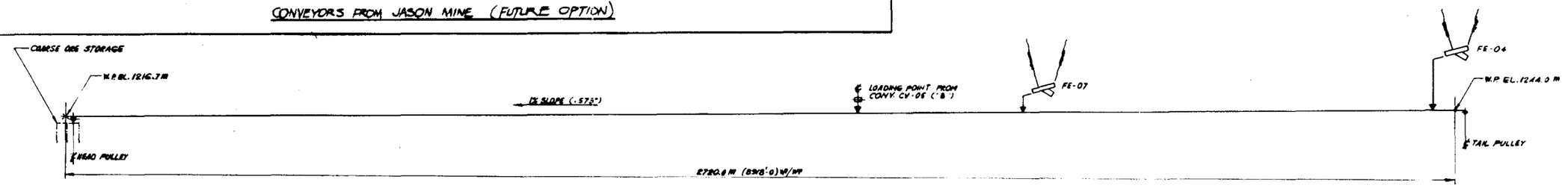



42"W. CONV. CV-14 PROFILE

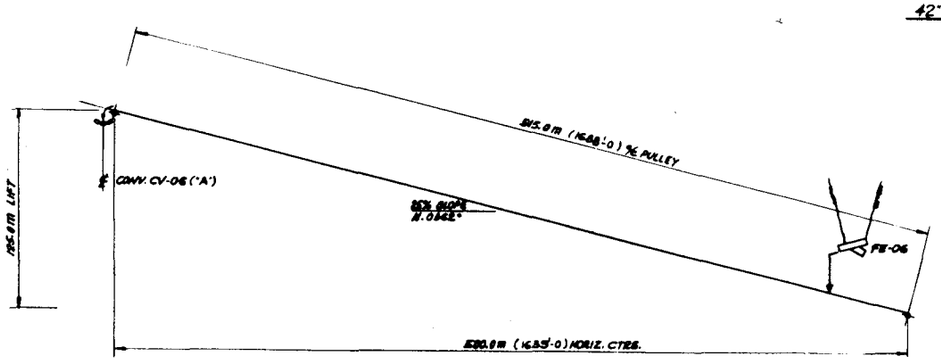
CONVEYORS FROM JASON MINE (FUTURE OPTION)




42"W. CONV. CV-04 ("C") PROFILE
SCALE 1:1250




42"W. CONV. CV-06 ("A") PROFILE
SCALE 1:3000




42"W. CONV. CV-05 ("B") PROFILE
SCALE 1:1250

CONVEYORS FROM TOM MINE

CONVEYOR DATA

| CONV. No. | SIZE | CAP'Y T/HR. | SPEED FT/M | HP |
|---|---|---|---|---|
| CV-12 | 42" | 400 | 200 | 100 |
| CV-13 | 42" | 400 | 200 | 150 |
| CV-14 | 42" | 400 | 200 | 125 |
| FROM JASON MINE (ABOVE GROUND) | | | | |
| CV-04 ("C") | 42" | 400 | 200 | 30 |
| CV-05 ("B") | 42" | 400 | 200 | 250 |
| CV-06 ("A") | 42" | 400 | 200 | 150 |
| FROM TOM MINE (UNDER GROUND) | | | | |

| No. | DATE | REVISIONS | BY | CHK | ENG | CLIENT |
|---|---|---|---|---|---|---|
| A | 84.4.18 | ISSUED FOR REPORT | LF | | | |

DESIGN G. GRAHAM | DRAWN | CHECKED | APPROVED L. PASTORE | DATE 84/4/18

BECHTEL CANADA ENGINEERS LIMITED
TORONTO, ONTARIO

HUDSON BAY MINING AND SMELTING CO., LIMITED AND ASHFORD RESOURCES LTD.
CAPITAL COST $7187 | TOM/JASON PROJECT

CONVEYOR PROFILES
CV 11, CV 12 & CV 13 FROM JASON MINE
CV 04 CV 05 & CV 06 FROM TOM MINE

| Job No. | Drawing No. | Rev |
|---|---|---|
| 16988 | M-112 | A |

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SCALING RODS — SCALING RODS — SIZE E

T.O. GRAT. EL. 146'-0"
T.O. GRAT. EL. 131'-0 7/8"
T.O. GRAT. EL. 155'-6"
T.O. GRAT. EL. 151'-0 7/8"
OPENING
OPEN
AIR RECEIVER
300-TM-07 ZINC THICKENER TANK (60'ϕ x 12') 300-TK-07
300-DV-21
300-FL-04 ZN FILTER
300-FL-01 ZN FILTER
300-CV-20
300-CV-17
PB FILTER 300-FL-01
300-CV-18
AIR RECEIVER
300-TM-05 LEAD THICKENER TANK (70'ϕ x 12') 300-TK-05
15'-0"
T.O. CHK'D @ EL. 130'-0"
REAGENT FEED STORAGE AREA
SCREW FEEDER 300-FE-18
DRUM FEED
FEATHER DRUM PUMPS 300-PP-46 & 47
PROMOTER DRUM PUMPS 300-PP-48 & 49
REAGENT FEED STORAGE AREA
T.O.C. FL. EL. 120'-6"
MILL OFFICES AND METALLURGICAL LAB. AREA
FLOOR EL. 131'-0 7/8"
OPENING
ZN SECOND CLEANERS 300-FT-21
ZN THIRD CLEANERS 300-FT-23
ZN FIRST CLEANERS 300-FT-19
T.O. CHK'D @ EL. 130'-1"
T.O. CHK'D @ EL. 131'-0 7/8"
ZN SCAVENGERS 300-FT-17
ZN ROUGHERS 300-FT-16
T.O. CHK'D @ EL. 129'-9 1/2"
LEAD SCAVENGERS 300-FT-05
LEAD ROUGHERS 300-FT-03
LEAD FIRST CLEANERS 300-FT-07
T.O. CHK'D @ EL. 130'-1"
LEAD FIRST CLEANER 300-FT-16
LEAD SECOND ROUGHERS 300-FT-15
LEAD THIRD CLEANERS 300-FT-09
LEAD SECOND CLEANERS 300-FT-11
T.O. CHK'D @ EL. 129'-5 1/4"
ZN CONDITIONERS 14'-0"
LEAD CONDITIONERS 14'-0"
CONTROL ROOM T.O.C. FL. EL. 131'-0 7/8"
ELECTRICAL ROOM T.O.C. FL. EL. 116'-0"
OPENING
OPEN
T.O. GRAT. EL. 116'-0"
PRIMARY MILL 300-ML-01
BALL FEED 300-DS-03
BALL STORAGE AREA
T.O.C. & CHK'D @ EL. 164'-0"
PRIMARY MILL BELT FEEDER 300-FE-11
MILL BELT CONV. 300-CV-10
T.O. CHK'D @ EL. 130'-0"
T.O. GRAT. EL. 147'-0"
300-CS-01
ORE BIN 300-BN-01
PEBBLE MILL BELT FEEDER 300-FE-12
PEBBLE BIN 300-BN-02
PEBBLE MILL 300-ML-02
PEBBLE MILL 300-ML-03
300-DS-07
300-DS-08
PEBBLE MILL FEED BELT CONV. 300-CV-16
REGRIND MILL 300-M-04
COARSE LEAD ROUGHERS 300-FT-01
FINISH LEAD CLEANER 300-FT-02
T.O. CHK'D @ EL. 164'-10 1/4"
T.O. CHK'D @ EL. 154'-10 3/4"
LAYDOWN AREA
WAREHOUSE AREA
LOW BAY SHOP AREA
HIGH BAY SHOP AREA
B M-115
A M-115

PLAN
MAIN OPERATING FLOORS
EL. 116'-0" & 131'-0 7/8"

MILL 300-ML-03
10'-0"
T.O. GRAT. EL. 147'-0"
SEC. CYCLONES 300-CS-02
7'-6"
13'-0"
MILL 300-ML-02
EL. 138'-6"
REGRIND CYCLONES 300-CS-03
11'-0"
8'-0"

PLAN – EL. 147'-0" 138'-6"

18'-0" BIN
T.O. CHK'D @ EL. 166'-0"
ORE (SURGE) BIN 300-BN-01
PEBBLE BELT CONV. 300-CV-09
15'-6"
300-DS-03
PEBBLE BIN 300-BN-02
10'-0" BIN

PLAN – EL. 166'-0"

PEBBLE DOUBLE DECK SCREEN 300-SC-01
300-DS-01 & 02
SCREEN ROLL-OUT POSITION
T.O. CHK'D @ EL. 176'-0"
T.O. GRAT. EL. 152'-0"
C.O. TRENCH BOTTOM 300-CV-09
CONV. WALKWAY
PEBBLE BIN 300-BN-02

PLAN – EL. 176'-0"

| Rev | Date | Description | By | Chk'd | Eng'r | Appr'd |
|---|---|---|---|---|---|---|
| A | 79 SEP | ISSUED FOR REPORT | ML | | | |

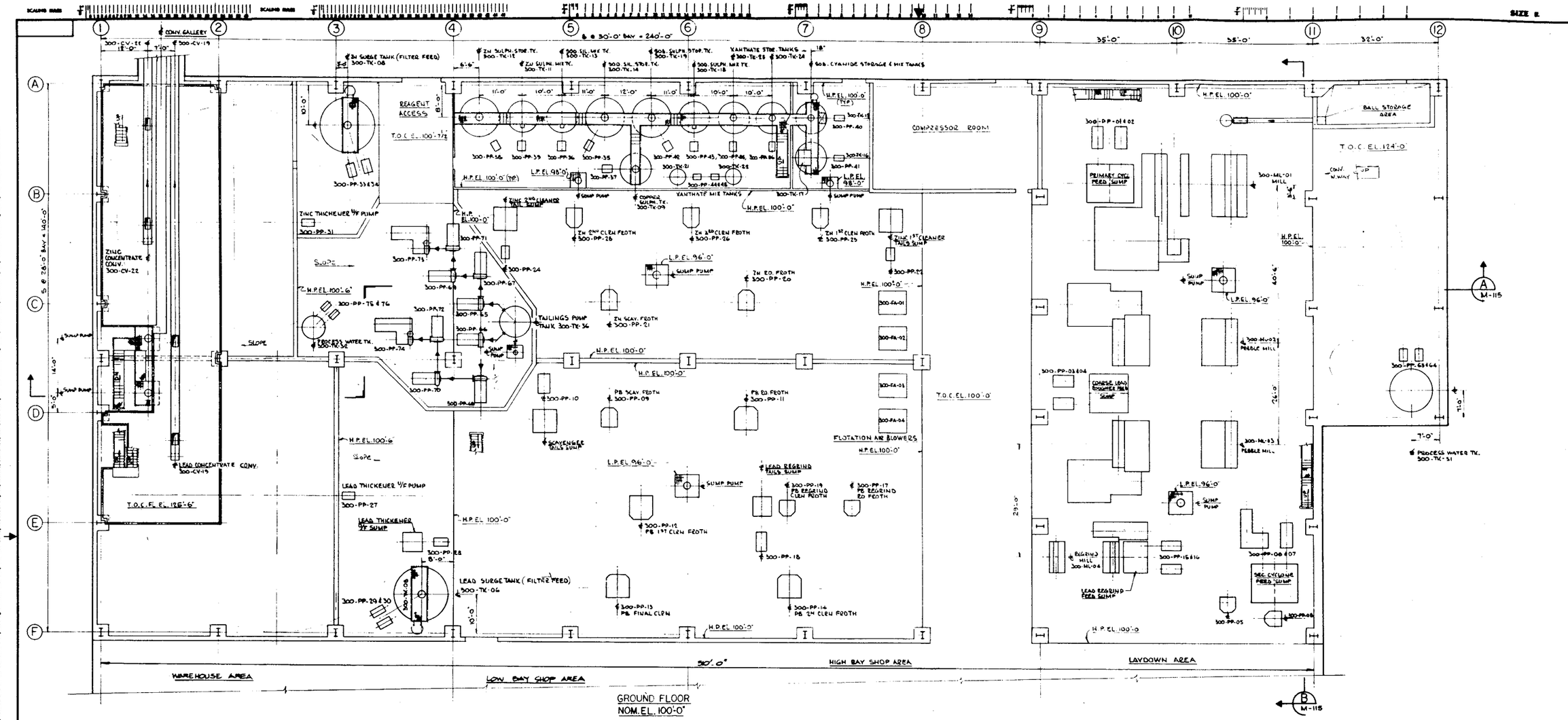
SCALE 1/8" = 1'-0" — DESIGNED ML — DRAWN — CHK'D — ENG'R — APP'D

BECHTEL CANADA ENGINEERS LIMITED
TORONTO, ONTARIO

HUDSON BAY MINING AND SMELTING CO., LIMITED AND ABERFORD RESOURCES LTD.
CAPITAL COST STUDY — TDH/HBMS PROJECT

# CONCENTRATOR GENERAL ARRANGEMENT PLANS & EQUIPMENT FLOORS

| Job No. | Drawing No. | Rev |
|---|---|---|
| 16988 | M-113 | A |




| | | | |
|---|---|---|---|
| A | 1/8" = 1'-0" | ISSUED FOR REPORT | AL |

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TORONTO, ONTARIO

HUDSON BAY MINING AND SMELTING CO., LIMITED
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CAPITAL COST STUDY — TOM/JACOB PROJECT

CONCENTRATOR
GENERAL ARRANGEMENT
PLAN AT GROUND FLOOR

| Job No. | Drawing No. | Rev |
|---|---|---|
| 16988 | M-114 | A |

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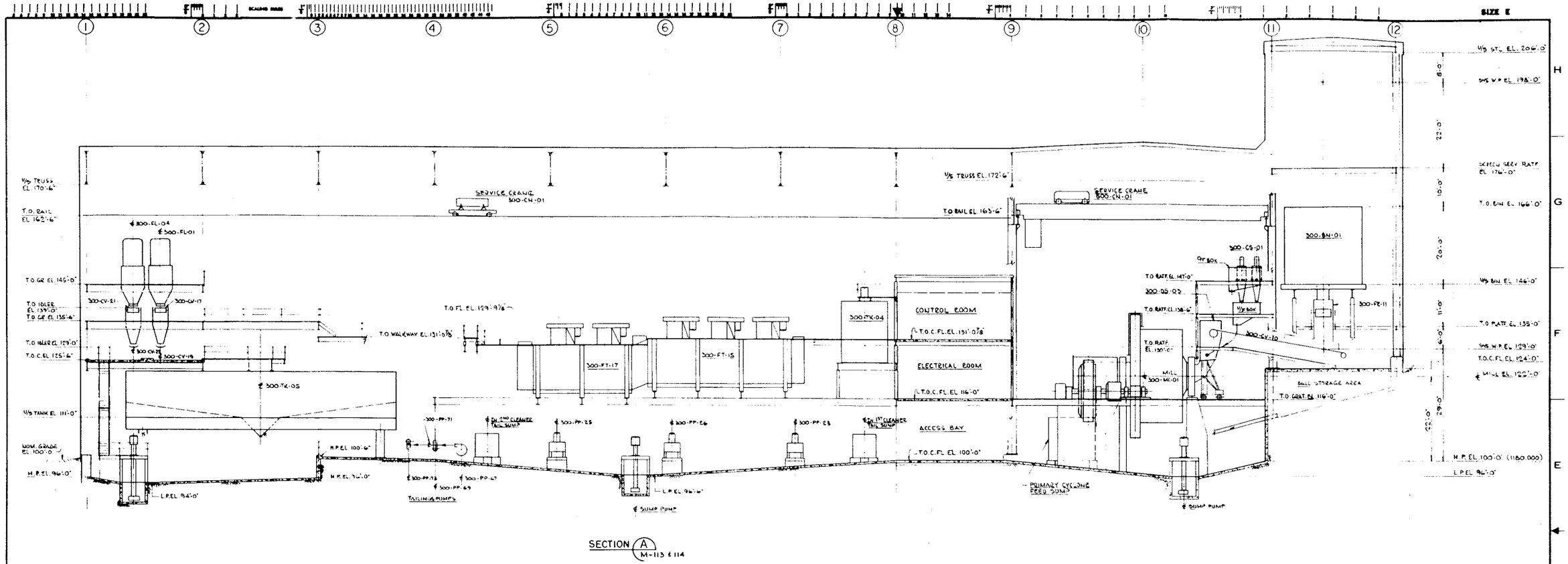

