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Consulting Engineers



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December 10, 1986

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Project: 62502

Mr. T. Van Wollen
Project Manager
Surf Inlet Mines Ltd.
701 - 744 West Hastings Street
Vancouver, B.C.
V6C 1A5

Dear Mr. Van Wollen:

Surf Inlet Mines Tailings Disposal Options

At the request of Mr. Art Freeze we have carried out a preliminary evaluation of tailings disposal options for the proposed Surf Inlet Mines project on Princess Royal Island. Our work for this assignment consisted of a visit to the site on 31 October/1 November 1986, followed by an office review of alternative disposal options and discussions with Norecol Environmental Consultants Ltd. The field reconnaissance was limited to an inspection of the waste dumps and old mill area. An aerial inspection by helicopter was not practicable due to low cloud level.

1.0 ORIGINAL MINE

The prospectus report notes that "development of the Surf Inlet property began as early as the turn of the century and production continued until 1926. The mine re-opened and produced gold between 1936 and 1942. In 1946 and 1947, the Pugsley Mine was dewatered and approximately 57,000 tons of gold ore was outlined. The mine has remained closed since 1947.

Surf Inlet Mines Ltd. has an option to re-develop the property, and the company has initiated a pre-feasibility study. Studies carried out to date indicate that known and potential ore reserves exist in both the Surf and Pugsley ore zones. Lower grade ore is also available within the stockpiles and waste dumps which are suitable for processing. In addition, the re-processing of low grade tailings material obtainable from the mouth of Paradise Creek at Bear Lake is a possible source of revenue."

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2.0 TAILING CHARACTERISTICS

The prospectus for the Surf Inlet Mine indicates that a total of approximately 1,300,000 tons of tailings will be produced, as a result of processing:

Original Waste Dump	300,000 tons
Original Tailings (Bear Lake)	950,000 tons
New underground operations	<u>57,000 tons</u>

Total 1,307,000 tons

For evaluation of tailings disposal alternatives we have considered that an additional 1,000,000 tons of tailings may become available from future underground mining operations. Hence the total tailings for the project may amount to approximately 2,300,000 tons.

It is proposed that the mill will operate at 300 tons/day. Consequently for planning purposes the mine life may range from 12 to 22 years.

Recent studies indicate the tailings will not be acid generating and will not contain cyanide, mercury or arsenic. Recent water quality tests, by Norecol Environmental Consultants Ltd., performed on samples taken from below the existing waste rock dumps indicate the rock is not acid generating.

Based upon processing 1,300,000 or 2,300,000 tons, and an assumed settled dry density of 1440 kg/m³, the total volume of tailings is estimated to occupy approximately 800,000 or 1,500,000 cubic metres.

We understand the tailings from the mill will contain at least 60% passing the #200 sieve size.

3.0 TAILINGS STORAGE OPTIONS

3.1 Sites Considered

A general layout plan of the project area is shown on drawing 62502-1. The following sites have been considered for possible tailings storage.

Mill Site	<i>This may well be the new mill-site? -?</i>	land disposal on the west-facing side hill slope, immediately down hill of the old mine
Paradise Fan	-	land disposal on the south-facing colluvial fan approximately 700 m east of the old mine
Paradise Creek Valley	-	land disposal along the north side of the Paradise Creek Valley
Paradise Lake	-	underwater disposal
Bear Lake	-	underwater disposal

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3.2 Mill Site: Side Hill impoundment

Estimated Storage Volume:	950,000 m ³
Estimated Embankment Volume:	1,700,000 m ³
Proposed Impoundment Crest:	elev. 100 m

Physical Features of the Site:

Heavily treed west-facing slope immediately south of mine; slope ranges from approximately 5H to 1V to 2.5H to 1V. A veneer of glacial moraine deposits overlies bedrock. Bedrock is expected to be within a few metres from ground surface. The toe of the proposed embankment may encroach upon Paradise Creek. Intermittent creek(s) drain south across the area. There is evidence of old rockfalls and debris flows on the east side of Paradise Creek.