SERVICE CRANE 300-CN-01
U/S TRUSS EL. 172'-6"
T.O. RAIL EL. 163'-6"
300-FL-04
300-FL-01
300-CV-21
300-CV-17
300-CV-19
300-TK-05
300-FT-17
300-FT-15
300-TK-04
CONTROL ROOM
ELECTRICAL ROOM
ACCESS BAY
300-CS-01
300-BN-01
300-FE-11
300-CV-10
300-ML-01
BALL STORAGE AREA
PRIMARY CYCLONE FEED SUMP
SUMP PUMP
TAILINGS PUMPS
SECTION A M-113 & 114
500-CN-01
300-CS-03, 9/F & 4/F BOXES
300-CS-02 9/F & 4/F BOXES
300-CS-01
300-ML-01 & 300-CV-10
BALL FEED BUCKET
MILL 300-ML-03
MILL 300-ML-02
300-FT-02
300-CV-16
300-CV-15
SEC. CYCLONE FEED SUMP
SECTION B M-113 & 114
ISSUED FOR REPORT
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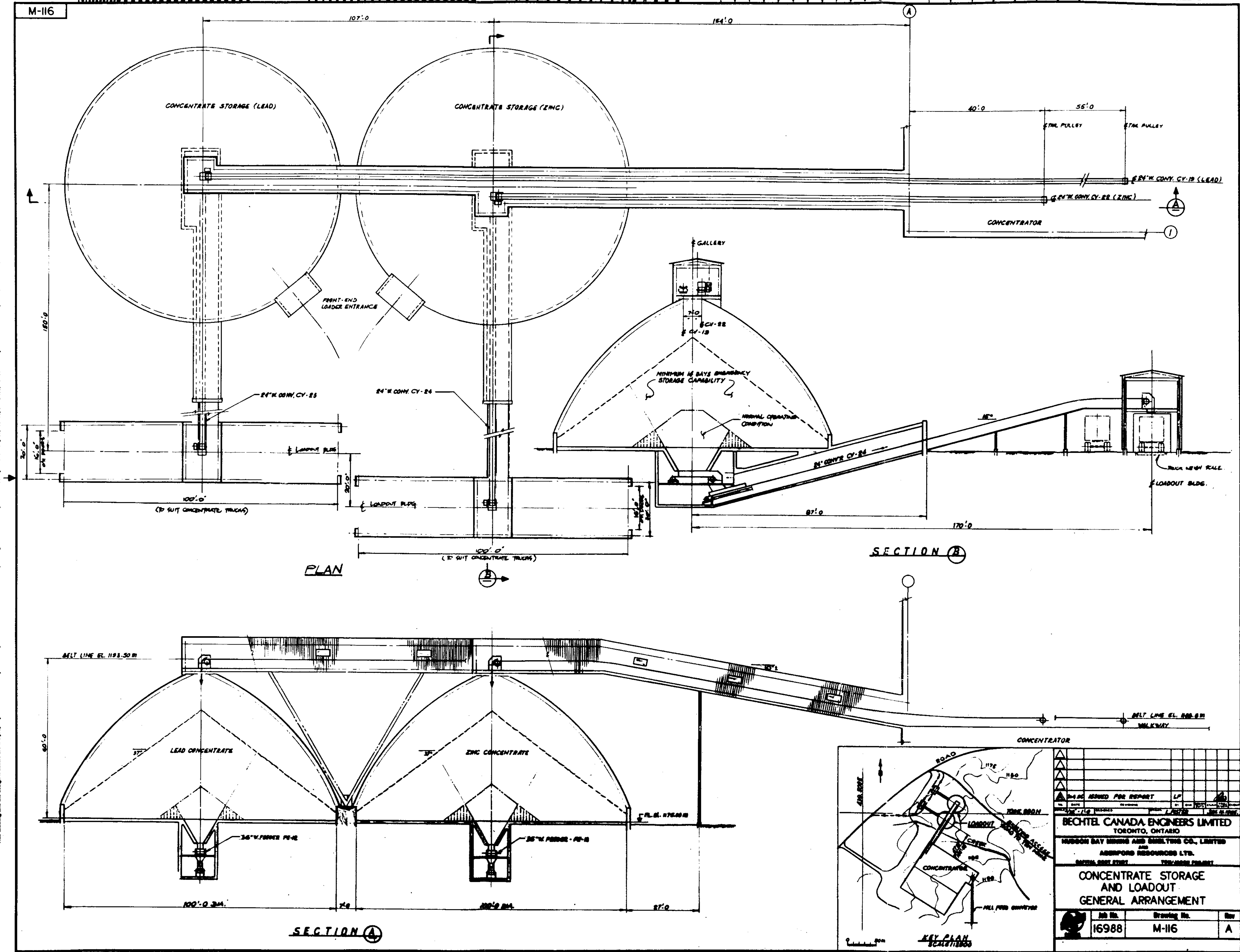
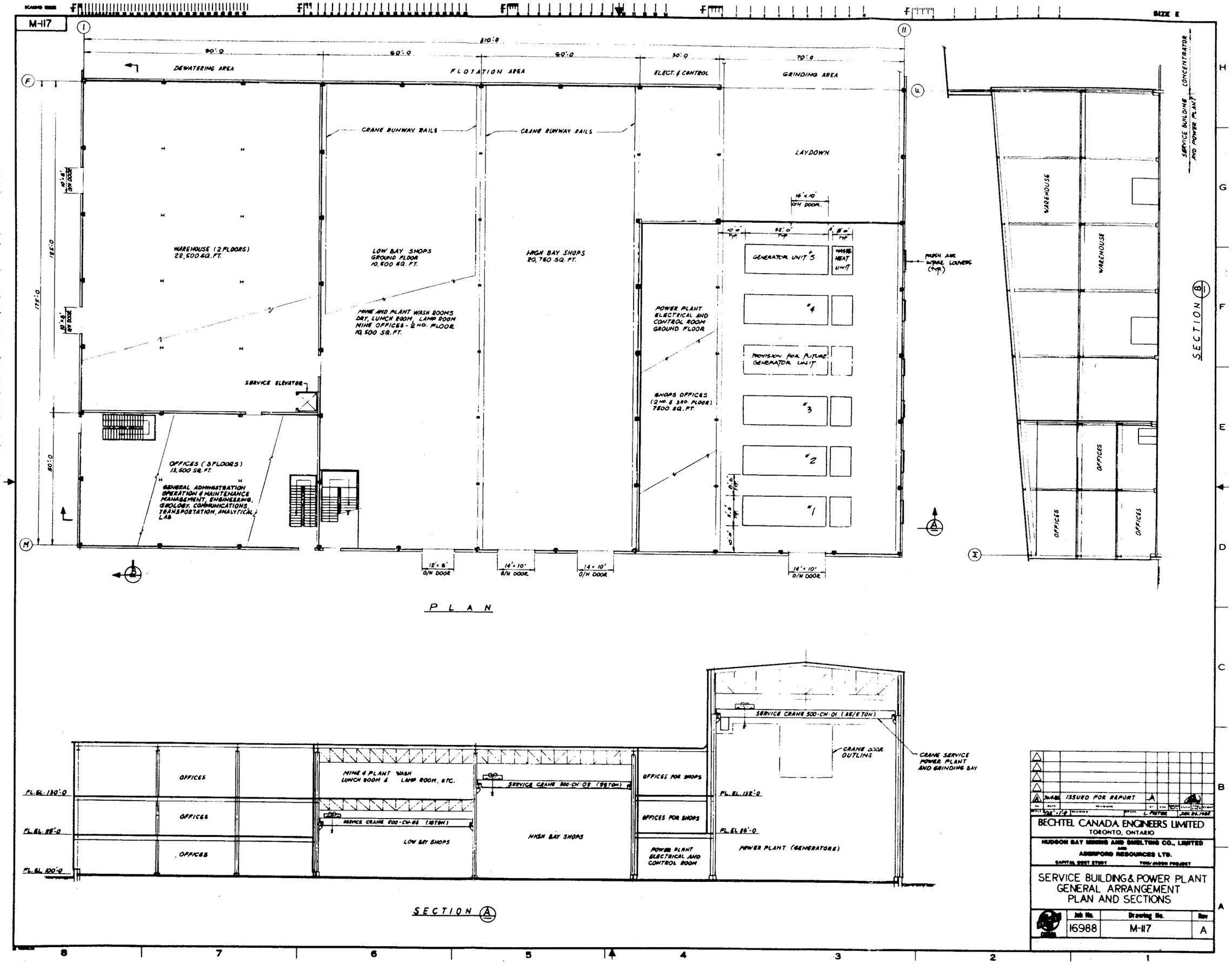
CAPITAL COST STUDY
TOM/JASON PROJECT
CONCENTRATOR
GENERAL ARRANGEMENT
SECTIONS
Job No. 16988
Drawing No. M-115
Rev A


M-116
CONCENTRATE STORAGE (LEAD)
CONCENTRATE STORAGE (ZINC)
FRONT-END LOADER ENTRANCE
24"W. CONV. CY-19 (LEAD)
24"W. CONV. CY-22 (ZINC)
CONCENTRATOR
24"W. CONV. CY-23
24"W. CONV. CY-24
LOADOUT BLDG
100'-0"
(TO SUIT CONCENTRATE TRUCKS)
PLAN
GALLERY
MINIMUM 14 DAYS EMERGENCY STORAGE CAPABILITY
NORMAL OPERATING CONDITION
TRUCK WEIGH SCALE
LOADOUT BLDG.
SECTION B
BELT LINE EL. 1193.50 m
LEAD CONCENTRATE
ZINC CONCENTRATE
WALKWAY
SECTION A
KEY PLAN
ROAD
LOADOUT
CONCENTRATOR
MILL FEED CONVEYOR
ISSUED FOR REPORT
BECHTEL CANADA ENGINEERS LIMITED
TORONTO, ONTARIO
HUDSON BAY MINING AND SMELTING CO., LIMITED
AND
ABERFORD RESOURCES LTD.
CONCENTRATE STORAGE
AND LOADOUT
GENERAL ARRANGEMENT
Job No.
16988
Drawing No.
M-116
Rev
A
SIZE E


M-117
SIZE E
310'-0
90'-0
60'-0
60'-0
30'-0
70'-0
DEWATERING AREA
FLOTATION AREA
ELECT. & CONTROL
GRINDING AREA
CRANE RUNWAY RAILS
CRANE RUNWAY RAILS
LAYDOWN
WAREHOUSE (2 FLOORS) 22,500 SQ. FT.
LOW BAY SHOPS GROUND FLOOR 10,500 SQ. FT.
HIGH BAY SHOPS 20,750 SQ. FT.
MINE AND PLANT WASH ROOMS DRY, LUNCH ROOM, LAMP ROOM MINE OFFICES - 2ND. FLOOR 10,500 SQ. FT.
POWER PLANT ELECTRICAL AND CONTROL ROOM GROUND FLOOR
SHOPS OFFICES (2ND. & 3RD. FLOOR) 7500 SQ. FT.
GENERATOR UNIT #5
WASTE HEAT UNIT
#4
PROVISION FOR FUTURE GENERATOR UNIT
#3
#2
#1
FRESH AIR INTAKE LOUVERS (TYP.)
SERVICE ELEVATOR
OFFICES (3 FLOORS) 13,500 SQ. FT.
GENERAL ADMINISTRATION OPERATION & MAINTENANCE MANAGEMENT, ENGINEERING, GEOLOGY, COMMUNICATIONS, TRANSPORTATION, ANALYTICAL LAB
12' x 8' O/H DOOR
14' x 10' O/H DOOR
14' x 10' O/H DOOR
14' x 10' O/H DOOR
175'-0
125'-0
50'-0
PLAN
WAREHOUSE
WAREHOUSE
OFFICES
OFFICES
OFFICES
SERVICE BUILDING CONCENTRATOR AND POWER PLANT
SECTION B
SERVICE CRANE 500-CN-01 (35/6 TON)
CRANE DOOR OUTLINE
CRANE SERVICE POWER PLANT AND GRINDING BAY
OFFICES
OFFICES
OFFICES
MINE & PLANT WASH LUNCH ROOM & LAMP ROOM, ETC.
SERVICE CRANE 500-CN-02 (25 TON)
SERVICE CRANE 500-CN-03 (10 TON)
LOW BAY SHOPS
HIGH BAY SHOPS
OFFICES FOR SHOPS
OFFICES FOR SHOPS
POWER PLANT ELECTRICAL AND CONTROL ROOM
POWER PLANT (GENERATORS)
FL. EL. 130'-0
FL. EL. 115'-0
FL. EL. 100'-0
FL. EL. 132'-0
FL. EL. 86'-0
SECTION A
ISSUED FOR REPORT
BECHTEL CANADA ENGINEERS LIMITED
TORONTO, ONTARIO
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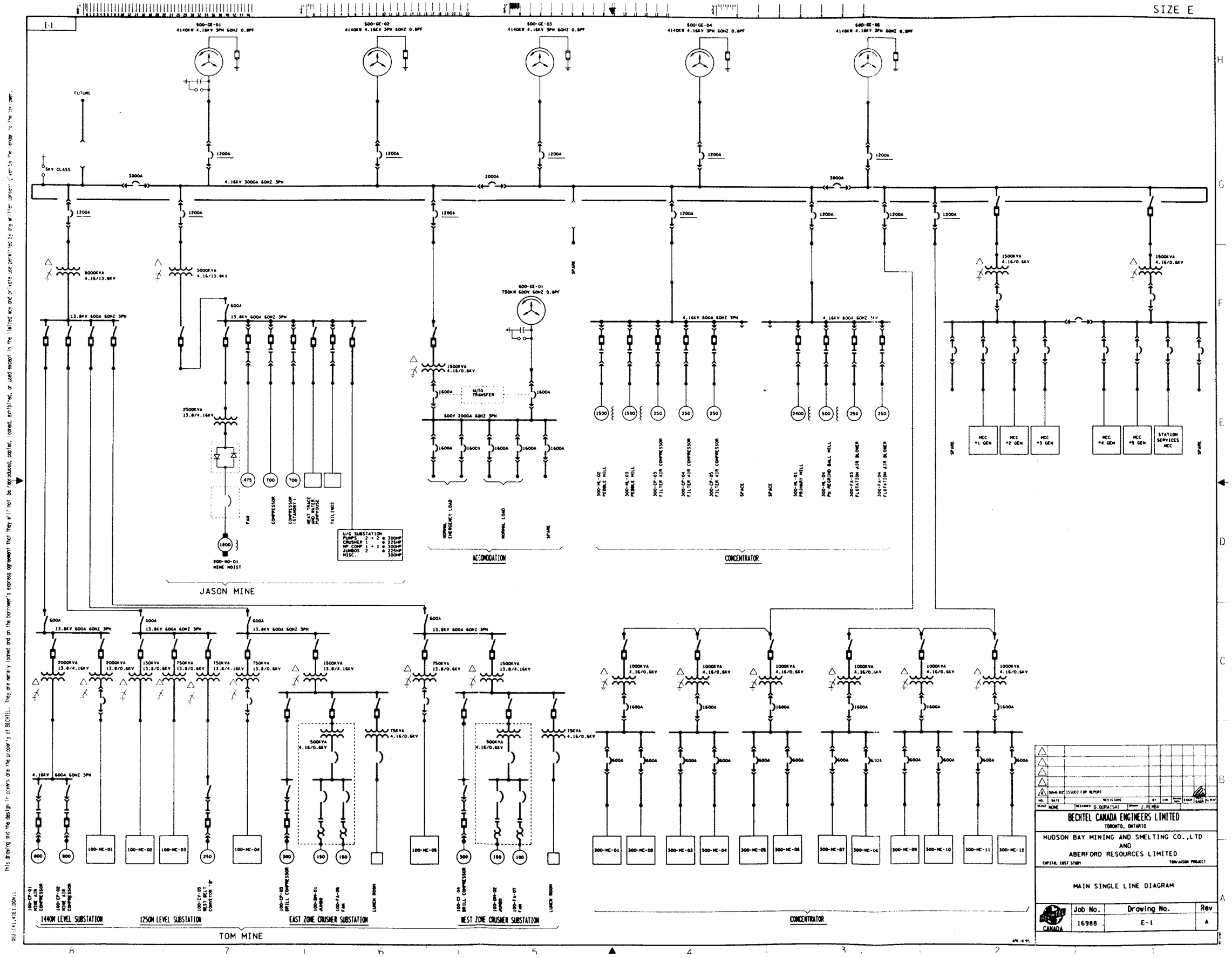
AND
ABERFORD RESOURCES LTD.
CAPITAL COST STUDY
TOM/JASON PROJECT
SERVICE BUILDING & POWER PLANT
GENERAL ARRANGEMENT
PLAN AND SECTIONS
Job No. 16988
Drawing No. M-117
Rev A

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HUDSON BAY MINING AND SMELTING
CO., LIMITED

AND

ABERFORD RESOURCES LIMITED

# FEASIBILITY STUDY

ON

TOM/JASON PROJECT

YUKON TERRITORY

091796

December, 1985

TOM/JASON PROJECT

## SECTION 4 - OPERATING COST STUDY

TABLE OF CONTENTS


4.1 OPERATING COST SUMMARY

4.2 POWER COSTS (FUEL ONLY)

4.3 MINING COSTS (INCLUDING PREPRODUCTION COSTS)

4.4 MILLING COSTS

4.5 ENGINEERING/TECHNICAL COSTS

4.6 SERVICE AND MAINTENANCE COSTS

4.7 ADMINISTRATION COSTS (MINE SITE)

4.8 ACCOMMODATION COSTS

4.9 TRANSPORTATION OF CONCENTRATES

4.10 ADMINISTRATION COSTS (WHITEHORSE)

## 4.1 OPERATING COST SUMMARY

### 4.1.1 BASIS OF ESTIMATE

Table 4.1-1 Preproduction and Operating costs

Table 4.1-2 Operating Cost Per Ton

Table 4.1-3 Summary of Operating Cost Estimate By Area

## 4.1 OPERATING COST SUMMARY

### 4.1.1 BASIS OF ESTIMATE

The estimate of operating costs covers the labour, power, fuel, materials and services required to mine and process ore from the Tom and Jason mines, transport the concentrates to market and dispose of tailings.

This estimate has been prepared using the following procedures:

- Visiting the site to evaluate local conditions.
- Obtaining local costs for materials, supplies and fuel by soliciting quotations from suppliers.
- Obtaining labour rates at Flin Flon.
- Estimating salary rates and local bonus.
- Obtaining unit costs at Flin Flon and adjusting for the Yukon Territory (mining costs only).

Mining costs estimated in this section include both direct operating costs and ongoing mine development costs. The latter contains some capital items including major development, minor development, mine equipment, exploration and a portion of the general mining expenses (GME). Mine development costs have been included in this section as they occur throughout the life of the operation (years 1-15) and because some ore comes from mine development.

Although preproduction capital costs are shown in Table 4.1.1, care has been taken to avoid duplication of any of these costs in the operating cost estimates in this section. Major capital cost items such as the crushing facilities, belt conveyors, hoists, air fans and heaters are described in Section 3, Capital Costs.

Operating costs for all other areas are based upon estimates of labour rates, hours, materials' costs and quantities consumed, plus allowances for specified items - e.g., safety, lubrication, miscellaneous, etc.

Power costs for surface operations are based upon the cost of fuel to generate power and the cost of converting that fuel to power. Power costs for mining operations are included in the unit costs used.

The cost of transportation of concentrates from the site to market is included in this section. For the purpose of the study, the destination for the concentrates was considered to be a port-based smelter in Japan.

Estimates of overhead costs for mine site administration, accomodation and Whitehorse office costs are included in this section.

PREPRODUCTION AND OPERATING COSTS (Total Dollars)

1985 $ x 1000

| YEAR | PREPRODUCTION CAPITAL COST | | | OPERATING COSTS | | | | | | | | | TOTAL PREPRODUCTION & OPERATING |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MINE | SURFACE | HAINES TERMINAL | MINE | MILL & SURFACE | ENG/TECH | MTCE | ADMIN (onsite) | ACCOM | TRANSPORT | ADMIN (Whitehorse) & HEAD OFFICE | TOTAL OPERATING | |
| 0 | | 6,000 | - | - | - | - | - | - | - | - | - | - | 6,000 |
| 1 | 34,085 | 90,000 | 3,000 | - | - | - | - | - | 126 | - | - | 126 | 127,211 |
| 2 | 38,833 | 86,600 | 6,000 | 2,491 | 7,779 | 193 | 2,487 | 2,006 | 1,082 | 17,779 | 1,312 | 35,129 | 166,562 |
| 3 | 16,911 | 1,400 | 1,000 | 24,619 | 18,137 | 385 | 4,758 | 3,772 | 2,095 | 32,385 | 1,640 | 87,791 | 107,102 |
| 4 | 17,188 | - | - | 23,642 | 18,137 | 385 | 4,758 | 3,772 | 2,320 | 34,713 | 1,632 | 89,359 | 106,547 |
| 5 | - | 800 | - | 35,111 | 18,137 | 385 | 4,758 | 3,772 | 2,117 | 32,481 | 1,745 | 98,506 | 99,306 |
| 6 | - | - | - | 35,095 | 18,137 | 385 | 4,758 | 3,772 | 2,161 | 32,990 | 1,745 | 99,043 | 99,043 |
| 7 | 2,039 | - | - | 32,778 | 18,137 | 385 | 4,758 | 3,772 | 2,112 | 28,646 | 1,721 | 92,309 | 94,349 |
| 8 | 14,488 | - | - | 31,228 | 18,137 | 385 | 4,758 | 3,772 | 2,390 | 20,376 | 1,709 | 82,755 | 97,243 |
| 9 | 13,354 | - | - | 30,210 | 18,137 | 385 | 4,758 | 3,772 | 2,383 | 21,697 | 1,698 | 83,040 | 96,394 |
| 10 | 3,515 | - | - | 35,007 | 18,137 | 385 | 4,758 | 3,772 | 1,920 | 30,187 | 1,742 | 95,908 | 99,423 |
| 11 | - | - | - | 41,012 | 18,137 | 385 | 4,758 | 3,772 | 1,968 | 26,550 | 1,802 | 98,384 | 98,384 |
| 12 | - | - | - | 41,179 | 18,137 | 385 | 4,758 | 3,772 | 1,944 | 23,145 | 1,804 | 95,124 | 95,124 |
| 13 | - | - | - | 43,563 | 18,137 | 385 | 4,758 | 3,772 | 2,017 | 17,573 | 1,828 | 92,033 | 92,033 |
| 14 | - | - | - | 41,835 | 18,137 | 385 | 4,758 | 3,772 | 1,868 | 23,746 | 1,809 | 96,310 | 96,310 |
| 15 | - | - | - | 17,407 | 8,044 | 178 | 1,618 | 2,046 | 1,549 | 9,223 | 844 | 40,909 | 40,909 |

Table 4.1-1

OPERATING COST PER TON

| YEAR | PRODUCTION (000's tons) | TOTAL DOLLAR COST ($000's) MINE | MILL | TRANSPORT | OTHER | TOTAL | UNIT OPERATING COST ($/Ton) MINE | MILL | TRANSPORT | OTHER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | - | - | - | - | - | - | - | - | - | - | - |
| 1 | - | - | - | - | - | - | - | - | - | - | - |
| 2 | 656 | 2,491 | 7,779 | 17,779 | 7,080 | 35,129 | 3.80 | 11.86 | 27.10 | 10.79 | 53.55 |
| 3 | 1,575 | 24,619 | 18,137 | 32,395 | 12,650 | 87,791 | 15.63 | 11.52 | 20.56 | 8.03 | 55.74 |
| 4 | 1,575 | 23,642 | 18,137 | 34,713 | 12,867 | 89,359 | 15.01 | 11.52 | 22.04 | 8.17 | 56.74 |
| 5 | 1,575 | 35,111 | 18,137 | 32,481 | 12,777 | 98,506 | 22.29 | 11.52 | 20.62 | 8.11 | 62.54 |
| 6 | 1,575 | 35,095 | 18,137 | 32,990 | 12,821 | 99,043 | 22.28 | 11.52 | 20.95 | 8.14 | 62.89 |
| 7 | 1,575 | 32,778 | 18,137 | 28,646 | 12,748 | 92,309 | 20.81 | 11.52 | 18.19 | 8.09 | 58.61 |
| 8 | 1,575 | 31,228 | 18,137 | 20,376 | 13,014 | 82,755 | 19.83 | 11.52 | 12.94 | 8.26 | 52.55 |
| 9 | 1,574.05 | 30,210 | 18,137 | 21,697 | 12,996 | 83,040 | 19.19 | 11.52 | 13.78 | 8.26 | 52.76 |
| 10 | 1,553.5 | 35,007 | 18,137 | 30,187 | 12,577 | 95,908 | 22.53 | 11.67 | 19.43 | 8.10 | 61.74 |
| 11 | 1,573 | 41,012 | 18,137 | 26,550 | 12,685 | 98,384 | 26.07 | 11.53 | 16.88 | 8.06 | 62.55 |
| 12 | 1,573 | 41,179 | 18,137 | 23,145 | 12,663 | 95,124 | 26.18 | 11.53 | 14.71 | 8.05 | 60.47 |
| 13 | 1,575 | 43,563 | 18,137 | 17,573 | 12,760 | 92,033 | 27.66 | 11.52 | 11.16 | 8.10 | 58.43 |
| 14 | 1,575 | 41,835 | 18,137 | 23,746 | 12,592 | 96,310 | 26.56 | 11.52 | 15.08 | 7.99 | 61.15 |
| 15 | 716.35 | 17,407 | 8,044 | 9,223 | 6,235 | 40,909 | 24.30 | 11.23 | 12.87 | 8.70 | 57.11 |

Table 4.1-2

SUMMARY OF OPERATING COST ESTIMATE BY AREA
(Full Production Years 3 - 14)

| | | Av. Annual Cost ($000's) | Unit Cost ($/ton ore) |
|---|---|---|---|
| Mining | - Direct Mining | 25,374 | 16.11 |
| | - Major Development | 2,054 | 1.30 |
| | - Minor Development | 5,435 | 3.45 |
| | - Equipment | 992 | 0.63 |
| | - Exploration | 751 | 0.48 |
| | | 34,606 | 21.97 |
| Milling | - Personnel | 3,098 | 1.97 |
| | - Operating Supplies | 7,344 | 4.66 |
| | - Maintenance Supplies | 1,262 | 0.80 |
| | - Fuel For Power | 6,433 | 4.09 |
| | | 18,137 | 11.52 |
| Engineering/ Environmental | - Personnel | 370 | 0.23 |
| | - Supplies | 15 | 0.01 |
| | | 385 | 0.24 |
| Services/ Maintenance | - Personnel | 2,602 | 1.65 |
| | - Supplies | 1,553 | 0.99 |
| | - Fuel For Power | 603 | 0.38 |
| | | 4,758 | 3.02 |
| Mini Admin | - Personnel | 1,677 | 1.06 |
| | - Supplies | 2,095 | 1.33 |
| | | 3,772 | 2.39 |
| Accomodation | - Avg. Yr 3-14 | 2,106 | 1.34 |
| Whitehorse Admin. | - Personnel | 341 | 0.21 |
| | - Supplies | 750 | 0.48 |
| | | 1,091 | 0.69 |

Freight Costs - $ per wet ton of concentrate

| | |
|---|---|
| - Trucking to Haines, Alaska | $64.12 |
| - Dock Handling and Loading | 7.26 |
| - Ocean Freight (Japan) | 18.37 |
| | $89.75 |

Note: Mining costs vary significantly from year to year. See Table 4.1-2 for annual figures.

Table 4.1-3

## 4.2 POWER COSTS (FUEL ONLY)

## 4.2 POWER COSTS (Fuel Only)

Basis:

Power output at peak load = 18.5 kWh per Imperial gallon diesel

Estimated output at 75% load = 17.9 kWh per Imperial gallon diesel

Estimated output at 50% load = 16.7 kWh per Imperial gallon diesel

then estimated power output = 17.6 to 18.05 kWh/gal

Allow 17.9 kWh/gal

Cost per gallon = 51.7 cents/litre base price
- 5.0 cents/litre producer's discount
- 3.6 cents/litre mining rebate tax
+ 0 Yukon Tax

43.1 cents/litre at Ross River

= $1.959 per gallon at Ross River

Road Transportation = $730 per load of 7,100 gallons

= 0.103/gallon

Cost at Mac Pass = $1.959 + $0.103

= $2.062/gallon

Therefore cost of power = $2.062/17.9

= $0.115 per kWh in fuel only

## 4.3 MINING COSTS

### CONTENTS

4.3.1 BASIS OF ESTIMATE

4.3.2 SUMMARY OF MINING COSTS

Table 4.3-1 Tom and Jason Properties - Total Mine Preproduction and Operating Cost Summary

Table 4.3-2 Summary of Tom Mining Costs

Table 4.3-3 Tom Property - Mine Preproduction Cost Breakdown

Table 4.3-4 Tom Property - Mine Preproduction Cost Breakdown with G.M.E. Allocation

Table 4.3-5 Tom Property - Mine Preproduction and Operating Cost Summary

Table 4.3-6 Summary of Jason Mining Costs

Table 4.3-7 Jason Property - Mine Preproduction Cost Breakdown

Table 4.3-8 Jason Property - Mine Preproduction Cost Breakdown with G.M.E. Allocation

Table 4.3-9 Jason Property - Mine Preproduction and Operating Cost Summary

Table 4.3-10 Derivation of Unit Mining Costs

Table 4.3-11 Tom - Direct Mining costs

Table 4.3-12 Jason South Zone - Direct Mining Costs

Table 4.3-13 Jason Main Zone - Direct Mining Costs

Table 4.3-14 Total Direct Mining Costs

Table 4.3-15 Total General Mine Expense

Table 4.3-16 Tom - General Mine Expense

Table 4.3-17 Jason South Zone - General Mine Expense

Table 4.3-18 Jason Main Zone - General Mine Expense

Table 4.3-19 Tom Mine Equipment

Table 4.3-20 Jason South Zone UIpper Lens Mine Equipment

Table 4.3-21 Jason South Zone Middle Lens Mine Equipment

Table 4.3-22 Jason Main Zone Mine Equipment

Table 4.3-23 Summary of Development Costs

### 4.3.1 BASIS OF ESTIMATE

Individual costs have been developed for mining the Tom, Jason South and Jason Main ore zones. These costs have been summed to provide total mining costs.

As described in Section 4.1.1, mining operating costs include both direct operating costs and ongoing development costs. Direct operating costs include product mining and a portion of the general mining expenses (G.M.E.). Development costs include major development, minor development, equipment and exploration. Equipment costs are based on historical experience at Flin Flon. Allowances have been estimated and included for exploration activities.

Mining costs are based upon stoping costs at Flin Flon, using the same mining methods, plus factors to allow for increased costs in the Yukon Territory. These factors have been estimated and take into account increased labour rates and additional transportation of materials, etc.

General mining expenses have been estimated based on experience at Flin Flon. A portion has been allocated to direct operating costs and a portion to development costs in accordance with the value of stoping (mining) costs versus the costs of major development, minor development, equipment and exploration.

Major and minor development costs are based upon unit rates for developing drifts and raises, and for slashing waste and ore. Unit costs and quantities are provided year by

year for each ore zone in the report "Tom-Jason Project, Mining Section of Study - May 1985", page 23 and pages 35-40.

Contractors will be used for initial development work, both at Tom and Jason. Crews will be hired to perform all production work and as these move in, the contractors will be terminated and all subsequent development work will be by hired crews.

Cost of accommodating and transporting the contractors' crews to and from the site will be the responsibility of the contractors and have not been detailed, but these are reflected in the higher unit costs of development by contractors' crews versus development by hired crews. Cost of accommodating and transporting hired crews are included in sections 4.8 and 4.7.2, respectively.

### 4.3.2 SUMMARY OF MINING COSTS

Total preproduction and operating costs for mining the Tom and Jason Properties are summarized in Table 4.3-1. Similar summaries for each of Tom and Jason infividually appear in Table 4.3-5 and Table 4.3-9 respectively. Although the preproduction costs are described and allowed for in Section 3 - Capital Costs, they are shown here as a portion of general mine expense (GME) is allocated to them.

Other tables in this section show the derivation of costs for direct mining, general mine expense, ongoing development, equipment and exploration and the allocation of these costs to the various ore zones.

TOM AND JASON PROPERTIES
TOTAL MINE PREPRODUCTION AND OPERATING COST SUMMARY

1985 $ x 1000

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Preproduction Capital Cost | 34,085 | 38,833 | 16,911 | 17,188 | - | - | 2,039 | 14,488 | 13,354 | 3,515 | - | - | - | - | - | 140,413 |
| Operating Costs | | | | | | | | | | | | | | | | |
| Mining | - | 2,491 | 17,173 | 19,578 | 24,660 | 22,390 | 22,144 | 19,758 | 22,700 | 26,262 | 29,919 | 31,961 | 33,173 | 34,765 | 15,439 | 322,413 |
| Major Dev. (ongoing) | - | - | 5,114 | 721 | 1,537 | 2,298 | 1,958 | 2,361 | 372 | 2,630 | 2,619 | 1,126 | 2,280 | 1,558 | 259 | 24,905 |
| Minor Dev. (ongoing) | - | - | 2,153 | 2,971 | 5,234 | 7,489 | 6,493 | 7,649 | 4,330 | 4,809 | 6,660 | 5,160 | 6,770 | 5,512 | 1,709 | 66,939 |
| Equipment (ongoing) | - | - | - | 212 | 934 | - | - | 1,280 | 2,602 | 1,128 | 1,565 | 2,932 | 1,340 | - | - | 11,902 |
| Exploration | - | - | 179 | 251 | 2,746 | 2,918 | 2,183 | 180 | 206 | 178 | 177 | - | - | - | - | 9,018 |
| Total Operating Costs | - | 2,491 | 24,619 | 23,642 | 35,111 | 35,095 | 32,778 | 31,228 | 30,210 | 35,007 | 41,012 | 41,179 | 43,563 | 41,835 | 17,407 | 435,177 |
| Ore Tonnage (000 tons) | | 656 | 1,575 | 1,575 | 1,575 | 1,575 | 1,575 | 1,575 | 1,574 | 1,553 | 1,573 | 1,573 | 1,575 | 1,575 | 716 | |
| Total Operating Cost ($/ton ore) | | 3.80 | 15.63 | 15.01 | 22.29 | 22.28 | 20.81 | 19.83 | 19.19 | 22.53 | 26.07 | 26.18 | 27.66 | 26.56 | 24.30 | |

Table 4.3-1

## SUMMARY OF TOM MINING COSTS

1985 $ x 1000

| | YEAR 1 | YEAR 2 | YEAR 3 | YEAR 4 | YEAR 5 | YEAR 6 | YEAR 7 | YEAR 8 | YEAR 9 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| Major Dev. | 17 190 | 6 697 | 2 853 | 286 | 54 | 643 | 787 | 422 | 65 | 28 997 |
| Minor Dev. | 975 | 6 698 | 1 201 | 1 179 | 1 148 | 1 794 | 2 610 | 1 983 | 687 | 18 275 |
| Equipment | 9 444 | 8 457 | 2 792 | 48 | 345 | | | | | 21 086 |
| Exploration | 300 | 300 | 100 | 100 | 100 | 100 | | | | 1 000 |
| GME | 4 514 | 8 616 | 5 505 | 2 451 | 2 811 | 3 841 | 5 054 | 3 981 | 1 190 | 37 963 |
| Subtotal | 32 423 | 30 768 | 12 451 | 4 064 | 4 458 | 6 378 | 8 451 | 6 386 | 1 942 | 107 321 |
| Mining | | 1 762 | 8 482 | 7 160 | 6 300 | 6 205 | 5 379 | 5 252 | 5 720 | 46 260 |
| GME | | 729 | 8 691 | 11 139 | 10 774 | 9 379 | 7 996 | 8 689 | 9 050 | 66 447 |
| Subtotal | | 2 491 | 17 173 | 18 299 | 17 074 | 15 584 | 13 375 | 13 941 | 14 770 | 112 707 |
| Total Cost | 32 423 | 33 259 | 29 624 | 22 363 | 21 532 | 21 962 | 21 826 | 20 327 | 16 712 | 220 028 |
| Total GME | 4 514 | 9 345 | 14 196 | 13 590 | 13 545 | 13 220 | 13 050 | 12 670 | 10 240 | 104 370 |

* Reference Page 25 - Tom/Jason Project - Mining Section of Study (May 1985)

Table 4.3-2

TOM PROPERTY - MINE
PREPRODUCTION COST BREAKDOWN

1985 $ x 1000

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| Major Dev. - Preproduction | 17,190 | 6,697 | - | - | - | - | - | - | - | 23,887 |
| - Ongoing | - | - | 2,853 | 286 | 54 | 643 | 787 | 422 | 65 | 5,110 |
| Minor Dev. - Preproduction | 975 | 6,698 | - | - | - | - | - | - | - | 7,673 |
| - Ongoing | - | - | 1,201 | 1,179 | 1,148 | 1,794 | 2,610 | 1,983 | 687 | 10,602 |
| Equipment - Preproduction | 9,444 | 8,457 | 2,792 | - | - | - | - | - | - | 20,693 |
| - Ongoing | - | - | - | 48 | 345 | - | - | - | - | 393 |
| Exploration - Preproduction | 300 | 300 | - | - | - | - | - | - | - | 600 |
| - Ongoing | - | - | 100 | 100 | 100 | 100 | - | - | - | 400 |
| GME | 4,514 | 8,616 | 5,505 | 2,451 | 2,811 | 3,841 | 5,054 | 3,981 | 1,190 | 37,963 |
| Sub Total | 32,423 | 30,768 | 12,451 | 4,064 | 4,458 | 6,378 | 8,451 | 6,386 | 1,942 | 107,321 |
| Mining | - | 2,491 | 17,173 | 18,299 | 17,074 | 15,584 | 13,375 | 13,941 | 14,770 | 112,707 |
| Total Cost | 32,423 | 33,259 | 29,624 | 22,363 | 21,532 | 21,962 | 21,826 | 20,327 | 16,712 | 220,028 |

Table 4.3-3

TOM PROPERTY - MINE
PREPRODUCTION COST BREAKDOWN WITH GME ALLOCATION

1985 $ x 1000

| | | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Major Dev. | - Preproduction | 19,970 | 9,302 | - | - | - | - | - | - | - | 29,272 |
| | - Ongoing | - | - | 5,114 | 721 | 146 | 1,617 | 1,958 | 1,121 | 168 | 10,845 |
| Minor Dev. | - Preproduction | 1,133 | 9,303 | - | - | - | - | - | - | - | 10,436 |
| | - Ongoing | - | - | 2,153 | 2,971 | 3,107 | 4,510 | 6,493 | 5,265 | 1,774 | 26,273 |
| Equipment | - Preproduction | 10,971 | 11,746 | 5,005 | - | - | - | - | - | - | 27,722 |
| | - Ongoing | - | - | - | 121 | 934 | - | - | - | - | 1,055 |
| Exploration | - Preproduction | 349 | 417 | - | - | - | - | - | - | - | 766 |
| | - Ongoing | - | - | 179 | 251 | 271 | 251 | - | - | - | 952 |
| Sub Total | | 32,423 | 30,768 | 12,451 | 4,064 | 4,458 | 6,378 | 8,451 | 6,386 | 1,942 | 107,321 |
| Mining | | - | 2,491 | 17,173 | 18,299 | 17,074 | 15,584 | 13,375 | 13,941 | 14,770 | 112,707 |
| Total Cost | | 32,423 | 33,259 | 29,624 | 22,363 | 21,532 | 21,962 | 21,826 | 20,327 | 16,712 | 220,028 |

Table 4.3-4

TOM PROPERTY - MINE
PREPRODUCTION AND OPERATING COST SUMMARY

1985 $ x 1000

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| Preproduction Capital Cost | 32,423 | 30,768 | 5,005 | - | - | - | - | - | - | 68,196 |
| Operating Costs | | | | | | | | | | |
| Mining | - | 2,491 | 17,173 | 18,299 | 17,074 | 15,584 | 13,375 | 13,941 | 14,770 | 112,707 |
| Major Dev. (ongoing) | - | - | 5,114 | 721 | 146 | 1,617 | 1,958 | 1,121 | 168 | 10,845 |
| Minor Dev. (ongoing) | - | - | 2,153 | 2,971 | 3,107 | 4,510 | 6,493 | 5,265 | 1,774 | 26,273 |
| Equipment (ongoing) | - | - | - | 121 | 934 | - | - | - | - | 1,055 |
| Exploration | - | - | 179 | 251 | 271 | 251 | - | - | - | 952 |
| Total Operating Costs | - | 2,491 | 24,619 | 22,363 | 21,532 | 21,962 | 21,826 | 20,327 | 16,712 | 151,832 |
| Ore Tonnage (000 tons) | | 656 | 1,575 | 1,244 | 1,050 | 1,050 | 1,050 | 1,050 | 966 | |
| Total Operating Cost ($/ton ore) | | 3.80 | 15.63 | 17.98 | 20.51 | 20.92 | 20.79 | 19.36 | 17.30 | |