3.3 Paradise Fan: Sidehill Impoundment

Estimated Storage Volume:	1,200,000 m ³
Estimated Embankment Volume:	1,300,000 m ³
Proposed Impoundment Crest:	elev. 100 m

Physical Features of the Site:

Heavily treed south-facing slope approximately 700 m east of mine, formed as a fan from two mountain creeks which drain into Paradise Lake. Slopes typically are about 5H to 1V. Surficial soils consist of colluvial sands, gravels and boulders of unknown depth. The two main creeks which form the fan are presently situated along the east and west boundaries. There is evidence of numerous drainage and outwash channels within the fan.

We anticipate that granular materials deposited in the fan are in a loose to medium dense state. Consequently they may be susceptible to liquefaction during an earthquake, which would affect the integrity of a tailings impoundment at this site.

3.4 Paradise Valley: Sidehill Impoundment

Estimated Storage Volume:	2,000,000 m ³
Estimated Embankment Volume:	2,700,000 m ³
Proposed Impoundment Crest Elevation:	90 m

Physical Features of the Site:

Heavily treed south-facing slope in Paradise Creek Valley, west of mine site. The hillside slope ranges from about 8V to 1 HV 2V to 1. Channels of Paradise Creek occupy the valley floor. A site located on the north-facing slope of Paradise Valley would have similar characteristics.

8H 1V 2H 51V

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3.5 Paradise Lake: Underwater Disposal

Lake Depth: unknown
Lake area: in excess of 600,000 m²

If we assume that the average depth of Paradise Lake is 15 m, deposition of 800,000 m³ of tailings into the lake would occupy about 10% of the lake volume, or about 20% for 1,500,000 m³ of tailings.

3.6 Bear Lake: Underwater Disposal

Lake depth depth 24 m measured at outflow to Paradise Creek.
Lake area in excess of 5,000,000 m².

The mouth of Paradise Creek presently contains tailings deposited during 1926 to 1942. The prospectus for the new mine plan includes reclaiming these old tailings. Hence, Bear Lake will be disturbed as a result of dredging the existing tailings.

It was assumed that the average depth of Bear Lake is 15 m, deposition of 800,000 m³ of tailings would occupy about 1% of the lake volumes, or about 2% for 1,500,000 m³ of tailings.

4.0 DISCUSSION

4.1 On-Land Disposal

The topography on Princess Royal Island is rugged mountainous terrain, with steep valley walls. The surficial soils in the lower elevations consist of glacial moraine deposits and colluvial fans overlying bedrock. The island is covered by numerous lakes and mountain creeks. The area is subject to high precipitation. Nearby records indicate the total annual precipitation is of the order of 2000 mm, with a maximum 24-hr. precipitation of 100 mm. The records indicate that measurable precipitation falls about 200 days annually. The volume of water carried in the mountain creeks will vary considerably throughout the year. In the study area the mountain creeks carry large boulders and cobbles and there is evidence of lateral creek bed movements.

unpractical
Consequently any on-land tailings impoundment facility has to be designed to cope with the natural hazards of the area, both during mining operation and after closing down the mine. These natural hazards are high precipitation, active mountain creeks, rock falls and debris slides.

Princess Royal Island is situated in the area of high seismic risk, consequently impoundment embankments would require to be designed to withstand high seismic shocks.

4.2 Tailings Storage Capacities

As noted in Section 2.0, the required storage capacities are approximately 800,000 m³ for the present needs with a possible extension to 1,500,000 m³ for a continuation of underground mining operations.

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Estimated storage capacities and embankment volumes for the tailing solids for the three on-land tailing alternatives and natural hazards for each site are summarized on the attached table. Included on the table is information on underwater disposal in either Paradise or Bear Lakes which indicate the probable depth of deposits and a percentage of lake bed area that may be affected by underwater disposal.

The data included in the table is considered suitable, at this time, for comparing tailings deposition alternatives. We believe that for on-land disposal:

- Paradise Fan should be eliminated from consideration due to the highly active creek activity on the fan which could conceivably wash the impounded into Paradise Lake and the potential for liquefaction of the subsoils in the alluvial fan deposits.
- Mill Site has the only capacity for the proposed initial mining operations. A second site will be required for if underground mining is re-activated.
- Paradise Valley could have the capacity for the total proposed mining operations. Relocation and control of Paradise Creek will be necessary.