Table 4.3-5

## SUMMARY OF JASON MINING COSTS

1985 $ x 1000

| | YEAR 1 | YEAR 2 | YEAR 3 | YEAR 4 | YEAR 5 | YEAR 6 | YEAR 7 | YEAR 8 | YEAR 9 | YEAR 10 | YEAR 11 | YEAR 12 | YEAR 13 | YEAR 14 | YEAR 15 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Major Dev. | 375 | 6 516 | 5 587 | 4 204 | 618 | 281 | - | 2 108 | 1 229 | 1 480 | 1 522 | 616 | 1 330 | 881 | 141 | 26 888 |
| Minor Dev. | - | - | - | 5 287 | 945 | 1 229 | - | 2 477 | 2 936 | 2 706 | 3 766 | 2 822 | 3 949 | 3 116 | 930 | 30 163 |
| Equipment | 712 | 259 | 3 019 | 3 025 | - | - | 877 | 6 203 | 4 922 | 2 613 | 885 | 1 603 | 782 | - | - | 24 900 |
| Exploration | - | - | 570 | 386 | 1 100 | 1 100 | 939 | 100 | 100 | 100 | 100 | - | - | - | - | 4 495 |
| GME | 575 | 1 290 | 2 730 | 4 286 | 3 330 | 3 717 | 2 406 | 8 684 | 9 735 | 5 361 | 4 820 | 4 177 | 4 329 | 3 073 | 897 | 59 410 |
| Subtotal | 1 662 | 8 065 | 11 906 | 17 188 | 5 993 | 6 327 | 4 222 | 19 572 | 18 922 | 12 260 | 11 093 | 9 218 | 10 390 | 7 070 | 1 968 | 145 856 |
| Mining | - | - | - | 960 | 3 371 | 2 808 | 3 770 | 3 236 | 3 850 | 14 778 | 16 919 | 17 478 | 18 652 | 19 653 | 8 403 | 113 878 |
| GME | - | - | - | 319 | 4 215 | 3 998 | 4 999 | 2 581 | 4 080 | 11 484 | 13 000 | 14 483 | 14 521 | 15 112 | 7 036 | 95 823 |
| Subtotal | - | - | - | 1 279 | 7 586 | 6 806 | 8 769 | 5 817 | 7 930 | 26 262 | 29 919 | 31 961 | 33 173 | 34 765 | 15 439 | 209 706 |
| Total Cost | 1 662 | 8 065 | 11 906 | 18 467 | 13 579 | 13 133 | 12 991 | 25 389 | 26 852 | 38 522 | 41 012 | 41 179 | 43 563 | 41 835 | 17 407 | 355 562 |
| Total GME | 575 | 1 290 | 2 730 | 4 605 | 7 545 | 7 715 | 7 405 | 11 265 | 13 815 | 16 845 | 17 820 | 18 660 | 18 850 | 18 185 | 7 933 | 155 233 |

* Reference Page 31 - Tom/Jason Project - Mining Section of Study (May 1985)

Table 4.3-6

JASON PROPERTY - MINE
PREPRODUCTION COST BREAKDOWN

1985 $ x 1000

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Major Dev. - Preproduction | 375 | 6,516 | 5,587 | 4,204 | - | - | - | 1,418 | 1,130 | - | - | - | - | - | - | 19,230 |
| - Ongoing | - | - | - | - | 618 | 281 | - | 690 | 99 | 1,480 | 1,522 | 616 | 1,330 | 881 | 141 | 7,658 |
| Minor Dev. - Preproduction | - | - | - | 5,287 | - | - | - | 1,151 | 1,695 | - | - | - | - | - | - | 8,133 |
| - Ongoing | - | - | - | - | 945 | 1,229 | - | 1,326 | 1,241 | 2,706 | 3,766 | 2,822 | 3,949 | 3,116 | 930 | 22,030 |
| Equipment - Preproduction | 712 | 259 | 3,019 | 3,025 | - | - | 877 | 5,491 | 3,659 | 1,978 | - | - | - | - | - | 19,020 |
| - Ongoing | - | - | - | - | - | - | - | 712 | 1,263 | 635 | 885 | 1,603 | 782 | - | - | 5,880 |
| Exploration - Preproduction | - | - | 570 | 386 | - | - | - | - | - | - | - | - | - | - | - | 956 |
| - Ongoing | - | - | - | - | 1,100 | 1,100 | 939 | 100 | 100 | 100 | 100 | - | - | - | - | 3,539 |
| GME | 575 | 1,290 | 2,730 | 4,286 | 3,330 | 3,717 | 2,406 | 8,684 | 9,735 | 5,361 | 4,820 | 4,177 | 4,329 | 3,073 | 897 | 59,410 |
| Sub Total | 1,662 | 8,065 | 11,906 | 17,188 | 5,993 | 6,327 | 4,222 | 19,572 | 18,922 | 12,260 | 11,093 | 9,218 | 10,390 | 7,070 | 1,968 | 145,856 |
| Mining | - | - | - | 1,279 | 7,586 | 6,806 | 8,769 | 5,817 | 7,930 | 26,262 | 29,919 | 31,961 | 33,173 | 34,765 | 15,439 | 209,706 |
| Total Cost | 1,662 | 8,065 | 11,906 | 18,467 | 13,579 | 13,133 | 12,991 | 25,389 | 26,852 | 38,522 | 41,012 | 41,179 | 43,563 | 41,835 | 17,407 | 355,562 |

Table 4.3-7

JASON PROPERTY - MINE
PREPRODUCTION COST BREAKDOWN WITH GME ALLOCATION

1985 $ x 1000

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Major Dev. - Preproduction | 573 | 7,757 | 7,249 | 5,601 | - | - | - | 2,549 | 2,327 | - | - | - | - | - | - | 26,056 |
| - Ongoing | - | - | - | - | 1,391 | 681 | - | 1,240 | 204 | 2,630 | 2,691 | 1,126 | 2,280 | 1,558 | 259 | 14,060 |
| Minor Dev. - Preproduction | - | - | - | 7,043 | - | - | - | 2,069 | 3,491 | - | - | - | - | - | - | 12,603 |
| - Ongoing | - | - | - | - | 2,127 | 2,979 | - | 2,384 | 2,556 | 4,809 | 6,660 | 5,160 | 6,770 | 5,512 | 1,709 | 40,666 |
| Equipment - Preproduction | 1,089 | 308 | 3,917 | 4,030 | - | - | 2,039 | 9,870 | 7,536 | 3,515 | - | - | - | - | - | 32,304 |
| - Ongoing | - | - | - | - | - | - | - | 1,280 | 2,602 | 1,128 | 1,565 | 2,932 | 1,340 | - | - | 10,847 |
| Exploration - Preproduction | - | - | 740 | 514 | - | - | - | - | - | - | - | - | - | - | - | 1,254 |
| - Ongoing | - | - | - | - | 2,475 | 2,667 | 2,183 | 180 | 206 | 178 | 177 | - | - | - | - | 8,066 |
| Sub Total | 1,662 | 8,065 | 11,906 | 17,188 | 5,993 | 6,327 | 4,222 | 19,572 | 18,922 | 12,260 | 11,093 | 9,218 | 10,390 | 7,070 | 1,968 | 145,856 |
| Mining | - | - | - | 1,279 | 7,586 | 6,806 | 8,769 | 5,817 | 7,930 | 26,262 | 29,919 | 31,961 | 33,173 | 34,765 | 15,439 | 209,706 |
| Total Cost | 1,662 | 8,065 | 11,906 | 18,467 | 13,579 | 13,133 | 12,991 | 25,389 | 26,852 | 38,522 | 41,012 | 41,179 | 43,563 | 41,835 | 17,407 | 355,562 |

Table 4.3-8

JASON PROPERTY - MINE
PREPRODUCTION AND OPERATING COST SUMMARY

1985 $ x 1000

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Preproduction Capital Cost | 1,662 | 8,065 | 11,906 | 17,188 | - | - | 2,039 | 14,488 | 13,354 | 3,515 | - | - | - | - | - | 72,217 |
| Operating Costs | | | | | | | | | | | | | | | | |
| Mining | - | - | - | 1,279 | 7,586 | 6,806 | 8,769 | 5,817 | 7,930 | 26,262 | 29,919 | 31,961 | 33,173 | 34,765 | 15,439 | 209,706 |
| Major Dev. (ongoing) | - | - | - | - | 1,391 | 681 | - | 1,240 | 204 | 2,630 | 2,619 | 1,126 | 2,280 | 1,558 | 259 | 14,060 |
| Minor Dev. (ongoing) | - | - | - | - | 2,127 | 2,979 | - | 2,384 | 2,556 | 4,809 | 6,660 | 5,160 | 6,770 | 5,512 | 1,709 | 40,666 |
| Equipment (ongoing) | - | - | - | - | - | - | - | 1,280 | 2,602 | 1,128 | 1,565 | 2,932 | 1,340 | - | - | 10,847 |
| Exploration | - | - | - | - | 2,475 | 2,667 | 2,183 | 180 | 206 | 178 | 177 | - | - | - | - | 8,066 |
| Total Operating Costs | - | - | - | 1,279 | 13,579 | 13,133 | 10,952 | 10,901 | 13,498 | 35,007 | 41,012 | 41,179 | 43,563 | 41,835 | 17,407 | 283,345 |
| Ore Tonnage (000 tons) | | | | 331 | 525 | 525 | 525 | 525 | 608 | 1,553 | 1,573 | 1,573 | 1,575 | 1,575 | 716 | |
| Total Operating Cost ($/ton ore) | | | | 3.86 | 15.86 | 25.02 | 20.86 | 20.76 | 22.20 | 22.54 | 26.07 | 26.18 | 27.66 | 26.56 | 24.30 | |

Table 4.3-9

## DERIVATION OF UNIT MINING COSTS

### TOM (VCR)

### Unit Costs ($/ton)

| | Flin Flon | Yukon Factor | Yukon Cost |
|---|---|---|---|
| ITH Drilling | 0.63 | 40% | 0.88 |
| VCR Blasting | 1.31 | " | 1.83 |
| Mucking | 1.80 | " | 2.52 |
| Crushing | 0.24 | " | 0.34 |
| Conveying | 6 x 0.09 | " | 0.76 |
| Total Unit Cost ($/ton) = | | | 6.33 |

### JASON SOUTH (VCR)

| | | | |
|---|---|---|---|
| ITH Drilling | 0.63 | 40% | 0.88 |
| VCR Blasting | 1.31 | " | 1.83 |
| Mucking | 1.80 | " | 2.52 |
| Crushing | 0.24 | " | 0.34 |
| Conveying | 2 x 0.09 | " | 0.25 |
| Surface Haulage | 1.05 | 30% | 1.36 |
| Total Unit Cost ($/ton) = | | | 7.18 |

Table 4.3-10
Sheet 1

## JASON MAIN

### Unit Costs ($/ton)

| | Flin Flon | Yukon Factor | Yukon Cost |
|---|---|---|---|
| Drilling | 1.65 | +30% | 2.15 |
| Blasting | 1.23 | " | 1.60 |
| Ground Support | 0.20 | " | 0.26 |
| Mucking | 3.00 | " | 3.90 |
| Truck to Crusher | 1.54 | " | 2.00 |
| Crushing | 0.30 | " | 0.39 |
| Conveying (to surface) | 0.23 | " | 0.30 |
| Truck to mill | 1.05 | " | 1.36 |
| | | | 11.96 |
| Fill Cost = Quarry + deliver = | | | 4.22 |
| (2.15 = 1.60 = 3.00) / 1.6 = | | | 1.00 |
| | | | 5.22 |
| Total unit cost ($/ton) = | | | 17.18 |

Table 4.3-10
Sheet 2

## TOM - DIRECT MINING COSTS

| Year | Development Ore | | | Stoping | | | Total |
|---|---|---|---|---|---|---|---|
| | Tons (000's) | $/ton | Cost ($000's) | Tons (000's) | $/ton | Cost ($000's) | Cost ($000's) |
| 1 | 38.6* | none | - | | | | |
| 2 | 377.7* | " | - | 278.3 | 6.33 | 1,762 | 1,762 |
| 3 | 235.0 | " | - | 1,340.0 | " | 8,482 | 8,482 |
| 4 | 112.6 | " | - | 1,131.2 | " | 7,160 | 7,160 |
| 5 | 54.7 | " | - | 995.3 | " | 6,300 | 6,300 |
| 6 | 69.8 | " | - | 980.2 | " | 6,205 | 6,205 |
| 7 | 200.2 | " | - | 849.8 | " | 5,379 | 5,379 |
| 8 | 220.3 | " | - | 829.7 | " | 5,252 | 5,252 |
| 9 | 62.3 | " | - | 903.6 | " | 5,720 | 5,720 |
| Total | 1,332.6 | | | 7,308.1 | | | 46,260 |

* 275,700 tons stockpiled at start-up

Table 4.3-11

## JASON SOUTH ZONE - DIRECT MINING COSTS

| Year | Development Ore | | | Stoping | | | Total |
|---|---|---|---|---|---|---|---|
| | Tons (000's) | $/ton (Trucking) | Cost ($000's) | Tons (000's) | $/ton | Cost ($000's) | Cost ($000's) |
| 4 | 243.7 | 1.36 | 331.4 | 87.5 | 7.18 | 628.3 | 959.7 |
| 5 | 68.4 | " | 93.0 | 456.6 | " | 3,278.4 | 3,371.4 |
| 6 | 165.2 | " | 224.7 | 359.8 | " | 2,583.4 | 2,808.1 |
| 7 | | | | 525.0 | " | 3,769.5 | 3,769.5 |
| 8 | 91.6 | " | 124.6 | 433.4 | " | 3,111.8 | 3,236.4 |
| 9 | 88.7 | " | 120.6 | 519.45 | " | 3,729.7 | 3,850.3 |
| 10 | 65.5 | " | 89.1 | 742.5 | " | 5,331.1 | 5,420.2 |
| 11 | 142.7 | " | 194.1 | 665.3 | " | 4,776.9 | 4,971.0 |
| 12 | 72.8 | " | 99.0 | 735.2 | " | 5,278.7 | 5,377.7 |
| 13 | 49.4 | " | 67.2 | 526.0 | " | 3,776.7 | 3,843.9 |
| 14 | 42.1 | " | 57.3 | 532.9 | " | 3,826.2 | 3,883.5 |
| 15 | 3.3 | " | 4.5 | 227.5 | " | 1,633.5 | 1,638.0 |
| Total | 1,033.4 | | 1,405.5 | 5,811.15 | | 41,724.2 | 43,129.7 |

Table 4.3-12

## JASOM MAIN ZONE - DIRECT MINING COSTS

| Year | Development Ore | | | Stoping | | | Total |
|---|---|---|---|---|---|---|---|
| | Tons (000's) | $/ton (Trucking) | Cost ($000's) | Tons (000's) | $/ton | Cost ($000's) | Cost ($000's) |
| 10 | 218.1 | 1.36 | 296.6 | 527.4 | 17.18 | 9,060.7 | 9,357.3 |
| 11 | 75.5 | " | 102.7 | 689.5 | " | 11,845.6 | 11,948.3 |
| 12 | 65.9 | " | 89.6 | 699.1 | " | 12,010.5 | 12,100.1 |
| 13 | 149.9 | " | 203.9 | 850.1 | " | 14,604.7 | 14,808.6 |
| 14 | 89.2 | " | 121.3 | 910.8 | " | 15,647.5 | 15,768.8 |
| 15 | 99.7 | " | 135.6 | 385.9 | " | 6,629.8 | 6,765.4 |
| Total | 698.3 | | 949.7 | 4,062.8 | | 69,798.8 | 70,748.5 |

Table 4.3-13

## TOTAL DIRECT MINING COSTS

| Year | Tom | Jason South | Jason Main | Total |
|---|---|---|---|---|
| 1 | | | | - |
| 2 | 1,762 | - | - | 1,762 |
| 3 | 8,482 | - | - | 8,482 |
| 4 | 7,160 | 960 | - | 18,120 |
| 5 | 6,300 | 3,371 | - | 9,671 |
| 6 | 6,205 | 2,808 | - | 9,013 |
| 7 | 5,379 | 3,770 | - | 9,149 |
| 8 | 5,252 | 3,236 | - | 8,488 |
| 9 | 5,720 | 3,850 | - | 9,570 |
| 10 | - | 5,420 | 9,357 | 14,777 |
| 11 | - | 4,971 | 11,948 | 16,919 |
| 12 | - | 5,377 | 12,100 | 17,477 |
| 13 | - | 3,844 | 14,809 | 18,653 |
| 14 | - | 3,884 | 15,769 | 19,653 |
| 15 | - | 1,638 | 6,765 | 8,403 |
| Total | 46,260 | 43,130 | 70,749 | 160,138 |

Table 4.3-14

## TOTAL GENERAL MINE EXPENSE

(1985 $ x 1000)

| Years | Tom | Jason South | Jason Main | Total |
|---|---|---|---|---|
| 1 | 4,514 | 575 | - | 5,089 |
| 2 | 9,345 | 1,290 | - | 10,635 |
| 3 | 14,196 | 2,730 | - | 16,926 |
| 4 | 13,590 | 4,605 | - | 18,195 |
| 5 | 13,545 | 7,545 | - | 21,090 |
| 6 | 13,220 | 7,715 | - | 20,935 |
| 7 | 13,050 | 7,405 | - | 20,455 |
| 8 | 12,670 | 8,040 | 3,225 | 23,935 |
| 9 | 10,240 | 8,450 | 5,365 | 24,055 |
| 10 | - | 8,535 | 8,310 | 16,845 |
| 11 | - | 8,695 | 9,125 | 17,820 |
| 12 | - | 8,475 | 10,185 | 18,660 |
| 13 | - | 8,060 | 10,790 | 18,850 |
| 14 | - | 7,290 | 10,895 | 18,185 |
| 15 | - | 2,850 | 5,083 | 7,933 |

Table 4.3-15

TOM GENERAL MINING EXPENSE

1985 $ x 1000

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 |
|---|---|---|---|---|---|---|---|---|---|
| Fuel & Lube | 1,000 | 1,800 | 1,625 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 900 |
| Level Maint. | - | 50 | 192 | 150 | 150 | 150 | 150 | 150 | 100 |
| Pumping | 100 | 100 | 180 | 180 | 180 | 180 | 180 | 180 | 180 |
| Ventilation | 1,000 | 1,275 | 1,275 | 1,275 | 1,275 | 1,275 | 1,000 | 1,000 | 800 |
| Small Tools | - | - | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| Handling Supplies | 50 | 50 | 90 | 90 | 90 | 90 | 90 | 90 | 70 |
| Powder Mag. | 24 | 30 | 60 | 60 | 60 | 60 | 60 | 60 | 50 |
| Power | 1,000 | 2,500 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 4,000 |
| Safety | 30 | 50 | 85 | 50 | 50 | 50 | 50 | 50 | 40 |
| Area Costs | 200 | 300 | 444 | 400 | 400 | 400 | 400 | 400 | 300 |
| Miscellaneous | 200 | 300 | 360 | 300 | 300 | 250 | 250 | 200 | 150 |
| Transportation | 60 | 90 | 120 | 120 | 120 | 120 | 120 | 120 | 100 |
| Comp. Air | 100 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 100 |
| Surf. Buildings | 50 | 50 | 200 | 200 | 200 | 200 | 200 | 200 | 150 |
| Major Repairs | - | - | - | 200 | 200 | 200 | 200 | 200 | - |
| Equip. M&R | 100 | 400 | 600 | 600 | 600 | 600 | 600 | 600 | 400 |
| Rock Handling | 50 | 300 | 50 | 50 | 50 | 50 | 50 | 20 | - |
| Engineering | 300 | 650 | 840 | 840 | 800 | 800 | 800 | 700 | 600 |
| Geology | 100 | 180 | 180 | 180 | 180 | 180 | 120 | 120 | 120 |
| Supervision | 50 | 100 | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| Fringe Benefits | 100 | 1,000 | 2,115 | 2,115 | 2,110 | 2,110 | 2,000 | 1,800 | 1,600 |
| TOTALS | 4,514 | 9,345 | 14,196 | 13,590 | 13,545 | 13,220 | 13,050 | 12,670 | 10,240 |

Table 4.3-16

## JASON SOUTH ZONE - GENERAL MINING EXPENSE

1985 $ x 1000

| YEAR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hoisting | - | - | 200 | 400 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 200 |
| Fuel & Lube | 5 | 20 | 70 | 130 | 180 | 180 | 180 | 180 | 230 | 230 | 230 | 230 | 180 | 120 | 60 |
| Level Maint. | - | - | - | 60 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 100 | - |
| Pumping | - | - | 40 | 100 | 180 | 180 | 180 | 180 | 180 | 180 | 180 | 180 | 180 | 180 | 80 |
| Ventilation | - | 20 | 50 | 250 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 250 | 120 |
| Small Tools | - | - | - | 50 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | - |
| Handling Supplies | - | 100 | 100 | 100 | 120 | 120 | 120 | 120 | 180 | 180 | 180 | 180 | 120 | 120 | 50 |
| Powder Magzine | - | - | 10 | 20 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 10 |
| Power | 200 | 500 | 700 | 1 200 | 2 000 | 2 000 | 2 000 | 2 000 | 2 000 | 2 000 | 2 000 | 2 000 | 2 000 | 2 000 | 800 |
| Safety | - | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| Area Costs | 40 | 60 | 120 | 200 | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 180 | 100 |
| Miscellaneous | 10 | 20 | 50 | 150 | 220 | 220 | 220 | 220 | 220 | 220 | 220 | 220 | 220 | 180 | 80 |
| Transportation | 10 | 10 | 30 | 60 | 60 | 60 | 60 | 80 | 80 | 80 | 80 | 80 | 60 | 60 | 25 |
| Compressed Air | 5 | 10 | 100 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 50 |
| Surface Building | 10 | 30 | 80 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 50 |
| Major Repairs | - | - | - | - | - | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| Equipment M&R | - | - | 40 | 180 | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 95 |
| Engineering | 50 | 50 | 200 | 300 | 300 | 300 | 380 | 380 | 420 | 420 | 380 | 380 | 300 | 300 | 120 |
| Geology | - | 30 | 50 | 75 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 40 |
| Supervision | 70 | 70 | 180 | 350 | 350 | 350 | 350 | 460 | 460 | 460 | 460 | 460 | 350 | 350 | 140 |
| Fringe Benefits | 100 | 150 | 300 | 900 | 1 270 | 1 320 | 970 | 1 390 | 1 600 | 1 670 | 1 850 | 1 660 | 1 620 | 1 180 | 410 |
| Subtotal | 500 | 1 120 | 2 370 | 4 005 | 6 560 | 6 710 | 6 440 | 6 990 | 7 350 | 7 420 | 7 560 | 7 370 | 7 010 | 6 340 | 2 480 |
| Contingency @ 15% | 75 | 170 | 360 | 600 | 985 | 1 005 | 965 | 1 050 | 1 100 | 1 115 | 1 135 | 1 105 | 1 050 | 950 | 370 |
| TOTAL GME | 575 | 1 290 | 2 730 | 4 605 | 7 545 | 7 715 | 7 405 | 8 040 | 8 450 | 8 535 | 8 695 | 8 475 | 8 060 | 7 290 | 2 850 |

Table 4.3-17

## JASON MAIN ZONE - GENERAL MINING EXPENSE

1985 $ x 1000

| YEAR | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|
| Fuel & Lube | 220 | 350 | 600 | 700 | 800 | 900 | 1 000 | 500 |
| Level Maint. | 50 | 100 | 150 | 150 | 200 | 250 | 250 | 150 |
| Pumping | 50 | 100 | 100 | 100 | 100 | 100 | 100 | 50 |
| Ventilation | 300 | 500 | 650 | 750 | 850 | 850 | 850 | 500 |
| Small Tools | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Handling Supplies | 60 | 80 | 100 | 120 | 120 | 120 | 120 | 60 |
| Power | 500 | 1 000 | 2 000 | 2 500 | 3 000 | 3 000 | 3 000 | 1 500 |
| Safety | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 20 |
| Area Costs | 100 | 200 | 200 | 200 | 200 | 200 | 200 | 100 |
| Miscellaneous | 100 | 150 | 200 | 250 | 250 | 250 | 250 | 100 |
| Transportation | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 40 |
| Compressed Air | 20 | 50 | 80 | 100 | 100 | 100 | 100 | 50 |
| Surface Buildings | 75 | 75 | 100 | 150 | 200 | 200 | 200 | 100 |
| Major Repairs | - | 200 | 200 | 200 | 200 | 200 | 200 | - |
| Equipment M&R | 100 | 300 | 500 | 500 | 500 | 500 | 400 | - |
| Engineering | 100 | 200 | 200 | 250 | 250 | 250 | 200 | 100 |
| Geology | 50 | 100 | 100 | 100 | 100 | 100 | 100 | 50 |
| Supervision | 240 | 295 | 350 | 350 | 350 | 350 | 350 | 175 |
| Fringes | 700 | 825 | 1 555 | 1 375 | 1 495 | 1 870 | 2 105 | 885 |
| SUBTOTAL | 2 805 | 4 665 | 7 225 | 7 935 | 8 855 | 9 380 | 9 475 | 4 420 |
| Contingency @ 15% | 420 | 700 | 1 085 | 1 190 | 1 330 | 1 410 | 1 420 | 665 |
| TOTAL | 3 225 | 5 365 | 8 310 | 9 125 | 10 185 | 10 790 | 10 895 | 5 083 |

Table 4.3-18

## TOM MINE EQUIPMENT

1985 $ x 1000

| | | YEAR 1* | YEAR 2* | YEAR 3* | YEAR 4 | YEAR 5 | TOTALS |
|---|---|---|---|---|---|---|---|
| Crushers (elect.) | (3) | 300 | 300 | | | 300 | 900 |
| 5 Yd. Scoop | (5) | 675 | 450 | | | | 1 125 |
| 27-Ton Truck | (7) | 750 | 1 000 | NOTE: Bechtel estimates | | | 1 750 |
| Hyd. Jumbo | (3) | 1 314 | | will cover: | | | 1 314 |
| Roofbolter | (2) | 200 | 200 | Crushers (3) Mech. & Civil | | | 400 |
| Anfo Loader | (2) | 165 | 165 | Conveyors & Feeders (3) | | | 330 |
| Serv. Trucks | (4) | 320 | 320 | Compressors (2) | | | 640 |
| Super. Vehicle | (8) | 100 | 100 | Mine Air Heating Plt. | | | 200 |
| Lube Truck | (1) | 165 | | | | | 165 |
| Scaler | (1) | 180 | | | | | 180 |
| Road Grader | (1) | 125 | | | | | 125 |
| 8 Yd. Scoop | (3) | | 300 | 600 | | | 900 |
| DTH Drills | (3) | | 340 | 170 | | | 510 |
| + Compressors | | | 120 | 60 | | | 180 |
| + Spare Hammers | (3) | | | 26 | | | 26 |
| L.H. Drills | (2) | | | 40 | | | 40 |
| Jacklegs | (12) | 12 | 12 | | | | 24 |
| Stopers | (12) | 12 | 12 | | | | 24 |
| Utility Hoists | (6) | 14 | 14 | 14 | | | 42 |
| Hat Lamps | (200) | 20 | | | | | 20 |
| Grizzlies | (9) | | 18 | 18 | 18 | | 54 |
| Chain Controls | (4) | | 16 | 8 | 8 | | 32 |
| Vent Cont. Doors | (8) | | 24 | 12 | 12 | | 48 |
| Fans - Aux. | | 40 | 20 | | | | 60 |
| - Main | (4) | 200 | | | | | 200 |
| Pumps - Hdg. | | 50 | 10 | | | | 60 |
| - Main | | 150 | 50 | | | | 200 |
| Safety, etc. | | 50 | | | | | 50 |
| U/G Shop Equip. | | | 50 | | | | 50 |
| Grout Pumps | | 56 | | | | | 56 |
| Initial Spares (10%) | | 443 | 325 | 96 | 4 | | 868 |
| Mine Electrics | | 2 842 | 3 478 | 1 374 | | | 7 694 |
| Miscellaneous | | 30 | 30 | 10 | | | 70 |
| Totals | | 8 213 | 7 354 | 2 428 | 42 | 300 | 18 337 |
| Contingency (15%) | | 1 231 | 1 103 | 364 | 6 | 45 | 2 749 |
| TOTAL | | 9 444 | 8 457 | 2 792 | 48 | 345 | 21 086 |

* Preproduction equipment cost

Table 4.3-19

## JASON SOUTH ZONE UPPER LENS MINE EQUIPMENT

1985 $ x 1000

| | | YEAR 1* | YEAR 2* | YEAR 3* | YEAR 4* | TOTALS |
|---|---|---|---|---|---|---|
| 5 WP + 1 Main LP Inst. | | NOTE: Bechtel | | 400 | | 400 |
| Eimco 620 | (2) | estimates will | | 200 | | 200 |
| Battery Loco 3-1/2 Ton | (2) | cover: | | 100 | | 100 |
| Spare Battery & Charger | (2) | Conveyor | | 26 | | 26 |
| Mine Cars - 100 cf | (6) | Compressors (2) | | 60 | | 60 |
| - 40 ft | (6) | Downcast Fans | | 18 | | 18 |
| Scooptram - 3.5 Yd. | (4) | Heating Plant | | 340 | 340 | 680 |
| - 2 Yd. | (2) | Crusher cost | | | 300 | 300 |
| ITH Drills | (2) | provided | | | 340 | 340 |
| 250 psi Comp. | (2) | | | | 104 | 104 |
| Spare Hammers | (2) | | | | 17 | 17 |
| L.H. Drills | (2) | | | | 40 | 40 |
| Jacklegs | (16) | | | | 35 | 35 |
| Stopers | (16) | | | | 35 | 35 |
| Utility Hoists - 8 Ton | (1) | | | | 20 | 20 |
| - 2 Ton | (4) | | | 14 | 14 | 28 |
| Hat Lamps | (120) | | 4 | 8 | | 12 |
| Grizzlies | (4) | | | | 24 | 24 |
| Chain Controls | (4) | | | | 32 | 32 |
| Vent. Cont. Doors | (6) | | | 18 | 18 | 36 |
| Shaft Vent Doors | (6) | | | 12 | 12 | 24 |
| Aux. Fans - 25000 cfm | (7) | | | 14 | 14 | 28 |
| - 10000 cfm | (4) | | | 6 | 6 | 12 |
| Skip 7-1/2 Ton | (1) | | 44 | | | 44 |
| Skip-Cage | (2) | | 65 | 65 | | 130 |
| Crusher (complete) | | | | | 1 120 | 1 120 |
| Hoist Ropes - Sinking 1-1/2" | (2) | 34 | | | 34 | 68 |
| 3200' - Production 1-1/2" | (2) | | 34 | | | 34 |
| Pumps - Heading | (2) | | | 3 | | 3 |
| - Main | (6) | | | 500 | | 500 |
| Jumbos (2B Penu.) | (3) | 585 | | | | 585 |
| Long Toms | (2) | | | 54 | | 54 |
| Robcron Pump | (1) | | | 4 | | 4 |
| Stamp Dumps | (3) | | | 30 | | 30 |
| Miscellaneous | | | | 50 | 50 | 100 |
| Safety, etc. | | | 50 | | | 50 |
| Mine Electrics | | | | 100 | 50 | 150 |
| Grout Pump | (2) | | 28 | 28 | | 56 |
| Shop Equip. U/G | | | | 25 | 25 | 50 |
| Initial Major Spare Parts | | | | 300 | | 300 |
| Totals | | 619 | 225 | 2 625 | 2 630 | 6 099 |
| Contingency @ 15% | | 93 | 34 | 394 | 395 | 916 |
| TOTAL | | 712 | 259 | 3 019 | 3 025 | 7 015 |

* Preproduction equipment cost

## JASON SOUTH ZONE MIDDLE LENS MINE EQUIPMENT

1985 $ x 103

| YEAR | | 8 | 9 | 10 | 11 | 12 | TOTAL |
|---|---|---|---|---|---|---|---|
| Scoops - 3.5 yd. | | 170 | 340 | 170 | | 170 | 850 |
| - 2 yd. | | 150 | 150 | | | 150 | 450 |
| ITH Drills | (2) | | 150 | 150 | | | 300 |
| 250 psi Comp. | (2) | | 170 | 170 | | | 340 |
| Vent. Doors | (12) | | 36 | | | | 36 |
| Aux. Fans 25 000 cfm | (6) | | 12 | 12 | | | 24 |
| Hoist Ropes 1-1/2" | | 34 | | | | 34 | 68 |
| Jumbo - 2 Boom Pneum. | (1) | 195 | | | | | 195 |
| Mine Electrics | | 50 | 100 | | | | 150 |
| Shop Equipment | | | 50 | | | | 50 |
| Battery Loci | | | 50 | 50 | | | 100 |
| Mine Cars | | 20 | 40 | | | | 60 |
| Subtotal | | 619 | 1 098 | 552 | | 354 | 2 623 |
| Contingency @ 15% | | 93 | 165 | 83 | | 53 | 394 |
| TOTAL | | 712 | 1 263 | 635 | | 407 | 3 017 |

Table 4.3-21

## JASON MAIN ZONE MINE EQUIPMENT

(1985 $ x 1000)

| YEAR | 7* | 8* | 9* | 10* | 11 | 12 | 13 | |
|---|---|---|---|---|---|---|---|---|
| Surface Fill Dumps | | 40 | | | | | | |
| Conveyor/Feeder | | 1100 | | | | | | |
| Crusher | | 1000 | | | | | | |
| U/G Service Shop | | 70 | | | | | | |
| Hydraulic Jumbo (2) | 438 | 438 | | | | | | |
| 5 Yd.3 Scooptrams (4) | 225 | 225 | 225 | 225 | | | | |
| 3-1/2 Yd.3 Scooptrams (3) | | 175 | 175 | 175 | | | | |
| 27-Ton Trucks (7) | | 250 | 250 | 250 | 250 | 250 | 500 | |
| 13-Ton Trucks (2) | | | | | | 180 | 180 | |
| Anfo Trucks (2) | | 165 | 165 | | | | | |
| Roof Bolter | | 200 | | | | | | |
| Road Grader | | 125 | | | | | | |
| Hyd. Longhole Wagons (3) | | | 540 | 270 | | | | |
| Jacklegs | | 16 | 16 | | | | | |
| Stopers | | 16 | 16 | | | | | |
| Hat Lamps | 75 | | | | | | | |
| U/G Truck Dump | | | 20 | | | | | |
| Face Pumps | 5 | 5 | 5 | | | | | |
| Sump Pumps | | 90 | | | | 90 | | |
| Grout Pumps | | 60 | 60 | | | | | |
| Aux. Vent. Fans | 20 | 20 | 20 | 20 | 20 | 20 | | |
| Mine Electrics | | 500 | 500 | 500 | 500 | 500 | | |
| Mancarriers (2) | | 160 | 160 | | | | | |
| Staff Toyotas | | 120 | | | | | | |
| Surface Quarry Equip.: | | | | | | | | |
| Blasthole Drill Wagon | | | 160 | 160 | | | | |
| Explosives Truck | | | 150 | | | | | |
| Front End Loader | | | 250 | | | | | |
| Dump Trucks | | | 120 | 120 | | | | |
| Compressor | | | 100 | | | | | |
| Dozer | | | 250 | | | | | |
| SUBTOTAL | 763 | 4775 | 3182 | 1720 | 770 | 1040 | 680 | |
| Contingency (15%) | 114 | 716 | 477 | 258 | 115 | 156 | 102 | |
| TOTAL | 877 | 5491 | 3659 | 1978 | 885 | 1196 | 782 | 14 868 |

* Preproduction equipment cost

Table 4.3-22

## SUMMARY OF DEVELOPMENT COSTS

(1985 $ x 1000)

| Year | Major Development | | | Minor Development | | |
|---|---|---|---|---|---|---|
| | Tom East | Tom West | Total | Tom East | Tom West | Total |
| 1 | 6,893 | 10,297 | 17,190 | 623 | 352 | 975 |
| 2 | 2,810 | 3,887 | 6,697 | 4,785 | 1,913 | 6,698 |
| 3 | 826 | 2,027 | 2,853 | 501 | 700 | 1,201 |
| 4 | - | 286 | 286 | 204 | 975 | 1,179 |
| 5 | - | 54 | 54 | 706 | 442 | 1,148 |
| 6 | - | 643 | 643 | 872 | 921 | 1,793 |
| 7 | - | 787 | 787 | 235 | 2,375 | 2,610 |
| 8 | - | 422 | 422 | - | 1,983 | 1,983 |
| 9 | - | 65 | 65 | - | 687 | 687 |
| | Jason S. | Jason M. | Total | Jason S. | Jason M. | Total |
| 1 | 375 | - | 375 | - | - | - |
| 2 | 6,516 | - | 6,516 | - | - | - |
| 3 | 5,587 | - | 5,587 | - | - | - |
| 4 | 4,204 | - | 4,204 | 5,287 | - | 5,287 |
| 5 | 618 | - | 618 | 945 | - | 945 |
| 6 | 281 | - | 281 | 1,229 | - | 1,229 |
| 7 | - | - | - | - | - | - |
| 8 | 690 | 1,418 | 2,108 | 1,326 | 1,151 | 2,477 |
| 9 | 99 | 1,130 | 1,229 | 1,241 | 1,695 | 2,936 |
| 10 | 718 | 762 | 1,480 | 1,183 | 1,523 | 2,706 |
| 11 | 1,099 | 423 | 1,522 | 2,108 | 1,658 | 3,766 |
| 12 | 50 | 566 | 616 | 1,216 | 1,606 | 2,822 |
| 13 | 166 | 1,164 | 1,330 | 660 | 3,289 | 3,949 |
| 14 | - | 881 | 881 | 989 | 2,127 | 3,116 |
| 15 | - | 141 | 141 | 337 | 593 | 0 |

* Before allocation of General Mine Expense and breakdown between preproduction and ongoing costs as presented in Table 4.3.6.1 and 4.3.6.2

Table 4.3-23

# 4.4 MILLING COSTS

## CONTENTS

4.4 MILLING COSTS

4.4.1 BASIS OF ESTIMATE

Table 4.4-1 Summary - Mill Operating Costs

Table 4.4-2 Mill Personnel - Annual Rates

Table 4.4-3 Mill Personnel - Yearly Costs

Table 4.4-4 Mill Operating Supplies - Annual Costs

Table 4.4-5 Mill Reagents

Table 4.4-6 Mill Maintenance Supplies

Table 4.4-7 Mill Power Costs

### 4.4.1 BASIS OF ESTIMATE

Operating costs for the mill include labour, operating supplies, maintenance supplies and fuel for power. Heating costs are considered nil, as waste heat from the power plant will be used for building heat.

All labour, staff and hourly paid will work two weeks on-site followed by one week off-site - i.e., fourteen days in, followed by seven days out. The mill will be shut down for two weeks over Christmas - New Years.

Hours worked per day by staff and days vacation taken per year do not affect their cost to the operation and, therefore, have not been taken into account. Staffing has been allocated such that subordinates can take over when senior staff members are off - e.g., Assistant Mill Superintendent will be on-site when the Mill Superintendent is out.

Mill hourly paid will work 12 hours per day when on-site - i.e., 34 weeks of 84 hours for a total of 2,688 hours per year, less vacations. As a basic work week is 40 hours, overtime will be paid for 2,688 hours minus 50 weeks of 40 hours (2,000 hours) - i.e., 688 hours. Overtime will be paid at time-and-a-half, and night shift at 25 cents over the hourly rate. Three persons will be hired per operating position (one day shift, one night shift, one off-site) plus two swing men. A maintenance crew is allocated to the mill.

Quantities of mill operating supplies were estimated from historical data. Reagent additions were estimated to be 75% of that used in laboratory test work. Prices were solicited from suppliers and cost of freight added.

Quantities of mill maintenance supplies were either estimated from historical data or allowances were provided.

Power consumption has been estimated, taking into account the connected horsepower, an estimate of the demand factor and an estimate of the coincidence factor (fraction of time operating). Cost of fuel per kWh is calculated in Section 4.2 and based on the diesel generators priced by Bechtel in their Capital Cost Estimate, Section 3.