The preliminary study does indicate that utilization of any of the on-land disposal sites will require large quantities of suitable borrow materials for embankment construction. The estimated volume in the embankment is about the same as the volume of stored tailings. The mill grind will produce tailings with at least 60% passing the #200 sieve size which is considered not suitable for embankment construction. Our preliminary reconnaissance of the study area indicates that the Paradise Fan is the only potential and practical source of borrow material. We estimate that utilization of the colluvial deposits in the Paradise Fan site may provide about 2,400,000 cu m³. Development of this active fan, however, is likely to cause major slides into Paradise Lake after removal of materials.

For underwater disposal, only Paradise and Bear Lakes are conveniently located close to the mine.

If Paradise Lake was used, most of the lake area upstream of the Paradise Creek outlet could be utilized for tailings disposal. We believe that by careful management of tailings deposition a minimum water depth of about 10 m may be possible after mining. The fishing values would be destroyed during tailings deposition. Based upon experience at Bear Lake, however, we believe that Paradise Lake can be rehabilitated after mine closure. The Paradise Creek outlet provides the single discharge point to monitor water quality to ensure that the required standards are met.

Bear Lake was historically used for tailings disposal and it has a fishery value today. Dredging of the original tailing deposits will disturb the lake. Depositing tailings into Bear lake would only occupy

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a relatively small volume of the lake capacity. There is, however, the possibility that water quality standards may be more difficult to control and achieve over this large body of water during mining operations.

5.0 CONCLUSIONS AND RECOMMENDATIONS

A preliminary reconnaissance has been made at the Surf Inlet Mines project to establish potential sites for tailings storage. We understand the tailings will not generate acid or toxic wastes. Three sites for on-land disposal were identified and two lakes for underwater disposal.


For on-land disposal the rugged topography and mountain creeks in the study area permits only the use of sidehill impoundments. The Paradise Valley site is considered to be the only possible site for an on land tailings impoundment. Development of this site will require large quantities of borrow material, (approximately 2,000,000 m³), it has the potential storage capacity for 800,000 m³ and further extension to in excess of 1,500,000 m³. almost equal to the estimated volume of tailings. At present, the only identified borrow material is the Paradise Fan. Development of the fan is expected to be difficult due to the presence of two mountain creeks which carry materials onto the fan.

For underwater disposal, either Paradise and Bear Lake could be used. Disposal of tailings into lakes is ^{presently} not readily accepted by the regulatory agencies. Consequently any lake disposal scheme would include a careful study of the hydrology, bathymetry, and water quality of the lake.

At this stage, before more detailed studies are made on either land or lake disposal, we recommend the contents of this preliminary evaluation be reviewed by yourselves and Norecol Environmental Consultants Ltd. Following this review, we believe it would then be prudent to meet with the necessary government agencies and obtain their input on both land and lake disposal alternatives.

Yours truly,

STEFFEN ROBERTSON & KIRSTEN (B.C.) INC.


J.W. Gadsby, P.Eng.
Director

*Looks like a good
storage site with
6. costley sand
problems as low
mine is close*

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Steffen Robertson and Kirsten
Summary of Tailing Disposal Options November 1986

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TAILING SITE	IMPOUNDMENT TYPE	ELEVATION AT CREST	ESTIMATED STORAGE CAPACITY (M3)	ESTIMATED EMBANKMENT VOLUME (M3)	REMARKS
Mill site	Sidehill	100 m	950,000	1,700,000	<ul style="list-style-type: none"> - toe close to Paradise Creek - receives uphill drainage - evidence of rockfall to the west
Paradise fan	Sidehill	100 m	1,200,000	1,300,000	<ul style="list-style-type: none"> - located on active fan with two mountain creeks with evidence of creeks meandering over the fan
Paradise Valley	Sidehill	90 m	2,000,000	2,700,000	<ul style="list-style-type: none"> - control of Paradise Creek channel required - receives uphill drainage - evidence of rockfall to the east
		Lake Depth	Surface Area (M2)		
Paradise Lake		unknown	600,000	Underwater Deposition of 800,000 m3 deposit would leave a deposit about 1.3 m thick and 1,500,000 m3 about 2.5 m thick	Lake not previously disturbed
Bear Lake	Underwater	24 m at outflow of Paradise Creek	5,000,000	Deposition of 800,000 m by 1 m thick will cover approximately 16% of lake bed, and 1,500,000 m3 approximately 30% of the lake bed.	Lake previously disturbed by deposition of tailings up to 1942. Present prospectus requires removal of approximately 950,000 tons of tailings which will disturb the lake.

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