## SUMMARY - MILL OPERATING COSTS

| | ANNUAL COST | | |
|---|---|---|---|
| | Yr. 2 | Yrs. 3-14 | Yr. 15 |
| Personnel | 1,549,000 | 3,098,000 | 1,276,000 |
| Operating Supplies | 3,067,000 | 7,344,000 | 3,341,000 |
| Maintenance Supplies | 484,000 | 1,262,000 | 501,000 |
| Fuel for Power | 2,679,000 | 6,433,000 | 2,926,000 |
| Heating (Waste Heat) | 0 | 0 | 0 |
| TOTAL | 7,779,000 | 18,137,000 | 8,044,000 |

Table 4.4-1

## MILL PERSONNEL - ANNUAL RATES

(1985 $)

| Supervisory/Staff | Rate | Total p.a. | Local Bonus %---p.a. | | Annual Earnings | Benefits %---p.a. | | Annual Cost |
|---|---|---|---|---|---|---|---|---|
| Mill Superintendent | 55,000 p.a. | 55,000 | 40 | 22,000 | 77,000 | 15 | 8,250 | 85,250 |
| Assistant Super. | 50,000 p.a. | 50,000 | 40 | 20,000 | 70,000 | 15 | 7,500 | 77,500 |
| Metallurgist | 42,000 p.a. | 42,000 | 40 | 16,800 | 58,800 | 15 | 6,300 | 65,100 |
| General Foreman | 45,000 p.a. | 45,000 | 40 | 18,000 | 63,000 | 15 | 6,750 | 69,570 |
| Chief Chemist | 36,000 p.a. | 36,000 | 40 | 14,400 | 50,400 | 15 | 5,400 | 55,800 |
| **Local Staff** | | | | | | | | |
| Shift Boss | 4,000/mo | 48,000 | | | | 15 | 7,200 | 55,200 |
| Asst. Assayer | 3,000/mo | 36,000 | | | | 15 | 5,400 | 41,400 |
| Mill Clerk | 2,400/mo | 28,800 | | | | 15 | 4,320 | 33,120 |

| Hourly Rated | Rate/Hr. | Hours Day | Hours Night (+$0.25) | Hours O/Time (+50%) | Annual Earnings | Benefits %(on 2000) | | Annual Cost |
|---|---|---|---|---|---|---|---|---|
| Grinding Operators | 12.73 | 1,344 | 1,344 | 688 | 38,933 | 29 | 7,383 | 46,317 |
| Flotation Operators | 12.91 | 1,344 | 1,344 | 688 | 39,479 | 29 | 7,488 | 46,967 |
| Dewatering Operators | 12.01 | 1,344 | 1,344 | 688 | 36,750 | 29 | 6,966 | 43,716 |
| Reagent Mixer | 11.47 | 1,344 | 1,344 | 688 | 35,113 | 29 | 6,653 | 41,766 |
| Swing man | 13.09 | 1,344 | 1,344 | 688 | 40,025 | 29 | 7,592 | 47,617 |
| Mill Helpers | 11.47 | 1,344 | 1,344 | 688 | 35,113 | 29 | 6,653 | 41,766 |
| Mill Labour | 10.57 | 1,344 | 1,344 | 688 | 32,384 | 29 | 6,131 | 38,515 |
| Swing man | 11.65 | 1,344 | 1,344 | 688 | 35,659 | 29 | 6,757 | 42,416 |
| Tailings Men | 12.01 | 1,344 | 1,344 | 688 | 36,750 | 29 | 6,966 | 43,716 |
| Load-out Men | 11.47 | 1,344 | 1,344 | 688 | 35,113 | 29 | 6,653 | 41,766 |
| Laboratory Tech. | 12.00 | 1,344 | 1,344 | 688 | 36,720 | 29 | 6,960 | 43,680 |
| Maintenance Lead Hand | 14.00 | 2,688 | | 688 | 42,448 | 29 | 8,445 | 50,893 |
| Mechanics | 13.63 | 2,688 | | 688 | 41,326 | 29 | 8,222 | 49,548 |
| Mechanics Helpers | 11.47 | 2,688 | | 688 | 34,777 | 29 | 6,919 | 41,696 |
| Welders | 13.81 | 2,688 | | 688 | 41,872 | 29 | 8,330 | 50,202 |
| Mill Wrights | 13.81 | 2,688 | | 688 | 41,872 | 29 | 8,330 | 50,202 |
| Electricians | 14.17 | 2,688 | | 688 | 42,963 | 29 | 8,547 | 51,511 |
| Instrument Technician | 14.17 | 2,688 | | 688 | 42,963 | 29 | 8,547 | 51,511 |

Table 4.4-2

## MILL PERSONNEL - YEARLY COSTS

| | | Year 2 | | | Years 3-14 | | Year 15 | | |
|---|---|---|---|---|---|---|---|---|---|
| Supervisory/Staff | Annual Cost | No. | Months | Cost p.a. | No. | Cost p.a. | No. | Months | Cost p.a. |
| Mill Superintendent | 85,250 | 1 | 6 | 42,625 | 1 | 85,250 | 1 | 6 | 42,625 |
| Assistant Super. | 77,500 | 1 | 6 | 38,750 | 1 | 77,500 | 1 | 6 | 38,570 |
| Metallurgist | 65,100 | 2 | 6 | 65,100 | 2 | 130,200 | 1 | 6 | 32,550 |
| General Foreman | 69,750 | 1 | 6 | 34,875 | 1 | 69,750 | 1 | 6 | 34,875 |
| Chief Chemist | 55,800 | 1 | 6 | 27,900 | 1 | 55,800 | 1 | 6 | 27,900 |
| | | 6 | | 209,250 | 6 | 418,500 | 5 | | 176,700 |
| Local Staff | | | | | | | | | |
| Shift Boss | 55,200 | 4 | 6 | 110,400 | 4 | 220,800 | 4 | 6 | 110,400 |
| Asst. Assayer | 41,400 | 1 | 6 | 20,700 | 1 | 41,400 | 1 | 6 | 20,700 |
| Mill Clerk | 33,120 | 1 | 6 | 16,560 | 1 | 33,120 | 1 | 6 | 16,560 |
| | | 6 | | 147,660 | 6 | 295,320 | 6 | | 147,660 |
| Hourly Rated | | | | | | | | | |
| Grinding Operators | 46,317 | 3 | 6 | 69,475 | 3 | 138,950 | 3 | 6 | 69,475 |
| Flotation Operators | 46,967 | 3 | 6 | 70,450 | 3 | 140,901 | 3 | 6 | 70,450 |
| Dewatering Operators | 43,716 | 3 | 6 | 56,574 | 3 | 131,148 | 3 | 6 | 65,574 |
| Reagent Mixer | 41,766 | 1 | 6 | 20,883 | 1 | 41,766 | 1 | 6 | 20,883 |
| Swing man | 47,617 | 1 | 6 | 23,809 | 1 | 47,617 | 1 | 6 | 23,809 |
| Mill Helpers | 41,766 | 6 | 6 | 25,297 | 6 | 250,594 | 6 | 6 | 125,297 |
| Mill Labour | 38,515 | 3 | 6 | 57,772 | 3 | 115,545 | 3 | 6 | 57,772 |
| Swing man | 42,416 | 1 | 6 | 21,208 | 1 | 42,416 | 1 | 6 | 21,208 |
| Tailings Men | 43,716 | 3 | 6 | 65,574 | 3 | 131,148 | 3 | 6 | 65,574 |
| Load-out Men | 41,766 | 3 | 6 | 62,648 | 3 | 125,297 | 3 | 6 | 62,648 |
| Laboratory Tech. | 43,680 | 3 | 6 | 65,520 | 3 | 131,040 | 1 | 6 | 21,840 |
| | | 30 | | 648,211 | 30 | 1,296,422 | 28 | | 604,531 |
| Maintenance Lead Hand | 50,893 | 2 | 6 | 50,893 | 2 | 101,786 | 2 | 6 | 50,893 |
| Mechanics | 49,548 | 9 | 6 | 222,965 | 9 | 445,930 | 6 | 6 | 148,643 |
| Mechanics Helpers | 41,696 | 2 | 6 | 41,696 | 2 | 83,391 | 1 | 6 | 20,848 |
| Welders | 50,202 | 2 | 6 | 50,202 | 2 | 100,404 | 1 | 6 | 25,101 |
| Mill Wrights | 50,202 | 3 | 6 | 75,303 | 3 | 150,606 | 2 | 6 | 50,202 |
| Electricians | 51,511 | 2 | 6 | 51,511 | 2 | 103,022 | 1 | 6 | 25,755 |
| Instrument Technician | 51,511 | 2 | 6 | 51,511 | 2 | 103,022 | 1 | 6 | 25,755 |
| | | 22 | | 544,080 | 22 | 1,088,161 | 14 | | 347,198 |
| Total Mill Personnel | | 64 | | 1,549,201 | | 3,098,402 | 53 | | 1,276,089 |

Table 4.4-3

## MILL OPERATING SUPPLIES - ANNUAL COSTS

| | Yr. 2<br>656,000 t. | Yrs. 3-14<br>1,575,000 t. | Yr. 15<br>716,350 t. |
|---|---|---|---|
| Grinding Steel: | | | |
| - Primary Mill (autogenous) | 0 | 0 | 0 |
| - Secondary Mills (pebbles) | 0 | 0 | 0 |
| - Regrind Mill (1-inch balls) | 90,000 | 220,000 | 100,000 |
| - 0.15 lb/kwh | | | |
| - 1.65 kWh/t | | | |
| - 92% efficiency | | | |
| - $0.30 f.o.b. Toronto | | | |
| - $0.215 freight / lb. of steel ball | | | |
| Filter Cloth | | | |
| - Lead concentrate filters(2) | 15,000 | 30,000 | 15,000 |
| - 5 cloths/yr.@1,575,000 pa | | | |
| - $3000/cloth | | | |
| - Zinc concentrate filters(2) | 18,000 | 36,000 | 18,000 |
| - 6 cloths/yr.@1,575,000 pa | | | |
| - $3000/cloth | | | |
| Analytical Supplies | | | |
| - Allow | 25,000 | 50,000 | 20,000 |
| Reagents | | | |
| - See Table 4.4-1 | 2,640,000 | 6,340,000 | 2,884,000 |
| Sub-Total | 2,788,000 | 6,676,000 | 3,037,000 |
| Contingency, 10% | 279,000 | 668,000 | 304,000 |
| Total Mill Operating Supplies | 3,067,000 | 7,344,000 | 3,341,000 |

Table 4.4-4

## MILL REAGENTS

| OPERATION | REAGENT ADDITION - POUNDS PER TON | | | | | | |
|---|---|---|---|---|---|---|---|
| | ZnSO4 | Na2SO3 | NaCN | AX-325 | MIBC | CuSO4 | AF-25 |
| #1 Pb Ro. Flotation | 1.20 | 2.00 | 0.30 | 0.22 | 0.08 | | |
| #1 Pb Cln Flotation | 0.40 | | 0.10 | | 0.01 | | |
| Regrind Flotation | 0.60 | 0.50 | 0.05 | 0.01 | 0.01 | | |
| Zinc Ro. Flotation | ____ | ____ | ____ | 0.15 | 0.05 | 1.50 | 0.05 |
| Total Lab Addition: | 2.20 | 2.50 | 0.45 | 0.38 | 0.15 | 1.50 | 0.05 |
| Estimated Plant Addition (75%): | 1.65 | 1.88 | 0.34 | 0.29 | 0.11 | 1.13 | 0.04 |
| Annual Requirement at 1,575,000 tpt: | 2,598,570 | 2,953,125 | 531,563 | 448,875 | 177,188 | 1,771,875 | 59,063 |
| Cost ($/lb.) | 0.75 | 0.24 | 0.86 | 0.86 | 0.66 | 0.36 | 1.83 |
| Freight ($/lb.) | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.15 | 0.45 |
| Reagent Cost ($/lb.) | 0.98 | 0.48 | 1.10 | 1.10 | 0.89 | 0.51 | 2.29 |
| Annual Cost at 1,575,000 tpy | 2,556,750 | 1,413,768 | 582,335 | 491,750 | 157,951 | 902,374 | 135,048 |

| | |
|---|---|
| Add Allowances for: | |
| - Lime | 50,000 |
| - Flocculant | 50,000 |
| Total Annual Cost at 1,575,000 tpy | 6,339,977 |

| | | |
|---|---|---|
| 656,000 tpy | Yr. 2 | 2,640,651 |
| 1,575,000 tpy | Yr. 3-14 | 6,339,977 |
| 716,350 tpy | Yr. 15 | 2,883,582 |

TABLE 4.4-5

## MILL MAINTENANCE SUPPLIES

| | ANNUAL COST | | |
|---|---|---|---|
| | Yr. 2 | Yrs. 3-14 | Yr. 15 |
| | 656,000 tpy | 1,575,000 tpy | 716,350 tpy |
| **Mill Liners** | | | |
| - Primary Mill (chrome-moly)<br>- 0.02 lb/kwh<br>- 8.25 kWh/t<br>- 92% efficiency<br>- $1.00/lb. f.o.b. Toronto<br>- $0.215/lb. freight | 123,000 | 343,000 | 156,000 |
| - Secondary Mills (2) (rubber)<br>- Allow $0.15/t. plant feed | 100,000 | 236,000 | 100,000 |
| - Regrind Mill (1) (rubber)<br>- Allow $0.02/t. plant feed | 13,000 | 32,000 | 14,000 |
| **Screens** | | | |
| - 6 Sections p.a. @ 1,575,000 tpy<br>- $1,500 per section | 3,000 | 9,000 | 4,500 |
| **Miscellaneous** | | | |
| - Grinding | 20,000 | 40,000 | 20,000 |
| - Conveyors | 10,000 | 25,000 | 10,000 |
| - Piping | 20,000 | 40,000 | 10,000 |
| - Pumping - lines | 25,000 | 50,000 | 20,000 |
| - other | 25,000 | 50,000 | 20,000 |
| - Flotation cells & machines | 5,000 | 20,000 | 5,000 |
| - Blowers | 5,000 | 20,000 | 5,000 |
| - Lubrication | 20,000 | 40,000 | 20,000 |
| - Grease | 5,000 | 10,000 | 5,000 |
| - Mill Office | 1,000 | 2,000 | 1,000 |
| - Change House | 5,000 | 10,000 | 5,000 |
| - Safety | 5,000 | 10,000 | 5,000 |
| - Tailings Line | 15,000 | 30,000 | 15,000 |
| - Electrical/Instrumentation | 15,000 | 30,000 | 15,000 |
| - Miscellaneous Minor | 25,000 | 50,000 | 25,000 |
| - Major Replacement | 0 | 100,000 | 0 |
| Sub-Total | 440,000 | 1,147,000 | 455,500 |
| Contingency, 10% | 44,000 | 115,000 | 45,500 |
| **Total Mill Maintenance Supplies** | 484,000 | 1,262,000 | 501,000 |

Table 4.4-6

## MILL POWER COSTS

### Mill Power Consumption

| Equipment | Connected H.P. | KWh | Demand Factor | Coinci-dence | Hours p.a. | kWh p.a. |
|---|---|---|---|---|---|---|
| Primary Mill | 2,400 | 1,800 | 0.95 | 1.00 | 7,560 | 12,927,600 |
| Secondary Mills | 3,000 | 2,250 | 0.95 | 1.00 | 7,560 | 16,159,500 |
| Regrind Mill | 500 | 375 | 0.95 | 1.00 | 7,560 | 2,693,250 |
| Slurry Pumps | 771 | 578 | 0.60 | 1.00 | 7,560 | 2,622,942 |
| Froth Pumps | 210 | 158 | 0.50 | 1.00 | 7,560 | 595,350 |
| Water Pumps | 180 | 135 | 0.65 | 1.00 | 8,400 | 737,100 |
| Tailings Pumps | 1,000 | 750 | 0.85 | 1.00 | 8,400 | 5,355,000 |
| Flotation Machines | 1,725 | 1,294 | 0.85 | 1.00 | 7,560 | 8,313,638 |
| Blowers | 500 | 375 | 0.85 | 1.00 | 7,560 | 2,409,750 |
| Filters | 160 | 120 | 0.80 | 1.00 | 7,560 | 725,760 |
| Filter Compressors | 500 | 375 | 0.85 | 1.00 | 7,560 | 2,409,750 |
| Conveyors | 49 | 37 | 0.60 | 1.00 | 7,560 | 166,698 |
| Feeders | 37 | 28 | 0.50 | 1.00 | 7,560 | 104,895 |
| Screens | 5 | 4 | 0.75 | 1.00 | 7,560 | 21,263 |
| Agitators | 105 | 79 | 0.80 | 1.00 | 8,760 | 551,880 |
| Thickeners | 10 | 8 | 0.50 | 1.00 | 8,760 | 32,850 |
| Sump Pumps | 60 | 45 | 0.50 | 0.05 | 8,760 | 9,855 |
| Reagent Mixing | 16 | 12 | 0.50 | 0.25 | 7,560 | 11,431 |
| Air Compressors | 75 | 56 | 0.85 | 0.20 | 8,400 | 80,325 |
| Crane | 40 | 30 | 0.25 | 0.10 | 8,400 | 6,300 |
| | | | | | | 55,935,136 |

### Cost of Fuel For Mill Power

| Annual Cost | tpy | kWh | $/kWh | Cost |
|---|---|---|---|---|
| Year 2 | 656,000 | 23,297,428 | .115 | 2,679,204 |
| Years 3-14 | 1,575,000 | 55,935,136 | .115 | 6,432,541 |
| Year 15 | 716,350 | 25,440,720 | .115 | 2,925,683 |

Table 4.4-7

## 4.5 ENGINEERING/TECHNICAL COSTS

### CONTENTS

4.5.1 BASIS OF ESTIMATE

Table 4.5-1 Summary - Engineering/Technical Costs

Table 4.5-2 Personnel Costs

Table 4.5-3 Supplies

### 4.5.1 BASIS OF ESTIMATE

These costs cover only those engineering and technical personnel (and their supplies) not included in the general mine expenses (GME).

## SUMMARY - ENGINEERING/TECHNICAL

Note that most engineering costs are included in General Mine Expenses, and therefore not included here.

| | Year 2 | Years 3 -14 | Year 15 |
|---|---|---|---|
| Personnel | 184,760 | 369,520 | 169,500 |
| Supplies | 8,150 | 15,300 | 8,500 |
| Total | 192,910 | 384,820 | 178,000 |

Table 4.5-1

## PERSONNEL COSTS

| Supervisory/Staff | Rate | Annual Rate | Local Bonus %---p.a. | | Annual Earnings | Benefits %---p.a. | | Annual Cost |
|---|---|---|---|---|---|---|---|---|
| Chief Environ. Engr. | 48,000 p.a. | | 40 | 19,200 | 67,200 | 15 | 7,200 | 74,400 |
| Environmental Engr. | 40,000 p.a. | | 40 | 16,000 | 56,000 | 15 | 6,000 | 62,000 |
| **Local Staff** | **Rate** | **Annual Rate** | | | | | | |
| Designer | 3,200/mo. | 38,400 | | | | 15 | 5,760 | 44,160 |
| Draftsmen/Layout | 3,000/mo. | 36,000 | | | | 15 | 5,400 | 41,400 |

| | | Year 2 | | | Years 3 - 14 | | | Year 15 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Supervisory/Staff | Annual Cost | No. | Months | Cost p.a. | No. | Cost p.a. | | No. | Months | Cost p.a. |
| Chief Environ. Engr. | 74,400 | 1 | 6 | 37,200 | 1 | 74,400 | | 1 | 9 | 55,800 |
| Environmental Engr. | 62,000 | 2 | 6 | 62,000 | 2 | 124,000 | | 2 | 9 | 93,000 |
| | | 3 | | 99,200 | 3 | 198,400 | | 3 | | 148,800 |
| Local Staff | | | | | | | | | | |
| Designer | 44,160 | 2 | 6 | 44,160 | 2 | 88,320 | | 0 | 0 | 0 |
| Draftsmen/Layout | 41,400 | 2 | 6 | 41,400 | 2 | 82,800 | | 1 | 6 | 20,700 |
| | | 4 | | 85,560 | 4 | 171,120 | | 1 | | 20,700 |
| Department Total | | 7 | | 184,760 | 7 | 369,520 | | 4 | | 169,500 |

Table 4.5-2

## SUPPLIES

| | Year 2 | Years 3 -14 | Year 15 |
|---|---|---|---|
| Office Supplies | 2,000 | 3,000 | 1,000 |
| Misc. travel | 2,000 | 4,000 | 2,000 |
| Vehicle Fuel (2 hrs./day x $9/hr.) | 3,150 | 6,300 | 4,500 |
| Misc. | 1,000 | 2,000 | 1,000 |
| Total Supplies | 8,150 | 15,300 | 8,500 |

Table 4.5-3

# 4.6 SERVICE AND MAINTENANCE COSTS

## CONTENTS

4.6.1 BASIS OF ESTIMATE

Table 4.6-1 Summary - Service and Maintenance

Table 4.6-2 Personnel Costs

Table 4.6-3 Supplies

Table 4.6-4 Power Costs

### 4.6.1 BASIS OF ESTIMATE

These costs cover the service and maintenance personnel (and their supplies) not included in the general mine expenses (GME) and not allocated to the mill.

Note that all costs of power other than fuel are allocated to this area. The only fuel allocated here is that required to operate motors in this area.

## SUMMARY - SERVICE AND MAINTENANCE COSTS

| | ANNUAL COST | | |
|---|---|---|---|
| | Yr. 2 | Yrs. 3-14 | Yr. 15 |
| Personnel | 1,301,000 | 2,602,000 | 882,000 |
| Supplies | 815,000 | 1,553,000 | 435,000 |
| Fuel for Power | 371,000 | 603,000 | 301,000 |
| Heating (Waste Heat) | 0 | 0 | 0 |
| Total | 2,487,000 | 4,758,000 | 1,618,000 |

Table 4.6-1

## PERSONNEL COSTS

| Supervisory/Staff | Rate | Local Bonus % | Bonus p.a. | Annual Earnings | Benefits % | Benefits p.a. | Annual Cost |
|---|---|---|---|---|---|---|---|
| Maintenance Super. | 55,000 p.a. | 40 | 22,000 | 77,000 | 15 | 8,250 | 85,250 |
| Chief Electrician | 45,000 p.a. | 40 | 18,000 | 63,000 | 15 | 6,750 | 69,750 |
| Master Mechanic | 45,000 p.a. | 40 | 18,000 | 63,000 | 15 | 6,750 | 69,750 |
| Mechanical Engineer | 40,000 p.a. | 40 | 16,000 | 56,000 | 15 | 6,000 | 62,000 |
| Electrical Engineer | 40,000 p.a. | 40 | 16,000 | 56,000 | 15 | 6,000 | 62,000 |
| Elec. Shop Foreman | 36,000 p.a. | 40 | 14,400 | 50,400 | 15 | 5,400 | 55,800 |
| Maint. Shop Foreman | 36,000 p.a. | 40 | 14,400 | 50,400 | 15 | 5,400 | 55,800 |
| Instrument Foreman | 36,000 p.a. | 40 | 14,400 | 50,400 | 15 | 5,400 | 55,800 |
| **Local Staff** | **Rate** | **Annual Rate** | | | | | |
| Stationary Engineer | 3,500/mo. | 42,000 | | | 15 | 6,300 | 48,300 |
| Maint. Planner | 2,400/mo. | 28,800 | | | 15 | 4,320 | 33,120 |
| Clerks | 2,200/mo. | 26,400 | | | 15 | 3,960 | 30,360 |

| Hourly Rated | Rate/Hr. | --- Hours --- Total | O/Time | Annual Earnings | Benefits % (on 2000) | | |
|---|---|---|---|---|---|---|---|
| Mechanics | 12.73 | 2,688 | 688 | 41,872 | 29 | 8,010 | 49,882 |
| Mechanics Helpers | 11.47 | 2,688 | 688 | 34,777 | 29 | 6,653 | 41,430 |
| Electricians | 13.81 | 2,688 | 688 | 41,872 | 29 | 8,010 | 49,882 |
| Machinists | 13.81 | 2,688 | 688 | 41,872 | 29 | 8,010 | 49,882 |
| Welders | 13.81 | 2,688 | 688 | 41,872 | 29 | 8,010 | 49,882 |
| Pipefitters | 13.81 | 2,688 | 688 | 41,872 | 29 | 8,010 | 49,882 |
| Carpenters | 13.81 | 2,688 | 688 | 41,872 | 29 | 8,010 | 49,882 |
| Painters | 13.81 | 2,688 | 688 | 41,872 | 29 | 8,010 | 49,882 |
| Vehicle Operators | 11.65 | 2,688 | 688 | 35,323 | 29 | 6,757 | 42,080 |
| Labourers | 10.57 | 2,688 | 688 | 32,048 | 29 | 6,131 | 38,179 |

| | | Year 2 | | | Years 3 - 14 | | Year 15 | | |
|---|---|---|---|---|---|---|---|---|---|
| Supervisory/Staff | Annual Cost | No. | Months | Cost p.a. | No. | Cost p.a. | No. | Months | Cost p.a. |
| Maintenance Super. | 85,250 | 1 | 6 | 42,625 | 1 | 85,250 | 1 | 8 | 56,833 |
| Chief Electrician | 69,750 | 1 | 6 | 34,875 | 1 | 69,750 | 1 | 8 | 46,500 |
| Master Mechanic | 69,750 | 1 | 6 | 34,875 | 1 | 69,750 | 1 | 8 | 46,500 |
| Mechanical Engineer | 62,000 | 1 | 6 | 31,000 | 1 | 62,000 | 0 | 0 | 0 |
| Electrical Engineer | 62,000 | 1 | 6 | 31,000 | 1 | 62,000 | 1 | 8 | 41,333 |
| Elec. Shop Foreman | 55,800 | 1 | 6 | 27,900 | 1 | 55,800 | 1 | 6 | 27,900 |
| Maint. Shop Foreman | 55,800 | 1 | 6 | 27,900 | 1 | 55,800 | 1 | 6 | 27,900 |
| Instrument Foreman | 55,800 | 1 | 6 | 27,900 | 1 | 55,800 | 1 | 6 | 27,900 |
| | | 8 | | 258,075 | 8 | 516,150 | 7 | | 274,867 |

Table 4.6-2
Sheet 1

| | | Year 2 | | | Years 3 - 14 | | Year 15 | | |
|---|---|---|---|---|---|---|---|---|---|
| Hourly Rated | Annual Cost | No. | Months | Cost p.a. | No. | Cost p.a. | No. | Months | Cost p.a. |
| Maint. Planner | 48,300 | 4 | 6 | 96,600 | 4 | 193,200 | 4 | 6 | 96,600 |
| Maint. Planner | 33,120 | 1 | 6 | 16,560 | 1 | 33,120 | 1 | 3 | 8,280 |
| Clerks | 30,360 | 3 | 6 | 45,540 | 3 | 91,080 | 2 | 3 | 15,180 |
| | | 8 | | 158,700 | 8 | 317,400 | 7 | | 120,060 |
| Hourly Rated | | | | | | | | | |
| Mechanics | 49,882 | 6 | 6 | 149,645 | 6 | 299,290 | 3 | 8 | 99,763 |
| Mechanics Helpers | 41,430 | 3 | 6 | 62,144 | 3 | 124,289 | 1 | 8 | 27,620 |
| Electricians | 49,882 | 6 | 6 | 149,645 | 6 | 299,290 | 3 | 8 | 99,763 |
| Machinistse | 49,882 | 3 | 6 | 74,823 | 3 | 149,645 | 1 | 6 | 24,941 |
| Welders | 49,882 | 3 | 6 | 74,823 | 3 | 149,645 | 1 | 8 | 33,254 |
| Pipefitters | 49,882 | 3 | 6 | 74,823 | 3 | 149,645 | 1 | 8 | 33,254 |
| Carpenters | 49,882 | 2 | 6 | 49,882 | 2 | 99,763 | 1 | 6 | 24,941 |
| Painters | 49,882 | 2 | 6 | 49,882 | 2 | 99,763 | 1 | 6 | 24,941 |
| Vehicle Operators | 42,080 | 4 | 6 | 84,160 | 4 | 168,319 | 2 | 6 | 42,080 |
| Labourers | 38,179 | 6 | 6 | 114,537 | 6 | 229,073 | 4 | 6 | 76,358 |
| | | 38 | | 884,362 | 38 | 1,768,724 | 18 | | 486,916 |
| Department Total | | 54 | | 1,301,137 | 54 | 2,602,274 | 32 | | 881,842 |

Table 4.6-2
Sheet 2

## SUPPLIES

| | ANNUAL COST | | |
|---|---|---|---|
| | Yr. 2 | Yrs. 3-14 | Yr. 15 |
| Allowances for: | | | |
| - Gasoline | 50,000 | 100,000 | 50,000 |
| - Diesel Fuel | 25,000 | 50,000 | 25,000 |
| - Shops, incl.: | 250,000 | 400,000 | 100,000 |
| - oxygen | | | |
| - acetylene | | | |
| - welding rod | | | |
| - plate | | | |
| - barstock | | | |
| - angle iron | | | |
| - channels | | | |
| - small tools | | | |
| - lubricants | | | |
| - paint | | | |
| - lumber | | | |
| - cable | | | |
| - electrical hardware | | | |
| - pipe, fitting | | | |
| - misc. hardware | | | |
| - Power house | | | |
| - Fuel oil (costed out) | - | - | - |
| - lubricants | 20,000 | 40,000 | 20,000 |
| - spares (5% capital equip.) | 400,000 | 830,000 | 200,000 |
| - other (0.5% capital equip.) | 40,000 | 83,000 | 20,000 |
| - Other, incl.: | 30,000 | 50,000 | 20,000 |
| - office | | | |
| - safety | | | |
| - misc. | | | |
| Total Supplies | 815,000 | 1,553,000 | 435,000 |

Table 4.6-3

## POWER COSTS

### Power Consumption

| Equipment | Connected H.P. | KWh | Demand Factor | Coinci-dence | Hours p.a. | kWh p.a. |
|---|---|---|---|---|---|---|
| Service Air | 250 | 188 | 0.90 | 0.25 | 8,400 | 354,375 |
| Power Plant | 320 | 240 | 0.85 | 0.95 | 8,760 | 1,697,688 |
| Accommodation | 120 | 90 | 0.85 | 0.50 | 8,760 | 335,070 |
| Tracing - all year | 0 | 1,100 | 1.00 | 0.15 | 8,760 | 1,445,400 |
| - emergency | 0 | 1,100 | 1.00 | 1.00 | 168 | 184,800 |
| Yard | 320 | 240 | 0.85 | 0.75 | 8,760 | 1,340,280 |
| | | | | | | 5,357,613 |

### Cost of Fuel For Power

| Annual Costs | Service Air | Power Plant | Accomod. | Tracing | Yard | Total kWh | Total Cost $.1125/kWh |
|---|---|---|---|---|---|---|---|
| Year 1 | 50,000 | 250,000 | 250,000 | | 150,000 | 700,000 | 78,750 |
| Year 2 | 250,000 | 1,500,000 | 300,000 | 500,000 | 750,000 | 3,300,000 | 371,250 |
| Year 3 - 14 | 354,375 | 1,697,688 | 335,070 | 1,630,200 | 1,340,280 | 5,357,613 | 602,731 |
| Year 15 | 177,188 | 848,844 | 167,535 | 815,100 | 670,140 | 2,678,807 | 301,366 |

Table 4.6-4

# 4.7 ADMINISTRATION COSTS (MINE SITE)

## CONTENTS

4.7.1 BASIS OF ESTIMATE

Table 4.7-1 Summary - Administration Costs (Mine Site)

Table 4.7-2 Personnel Costs

Table 4.7-3 Supplies

### 4.7.1 BASIS OF ESTIMATE

Administrative functions have been divided between the mine-site and Whitehorse in order to reduce camp costs, location bonus for staff and communications' costs. It is considered that personnel, recruiting, travel and legal activities are better handled in Whitehorse than at the mine-site. Estimates in this section are for mine-site administration only.

## SUMMARY - ADMINISTRATION COSTS (MINE SITE)

| | Yr. 2 | Yrs. 3-14 | Yr. 15 |
|---|---|---|---|
| Personnel | 838,354 | 1,676,709 | 989,787 |
| Supplies | 1,167,700 | 2,095,400 | 1,056,700 |
| Total | 2,006,054 | 3,772,109 | 2,046,487 |

Table 4.7-1

## PERSONNEL COSTS

| Supervisory/Staff | Rate | Local Bonus % | Bonus p.a. | Annual Earnings | Benefits % | Benefits p.a. | Annual Cost |
|---|---|---|---|---|---|---|---|
| Resident Manager | 65,000 p.a. | 40 | 26,000 | 91,000 | 15 | 9,750 | 100,750 |
| Assistant Manager | 60,000 p.a. | 40 | 24,000 | 84,000 | 15 | 9,000 | 93,000 |
| Director Safety | 40,000 p.a. | 40 | 16,000 | 56,000 | 15 | 6,000 | 62,000 |
| Camp Manager | 40,000 p.a. | 40 | 16,000 | 56,000 | 15 | 6,000 | 62,000 |
| Director Security | 36,000 p.a. | 40 | 14,400 | 50,400 | 15 | 5,400 | 55,800 |

| Local Staff | Rate | Annual Rate | Annual Earnings | Benefits % | Benefits p.a. | Annual Cost |
|---|---|---|---|---|---|---|
| First Aid/Nurse | 3,360/mo. | 40,320 | 40,320 | 15 | 6,048 | 46,368 |
| Time Keepers | 2,200/mo. | 26,400 | 26,400 | 15 | 3,960 | 30,360 |
| Warehouse Clerks | 2,200/mo. | 26,400 | 26,400 | 15 | 3,960 | 30,360 |
| Site Office Secretary | 1,700/mo. | 20,400 | 20,400 | 15 | 3,060 | 23,460 |
| Typist/Telex Operator | 1,500/mo. | 18,000 | 18,000 | 15 | 2,700 | 20,700 |

| Hourly Rated | Rate/Hr. | --- Hours --- Total | O/Time | Annual Earnings | Benefits % (on 2000) | Benefits p.a. | Annual Cost |
|---|---|---|---|---|---|---|---|
| Security Guards | 10.57 | 2,688 | 688 | 32,048 | 29 | 6,131 | 38,179 |
| Handy Men | 13.44 | 2,688 | 688 | 40,750 | 29 | 7,795 | 48,545 |
| Drivers | 10.57 | 2,688 | 688 | 32,048 | 29 | 6,131 | 38,179 |
| Labourers | 10.57 | 2,688 | 688 | 32,048 | 29 | 6,131 | 38,179 |
| Janitors | 10.57 | 2,688 | 688 | 32,048 | 29 | 6,131 | 38,179 |

| | | Year 2 | | | Years 3 - 14 | | | Year 15 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Supervisory/Staff | Annual Cost | No. | Months | Cost p.a. | No. | Cost p.a. | | No. | Months | Cost p.a. |
| Resident Manager | 100,750 | 1 | 6 | 50,375 | 1 | 100,750 | | 1 | 9 | 75,563 |
| Assistant Manager | 93,000 | 1 | 6 | 46,500 | 1 | 93,000 | | 0 | 0 | 0 |
| Director Safety | 62,000 | 1 | 6 | 31,000 | 1 | 62,000 | | 1 | 6 | 31,000 |
| Camp Manager | 62,000 | 1 | 6 | 31,000 | 1 | 62,000 | | 1 | 9 | 46,500 |
| Director Security | 55,800 | 1 | 6 | 27,900 | 1 | 55,800 | | 1 | 9 | 41,850 |
| | | 5 | | 186,775 | 5 | 373,550 | | 4 | | 194,913 |

Table 4.7-2
Sheet 1

| Local Staff | Annual Cost | Year 2 No. | Year 2 Months | Year 2 Cost p.a. | Years 3 - 14 No. | Years 3 - 14 Cost p.a. | Year 15 No. | Year 15 Months | Year 15 Cost p.a. |
|---|---|---|---|---|---|---|---|---|---|
| First Aid/Nurse | 46,368 | 3 | 6 | 69,552 | 3 | 139,104 | 3 | 6 | 69,552 |
| Time Keepers | 30,360 | 3 | 6 | 45,540 | 3 | 91,080 | 3 | 6 | 45,540 |
| Warehouse Clerks | 30,360 | 5 | 6 | 75,900 | 5 | 151,800 | 5 | 8 | 101,200 |
| Site Office Secretary | 23,460 | 2 | 6 | 23,460 | 2 | 46,920 | 2 | 8 | 31,280 |
| Typist/Telex Operator | 20,700 | 2 | 6 | 20,700 | 2 | 41,400 | 2 | 6 | 20,700 |
| | | 15 | | 125,152 | 15 | 470,304 | 15 | | 268,272 |
| Hourly Rates | | | | | | | | | |
| Security Guards | 38,179 | 6 | 6 | 114,537 | 6 | 229,073 | 6 | 9 | 171,805 |
| Handy Men | 48,545 | 3 | 6 | 72,818 | 3 | 145,636 | 3 | 8 | 97,091 |
| Drivers | 38,179 | 6 | 6 | 114,537 | 6 | 229,073 | 6 | 6 | 114,537 |
| Labourers | 38,179 | 3 | 6 | 57,268 | 3 | 114,537 | 3 | 7 | 66,813 |
| Janitors | 38,179 | 3 | 6 | 57,268 | 3 | 114,537 | 3 | 8 | 76,358 |
| | | 21 | | 416,427 | 21 | 832,855 | 21 | | 526,603 |

Table 4.7-2
Sheet 2

## SUPPLIES

| | | Yr. 2 | Yrs. 3-14 | Yr. 15 |
|---|---|---|---|---|
| Office Supplies | Allow | 20,000 | 30,000 | 10,000 |
| Safety, First Aid supplies | Allow | 30,000 | 30,000 | 30,000 |
| Communications (12-channel System) | | 81,000 | 162,000 | 108,000 |
| Computer Service | Allow | 100,000 | 100,000 | 50,000 |
| Misc. Travel | Allow | 50,000 | 50,000 | 20,000 |
| Bus Fuel (6 hrs/day @ $30/hr.) | | 31,500 | 63,000 | 31,500 |
| Vehicle Fuel (4*4 hrs/day @ $9/hr.) | | 25,200 | 50,400 | 25,200 |
| Fly-In/Fly-Out (12/wk. @ $2500 ea.) | | 780,000 | 1,560,000 | 780,000 |
| Miscellaneous | Allow | 50,000 | 50,000 | 2,000 |
| Total | | 1,167,700 | 2,095,400 | 1,056,700 |

Table 4.7-3

# 4.8 ACCOMMODATION COSTS

## CONTENTS

4.8.1 BASIS OF ESTIMATE

Table 4.8-1 Mancount

Table 4.8-2 Costs

### 4.2.8 ACCOMMODATION COSTS

Camp support will be contracted out. A cost of $19 per day per person in camp is used. This is based on current rates in the Yukon Territory and includes food, labour, laundry, cleaning, camp management and local transportation.

Only company personnel, the camp contractor's staff and four guests will be housed in the camp. Other contractors' crews will be housed by the contractors, not in the company camp.

Each person will retain his/her own room. However, costs have been calculated based on 2/3 of mancount on-site.

## 4.8 ACCOMMODATION COSTS

MANCOUNT

| Year: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mining: | | | | | | | | | | | | | | | |
| General Mine Engineering | 6 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 7 |
| Tom Mine | 11 | 117 | 210 | 158 | 154.5 | 159.5 | 173.5 | 157.5 | 137 | | | | | | |
| Jason Mine | 2 | 6 | 30 | 72 | 90 | 94 | 70 | 143 | 162 | 206 | 216 | 211 | 226 | 191 | 168 |
| Sub-total, Mining | 19 | 132 | 250 | 296 | 254.5 | 263.5 | 253.5 | 310.5 | 309 | 214 | 224 | 219 | 234 | 199 | 175 |
| Surface: | | | | | | | | | | | | | | | |
| Administration | 0 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 40 |
| Gen. Eng. and Environ. | 0 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 4 |
| Mill | 0 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 53 |
| Maintenance & Service | 0 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 32 |
| Sub-total, Surface | 0 | 166 | 166 | 166 | 166 | 166 | 166 | 166 | 166 | 166 | 166 | 166 | 166 | 166 | 129 |
| Total Mine-site Pay-roll | 9 | 298 | 416 | 462 | 420.5 | 429.5 | 419.5 | 476.5 | 475 | 380 | 390 | 385 | 400 | 365 | 304 |
| Camp Support Personnel: | | | | | | | | | | | | | | | |
| (1 per 12 people in camp) | 2 | 18 | 24 | 26 | 24 | 24 | 24 | 26 | 26 | 21 | 21 | 21 | 21 | 20 | 16 |
| Other: | | | | | | | | | | | | | | | |
| Guests | 2 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Total | 3 | 320 | 444 | 492 | 448.5 | 457.5 | 447.5 | 506.5 | 505 | 405 | 415 | 410 | 425 | 389 | 324 |

Table 4.8-1

ACCOMODATION COSTS

| Year: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ($19.00/d./person incl. food, transportation, labour, laundry, cleaning and management.) Allow 2/3 people in camp. Allow 10% contingency | | | | | | | | | | | | | | | |
| Mining | 92,657 | 643,720 | 1,219,167 | 1,443,493 | 1,241,111 | 1,285,000 | 1,236,235 | 1,514,205 | 1,506,890 | 1,043,607 | 1,092,373 | 1,067,990 | 1,141,140 | 970,457 | 853,417 |
| Surface | 0 | 404,763 | 809,527 | 809,527 | 809,527 | 809,527 | 809,527 | 809,527 | 809,527 | 809,527 | 809,527 | 809,527 | 809,527 | 809,527 | 629,090 |
| Camp support | incl. | incl. | incl. | incl. | incl. | incl. | incl. | incl. | incl. | incl. | incl. | incl. | incl. | incl. | incl. |
| Other | 33,250 | 33,250 | 66,500 | 66,500 | 66,500 | 66,500 | 66,500 | 66,500 | 66,500 | 66,500 | 66,500 | 66,500 | 66,500 | 66,500 | 66,500 |
| Total Costs | 125,907 | 1,081,733 | 2,095,194 | 2,319,520 | 2,117,138 | 2,161,027 | 2,112,262 | 2,390,232 | 2,382,917 | 1,919,634 | 1,968,400 | 1,944,017 | 2,017,167 | 1,846,484 | 1,549,007 |

Table 4.8-2

# 4.9 TRANSPORTATION OF CONCENTRATES

## CONTENTS


4.9.1 BASIS OF ESTIMATE

4.9.2 TRUCKING TO HAINES

.1 Mileage
.2 Hours
.3 Unit Weights
.4 Availability
.5 Trips per Annum
.6 Fuel Costs
.7 Running Costs
.8 Driver Costs
.9 Amortization
.10 Miscellaneous
.11 Total Trucking Costs per Rig
.12 Unit Trucking Cost

4.9.3 HAINES TO SMELTER

.1 Rates
.2 Unit Shipping Cost

4.9.4 UNIT TRANSPORTATION COSTS

Table 4.9-1 Transportation Cost Schedule

### 4.9.1 BASIS OF ESTIMATE

The costs of transporting concentrates to "market" are included in the operating costs. These costs include trucking to Haines, port costs and shipping costs.

Trucking will be contracted out. However, instead of soliciting contractors' quotations, trucking costs have been estimated based upon current labour rates and fuel prices, and on assumptions described below:

- The North Canol Road will be upgraded by the Canadian federal government to a quality capable of allowing 134,500 lb. seven axle vehicle combinations.

- Successful negotiation will be completed with the Alaskan government to allow seven axle vehicle combinations to be increased from the current 95,000 lb. limit to 134,000 lb. (as in Canada) for the 41 mile stretch from the Canadian/Alaskan border to Haines.

- 33.75 mph in summer and 22.5 mph in winter can be maintained from Mac Pass to Ross River.

- 42.5 mph in summer and 30 mph in Winter can be maintained from Ross River to Whitehorse and from Whitehorse to Haines.

- A bridge or ferry is provided across the Pelly River capable of handling 134,000 lb. seven axle combinations.

- Loads of 46.9 short tons are carried.

Port costs are based on recent rates at Skagway, Alaska.

Shipping rates are based upon current rates between the Western seaboard and Japanese ports serving smelters in that country. Unloading costs are not included.

## 4.9.2 TRUCKING TO HAINES

### .1 Mileage

| | Miles |
|---|---|
| Mac Pass to Ross River | 255 |
| Ross River to Whitehorse | 254 |
| Whitehorse to Haines | 135 |
| Total one-way | 644 |
| Return | 644 |
| Total return | 1,288 |

### .2 Hours

| | Summer | Winter |
|---|---|---|
| Loading at Mac Pass | 0.5 | 0.5 |
| Mac Pass to Ross River (33.75/22.5 mph) | 4.0 | 6.0 |
| Ferry/break | 0.5 | 0.5 |
| Ross River to Whitehorse (42.5/30 mph) | 6.0 | 8.5 |
| Break | 0.5 | 0.5 |
| Whitehorse to Haines (42.5/30 mph) | 6.0 | 8.5 |
| Unloading at Haines | 0.5 | 0.5 |
| Total one-way | 18.0 | 25.0 |
| Return | 18.0 | 25.0 |
| Total Return Trip | 36.0 | 50.0 |

### .3 Unit Weights

Based upon successful negotiation with Alaskan Government to allow seven axle vehicle combination to be increased from current 95,000 lb. to 134,500 lb. (as in Canada) for the 41 mile stretch from the border to Haines terminal:

| | |
|---|---|
| - Tractor | 22,000 lbs. |
| - Trailer | 14,500 lbs. |
| - Containers | 4,200 lbs. |
| - Payload | 93,800 lbs. |
| Total | 134,500 lbs. |

.4 Availability

Maintenance and heavy repairs = 5.5 days/month
= 66 days p.a.
= 1,584 hrs. p.a.

Running Repairs = 3 hrs./week
= 150 hrs. p.a.

Available time, 50 weeks p.a. = 350 x 24 - 1,584 - 150
= 6,666 hrs. p.a.

.5 Trips p.a.

Summer turnaround = 36.0 hrs. + 2 hrs. contingency
= 38.0 hrs.

Winter turnaround = 50.0 hrs. + 2 hrs. contingency
= 52.0 hrs.

No. of trips per Summer Season:
= 6,666 x 5 months p.a.
= 6,666 x 5/12
= 73

No. of trips per Winter Season:
= 6,666 x 7 months p.a.
= 6,666 x 7/12
= 75

Total number of trips p.a. = 73 + 75 = 148 per rig.

.6 Fuel Costs

| | | |
|---|---|---|
| Diesel Fuel - base | 38.00¢/l. | 38.40¢/l. |
| - F.S.T. | 3.45¢/l. | 3.49¢/l. |
| - Yukon Tax | 5.20¢/l. | 5.20¢/l. |
| Total | 46.65¢/l. | 47.09¢/l. |
| Equivalent | $2.12/gal. | $2.14/gal. |

| | | |
|---|---|---|
| Consumption - 1,018 miles Hiway @ 3.9 mpg | $ 553.37 | $ 558.59 |
| - 270 miles gravel @ 3.5 mpg | 163.54 | 165.09 |
| - Per Trip | $ 716.91 | $ 722.68 |
| - Annually | $52,334.43 | $54,201.00 |

- $106,535 p.a. per rig.

.7 Running Costs

Tractor
- tires - 6¢/mile
- repairs - 25¢/mile

Trailer
- tires - 9¢/mile
- repairs - 13¢/mile

Containers
- repairs - 2¢/mile

Tie-downs
- repairs - 1¢/mile

56¢/mile

Annual cost = 1,288 miles x 56¢ x 148 trips

= $106,479 per rig.

.8 Driver Costs

| | Summer 360 hrs. | Winter 50.0 hrs. |
|---|---|---|
| Hourly rate: $14.60/hr. | $ 525.60 | $ 730.00 |
| Mileage rate: $0.45/mile | $ 579.60 | $ 579.60 |
| Overtime: mileage + 0.5 hr/d. | $ 58.40 | $ 1,396.60 |
| Cost per Trip | $ 1,163.60 | $ 1,396.60 |
| No. of Trips per rig | 73 | 75 |
| Seasonal Cost per rig | $84,942.80 | $104,745.00 |

Annual cost per rig $189,687 p.a.

.9 Amortization

| | | |
|---|---|---|
| Tractor | - $96,000 x 80% over 3 years | = $25,600 |
| Trailers (2) | - $48,000 over 8 years | = $ 6,000 |
| Containers(2) | - $20,000 over 8 years | = $ 2,500 |
| Amortization per rig | | $34,100 pa |

.10 Miscellaneous Costs

| | | |
|---|---|---|
| U.S. Fees | Allow | $2,500 p.a. |
| Cleaning | Allow | $2,000 p.a. |
| Other | Allow | $2,500 p.a. |
| | | $8,000 p.a. |

.11 Total Trucking Costs Per Rig

Cost of operating one rig for one years is:

| | |
|---|---|
| - Fuel | $106,535 |
| - Running Costs | $106,749 |
| - Driver | $189,687 |
| - Amortization | $ 34,100 |
| - Misc. | $ 8,000 |
| | $445,071 p.a. |

.12 Unit Trucking Cost

Unit cost

= $445,071/148 trips of 46.9 short tons

= $64.12 per short ton

### 4.9.3 HAINES TO SMELTER (JAPAN)

.1 Rates

Dock Handling:

Dock Handling Cost = $7.26 per short ton (Cdn)

Ocean Freight:

Ocean freight cost from Haines, Alaska to Japan (20,000 metric tonne vessel) = $15.00 US per tonne. At an exchange rate of 0.74 the Ocean Cost = $18.37 per short ton

.2 Unit Shipping Cost

Unit Shipping Cost = Dock Handling + Ocean Freight

= $7.26/ton + $18.37/ton

= $25.63 per short ton

### 4.9.4 TOTAL UNIT TRANSPORTATION COSTS

Total Unit Transportation Cost

= Unit Trucking Cost + Unit Shipping Cost

= $64.12/ton + $25.63/ton

= $89.75 per short ton

## TRANSPORTATION COST SCHEDULE

| Year | Concentrate Tonnage (Short Tons) Dry | Wet (8% Moist) | Truck Cost $000's | Shipping Cost $000's | Total Cost $000's |
|---|---|---|---|---|---|
| 0 | - | | | | |
| 1 | - | | | | |
| 2 | 183,422 | 198,096 | 12,702 | 5,077 | 17,779 |
| 3 | 334,105 | 360,833 | 23,137 | 9,248 | 32,385 |
| 4 | 358,124 | 386,774 | 24,800 | 9,913 | 34,713 |
| 5 | 335,098 | 361,906 | 23,205 | 9,276 | 32,481 |
| 6 | 340,353 | 367,581 | 23,569 | 9,421 | 32,990 |
| 7 | 295,531 | 319,173 | 20,465 | 8,181 | 28,646 |
| 8 | 210,218 | 227,035 | 14,557 | 5,819 | 20,376 |
| 9 | 223,847 | 241,755 | 15,501 | 6,196 | 21,697 |
| 10 | 311,430 | 336,344 | 21,566 | 8,621 | 30,187 |
| 11 | 273,910 | 295,823 | 18,968 | 7,582 | 26,550 |
| 12 | 238,781 | 257,883 | 16,535 | 6,610 | 23,145 |
| 13 | 181,292 | 195,795 | 12,554 | 5,019 | 17,573 |
| 14 | 244,979 | 264,577 | 16,965 | 6,781 | 23,746 |
| 15 | 95,156 | 102,768 | 6,589 | 2,634 | 9,223 |

Table 4.9-1

# 4.10 ADMINISTRATION COSTS (WHITEHORSE)

## CONTENTS

4.10.1 BASIS OF ESTIMATE

Table 4.10-1 Summary Administration Costs (Whitehorse)

Table 4.10-2 Personnel Costs

Table 4.10-3 Supplies

### 4.10.1 BASIS OF ESTIMATE

Administrative services not provided at the mine-site are handled from a Whitehorse office. This section coverd the cost of operating that office. For financial purposes a further allowance of 1% of total operating cost is made for head office costs which are not included in this section.

SUMMARY - ADMINISTRATION COSTS (WHITEHORSE)

| | Year 2 | Years 3 - 14 | Year 15 |
|---|---|---|---|
| Personnel | 170,430 | 340,860 | 134,723 |
| Supplies | 970,000 | 750,000 | 395,000 |
| Total | 1,140,430 | 1,090,860 | 529,723 |

Table 4.10-1

## 4.10 ADMINISTRATION COSTS (WHITEHORSE)

### PERSONNEL

| Supervisory/Staff | Number | Rate | Benefits %---p.a. | | Annual Cost | Total Cost |
|---|---|---|---|---|---|---|
| Administration Mgr. | 1 | 50,000 p.a. | 15 | 7,500 | 57,500 | 57,500 |
| Accountant | 1 | 42,000 p.a. | 15 | 6,300 | 48,300 | 48,300 |
| Purchasing Agent | 1 | 36,000 p.a. | 15 | 5,400 | 41,400 | 41,400 |
| Director Personnel | 1 | 40,000 p.a. | 15 | 6,000 | 46,000 | 46,000 |
| | 4 | | | | | 193,200 |

| Local Staff | | Rate | Annual Rate | | | | |
|---|---|---|---|---|---|---|---|
| Accounting Clerks | 3 | 1,800/month | 21,600 | 15 | 3,240 | 24,840 | 74,520 |
| Personnel Assistant | 1 | 1,500/month | 18,000 | 15 | 2,700 | 20,700 | 20,700 |
| Travel Coordinator | 1 | 1,500/month | 18,000 | 15 | 2,700 | 20,700 | 20,700 |
| Secretary | 1 | 1,250/month | 15,000 | 15 | 2,250 | 17,250 | 17,250 |
| Typist/Telex Operator | 1 | 1,050/month | 12,600 | 15 | 1,890 | 14,490 | 14,490 |
| | 7 | | | | | | 147,660 |
| Department Total | 11 | | | | | | 340,860 |

| | | Year 2 | | Years 3 - 14 | | Year 15 | |
|---|---|---|---|---|---|---|---|
| Supervisory Staff | Cost p.a. | Months | Cost p.a. | Months | Cost p.a. | Months | Cost p.a. |
| Administration Mgr. | 57,500 | 6 | 28,750 | 12 | 57,500 | 9 | 43,125 |
| Accountant | 48,300 | 6 | 24,150 | 12 | 48,300 | 12 | 48,300 |
| Purchasing Agent | 41,400 | 6 | 20,700 | 12 | 41,400 | 6 | 20,700 |
| Director Personnel | 46,000 | 6 | 23,000 | 12 | 46,000 | 6 | 23,000 |
| | 193,200 | | 96,600 | | 193,200 | | 43,125 |
| Local Staff | | | | | | | |
| Accounting Clerks | 74,520 | 6 | 37,260 | 12 | 74,520 | 9 | 55,890 |
| Personnel Assistant | 20,700 | 6 | 10,350 | 12 | 20,700 | 3 | 5,175 |
| Travel Coordinator | 20,700 | 6 | 10,350 | 12 | 20,700 | 6 | 10,350 |
| Secretary | 17,250 | 6 | 8,625 | 12 | 17,250 | 9 | 12,938 |
| Typist/Telex Operator | 14,490 | 6 | 7,245 | 12 | 14,490 | 6 | 7,245 |
| | 147,660 | | 73,830 | | 147,660 | | 91,598 |
| Department Total | 340,860 | | 170,430 | | 340,860 | | 134,723 |

Table 4.10-2

SUPPLIES

| | | Year 2 | Years 3 - 14 | Year 15 |
|---|---|---|---|---|
| Office Supplies | Allow | 15,000 | 20,000 | 5,000 |
| Office Lease | Allow | 40,000 | 50,000 | 40,000 |
| Communications (2 hrs./d./person) | | 165,000 | 330,000 | 220,000 |
| Computer Service | Allow | 100,000 | 100,000 | 50,000 |
| Recruiting Expenses | Allow | 500,000 | 100,000 | 0 |
| Travel | Allow | 50,000 | 50,000 | 20,000 |
| Legal Counsel | Allow | 50,000 | 50,000 | 50,000 |
| Miscellaneous | Allow | 50,000 | 50,000 | 10,000 |
| Total | | 970,000 | 750,000 | 395,000 |

Table 4.10-3

TOM/JASON PROJECT

## SECTION 5 - WORKING CAPITAL ESTIMATE

TABLE OF CONTENTS


5.1 SUMMARY

5.2 BASIS OF ESTIMATE

5.3 CALCULATIONS

## 5.1 SUMMARY

The total working capital requirement is estimated to be $20.2 million as follows:

| | $ Cdn (millions) |
|---|---|
| Concentrate Inventory Production Costs (3.6 months) | $15.2 |
| Spares/Supplies Inventory | 4.0 |
| Work in Progress | 1.0 |
| Total Working Capital | $20.2 |

## 5.2 BASIS OF ESTIMATE

Working capital is required to fund the operation until cash flow is realized from concentrate sales. Items which must be financed from working capital are:

1. Operating costs while concentrate inventory is produced, shipped to the smelter and paid for under the contract terms.

2. Inventories of spare parts and operating supplies.

3. In-process product inventory.

## 5.3 CALCULATIONS

### Operating Costs

Assume lead and zinc concentrates are shipped separately in 20,000 ton vessels. At the initial production rate of 174,000 tons/year Pb concentrate and 160,000 tons/year Zn concnetrate, the time to produce the first shipments are:

| | | |
|---|---|---|
| Pb Concentrate - 20,000/174,000 x 365 days | = | 42 days |
| Zn Concentrate - 20,000/160,000 x 365 days | = | 46 days |
| | Say | 45 days |

| | | |
|---|---|---|
| Transit time for the concentrates to reach the smelter: Load time | | 5 |
| Travel time | | 10 |
| Unload time | | 3 |
| | | 18 days |

| | |
|---|---|
| Contract payment terms - from receipt | 30 days |

| | |
|---|---|
| Subtotal | 93 days |
| 15% Contingency | 14 |

| | |
|---|---|
| Total days operation to be financed by working capital | 107 days |
| | Approx. 3.6 months |

For Year 3 operating costs are $4.22 million per month and therefore the working capital required = 3.6 x $4.22 = $15.2 million

Spares/Supplies Inventory

This is estimated to be $4.0 million.

Inventory In Process

Allow 1 week operating cost = $1.0 million.